CITY ZONING COMMISSION
AGENDA-Tuesday, October 5, 2021, 4:30 p.m.
Miller Building, 1st Floor Conference Room
2825 3rd Avenue North, Billings, Montana

The City Zoning Commission will hold its public hearing in the 1st Floor Conference Room at 2825 3rd Avenue North (Miller Building). All interested persons are invited to attend in person or view the meeting on-line on the Billings-Planning & Community Services Facebook Page here; https://www.facebook.com/Billings-Planning-Community-Services-Department-1738982159659260/?ref=bookmarks .
A public comment phone line is available for on-line viewers to provide testimony during the specific Public Comment periods announced by the Chairman during the hearings. The call in phone number is (406)237-6165. All callers will be in a queued system and are asked to remain on hold and be patient. Calls will be taken in the order in which they are received. Callers will be restricted to 3 minutes of testimony as is customary.

Call the meeting to order.

Introduction of City Zoning Commission Members and Planning Department Staff.

Public Comment

Approval of Minutes:

The minutes of the Board meeting of September 7, 2021.

Disclosure of any Conflict of Interest-Members of the Commission and Staff

Disclosure of an Outside (Ex Parte Communication)-Members of the Commission and Staff
a.The Exparte Communication Binder is available at the Sign-In and Agenda Station.

Regular Business:

A. Opening of public hearings.

B. Reading of rules for the procedure by which the public hearings will be conducted.

C. Reading of notices of the public hearings on the following items:

Public Hearings:

a. **City Zone Change 999 -733 S 31st St W- CMU1 to CMU2** - A zone change request from Corridor Mixed Use 1 (CMU1) to Corridor Mixed Use 2 (CMU2) on Lot 4, Block 16A of Lampman Subdivision, an 62,464 Square foot parcel of land. A pre-application neighborhood meeting was held on August 12, 2021, at 733 S. 31st Street. Tax ID: A290320

b. **City Zone Change 1000- 436 Wicks Lane- N2 to NO** - From N2 to NO - A zone change request from Mid-Century Neighborhood (N-2) to Neighborhood Office (NO), on Lot 10, Block 1 of Arrowhead Subdivision, a .288 acre parcel of land. A pre-application neighborhood meeting was held on August 25, 2021, via Zoom virtual meeting. Tax ID: A02533A

c. **Zone Change 1001 - Text Amendment for Marijuana Business Regulations**-- a zoning text amendment initiated by the City Council on September 13, 2021, to allow marijuana businesses within the city limits in certain zone districts, and to establish use standards that include separation distances from parks, churches, schools, day care centers, youth centers and residential zones.

Other Business/Announcements

Adjournment

The City Council has designated Monday, October 25, 2021, at 5:30 p.m. as the date and time to receive the Zoning Commission recommendation and **conduct a public hearing for the first reading of the ordinance for this zone change** request. If approved on first reading, a **second reading public hearing will occur on Monday, November 8, 2021 at 5:30 pm.**

Before taking any action on an application for a **zone change**, the City Council shall first consider the findings and recommendations of the City Zoning Commission. In no case shall the City Council approve a zone change other than the one advertised. The City Council shall take one of the following actions on the zone change requests: 1) approve the application; 2) deny the application; 3) allow withdrawal of the application; or 4) delay the application for a period not to exceed thirty (30) days.

As provided in Montana Code Annotated, Section 76-2-305(2), in the event of a protest petition against such **zone change** signed by the owners of twenty-five (25) percent or more of: (1) the area of the lots included in any proposed change; or (2) those lots or units, as defined in MCA 70-23-102, **one hundred fifty (150) feet from a lot included in a proposed change**, such proposed amendment shall not become effective except by the favorable vote of two-thirds (2/3) of the present and voting members of the city council. For purposes of this protest provision interest in the common elements of the condominium, as expressed in the declaration, included in the calculation of the protest. If the property, as defined in 70-23-102, spans more than one lot, the percentage of the unit owner's undivided interest in the common elements must be multiplied by the total number of lots upon which the property is located. The percentage of the unit owner's undivided interest must be certified as correct by the unit owner seeking to protest a change or by the presiding officer of the association of unit owners. The protest petition must be received in the Planning Division office **by 5:00 p.m. on the Friday preceding the first reading of the ordinance by the City Council**.

Testimony regarding the above-mentioned item may also be submitted in writing to the Planning Division, 2825 3rd Avenue North, 4th Floor, Miller Building, Billings, MT 59101 (247-8676) or to the Mayor and City Council, P.O. Box 1178, Billings, MT 59103.

Additional information on any of these items is available in the Planning and Community Services Office. Public hearings are accessible to individuals with physical disabilities. Special arrangements for participation in the public hearings by individuals with hearing, speech, or vision impairment may be made upon request at least three days prior to the hearing. Please notify Robbin Bartley, Administrative Assistant, at 247-8676 or e-mail to bartleyr@billingsmt.gov

City Zoning Commission
Meeting Date: October 5, 2021

Information

Subject
The minutes of the Board meeting of September 7, 2021.

Attachments

BZC_2021_0907

City of Billings Zoning Commission
Meeting Minutes September 7, 2021

The City of Billings Zoning Commission met on Tuesday, September 7, 2021 at 4:30 p.m., 2825 3rd Avenue North in the Miller Building 1st Floor Conference Room. The public may attend in person or watch the meeting live on Facebook (see below). The Public may call in during specific Public Comment periods at **(406) 237-6165**. All callers will be in a queued system and are asked to remain on hold and be patient. Calls will be taken in the order in which they are received. Callers will be restricted to 3 minutes of testimony as is customary. Comments may be sent to **Board via email before 1:00 PM on Tuesday, September 7, 2021**. All e-mails received prior to this time will become part of the record for the public hearing. Live coverage can be viewed on the City of Billings Facebook page here; https://www.facebook.com/Billings-Planning-Community-Services-Department-1738982159659260/?ref=bookmarks

The City Council has designated Monday, September 27, 2021, at 5:30 p.m. as the date and time to receive the Zoning Commission recommendation and **conduct a public hearing for the first reading of the ordinance for this zone change** request. If approved on first reading, a **second reading public hearing will occur on Monday, October 11, 2021 at 5:30 pm.**

Commission and Staff		**01/05/2021**	**02/02/2021**	**03/02/2021**	**04/06/2021**	**05/04/2021**	**06/01/2021**	**07/06/2021**	**08/03/2021**	**09/07/2021**	**10/05/2021**	**11/02/2021**	**12/07/2021**
Mike Larson	Chairman	1	1	E	1	1	1	1	1	1			
Daniel J. Brooks	Commissioner	1	1	1	1	1	E	1	1	1			
VACANT	Commissioner	1	1	1	1	1	1	1	1	-	-	-	-
Greg McCall	Vice Chairman	E	1	E	E	E	E	1	E	1			
Trina White	Commissioner	1	1	1	A	1	1	1	1	1			
Wyeth Friday	Director, Planning & Community Services	-	-	-	-	-	1	-	-	-			
Monica Plecker	Division Planning Manager	-	-	-	-	-	-	-	-	-			
Nicole Cromwell	Planner, Zoning Coordinator	1	1	1	1	1	1	1	1	1			
Tammy Deines	Planning Clerk	-	-	-	-	-	-	1	-	-			
Dave Green	Planner II	-	-	-	-	-	-	-	-	-			
Karen Husman	Planner I	1	1	1	-	-	1	1	1	-			
Robbin Bartley	Administrative Support	1	1	1	1	1	1	-	1	1			

Total Number of 2021 Applications	01/05/2021	02/02/2021	03/02/2021	04/06/2021	05/04/2021	06/01/2021	07/06/2021	08/03/2021	09/07/2021	10/05/2021	11/02/2021	12/07/2021	TOTAL
Zone Change	-	2	1	1*	1	2	0	4	1				12
Special Review	2	0	0	0	0	0	1	0	0				3

Chairman Larson introduced the Planning Division Staff and Commission: Attending Staff were Nicole Cromwell, Zoning Coordinator, Karen Husman, Planner I and Robbin Bartley, Administrative Assistant (Virtually)

Attending:

Public Comment

Chairman Larson called for public comments. There were no public comments. Chairman Larson closed the public comment portion of the meeting.

Approval of Minutes: August 3, 2021

Commissioner Brooks made a motion and Commissioner White seconded the motion to approve the August 3, 2021 meeting minutes with changes to the conflict of interest from Yes to No for all commissioners. The motion carried with a unanimous voice vote.

Disclosure of Conflict of Interest

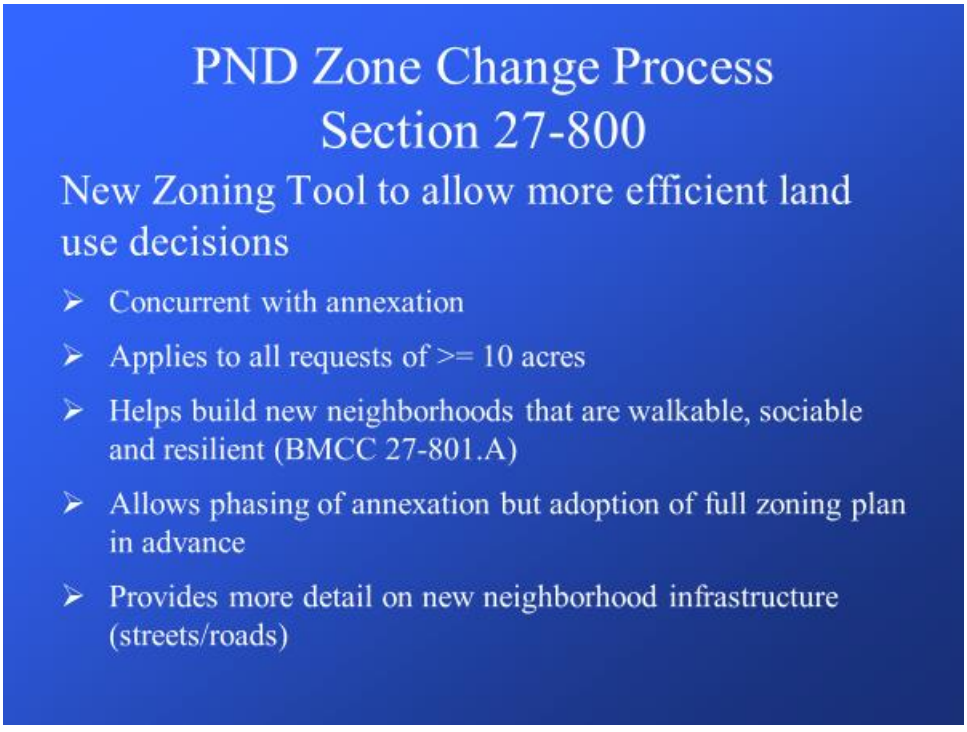
COMMISSIONER	Yes	No	ABSTAINED	ABSENT
Mike Larson		X		
Daniel J. Brooks		X		
VACANT				
Greg McCall		X		
Trina White		X		

Disclosure of Outside Communication

COMMISSIONER	Yes	No	ABSTAINED	ABSENT
Mike Larson		X		
Daniel J. Brooks		X		
VACANT				
Greg McCall		X		
Trina White		X		

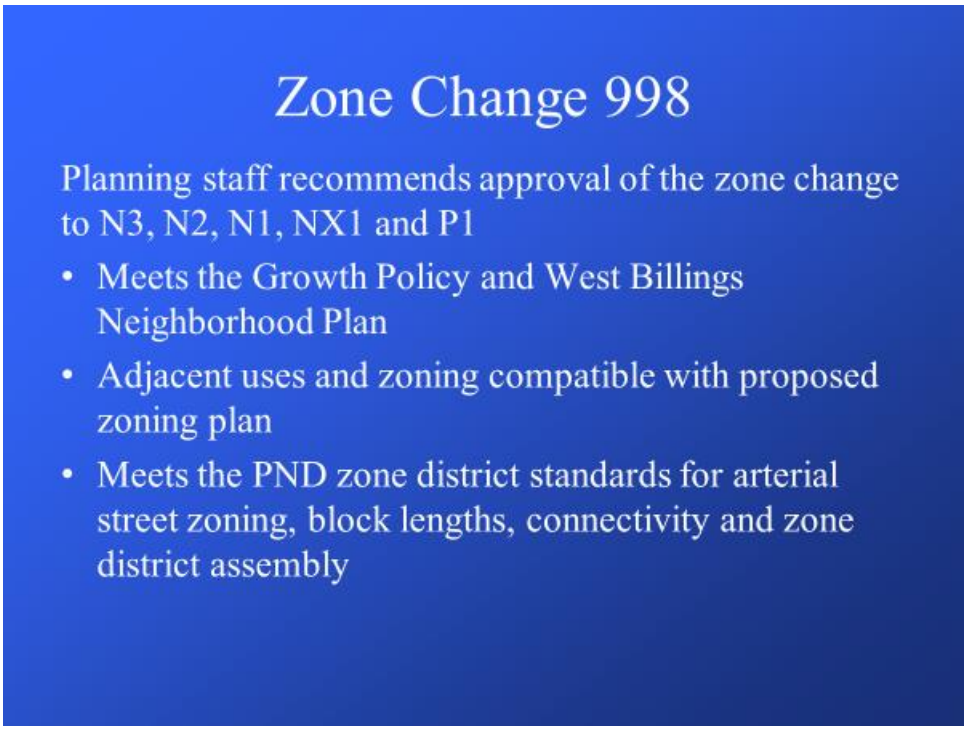
Public Hearings:

City Zone Change 998 – South of Sweet Grass Creek Dr, West of 54th St. W, East of 58th St. W & North of High Ditch - A zone change request from N4 to a Mixed Residential Planned Neighborhood Development (MR-PND) consisting of First Neighborhood Residential (N1), Mid-Century Neighborhood (N2), Suburban Neighborhood Residential (N3), Mixed Residential 1 (NX1) and Open Space, Parks and Recreation (P1) on RL Subdivision, Lot 1, 53.452 acres within the amended Block 7 Planting Area, Yellowstone Meadows Phase 3, an 53.452 acre parcel of land. A pre-application neighborhood meeting was held on July 21, 2021 at 6:00 pm in a virtual meeting format. Tax ID: C06082



Staff Recommendation:

Planning Staff recommends approval and adoption of the findings of the ten review criteria for Zone Change 998, a Mixed Residential Planned Neighborhood



Before making a recommendation to the City Council, the Zoning Commission shall consider the following findings of the ten review criteria for Zone Change
998:

(1) Whether the new zoning is designed in accordance with the growth policy;
(2) Whether the new zoning is designed to secure from fire and other dangers;
(3) Whether the new zoning will promote public health, public safety and general welfare;
(4) Whether the new zoning will facilitate the adequate provision of transportation, water, sewerage, schools, parks and other public requirements;
(5) Whether the new zoning will provide adequate light and air;
(6) Whether the new zoning will affect motorized and non-motorized transportation;
(7) Whether the new zoning will promote compatible urban growth;
(8) Whether the new zoning considers the character of the district and the peculiar suitability of the property for particular uses;
(9) Whether the new zoning will conserve the value of buildings; and
(10) Whether the new zoning will encourage the most appropriate use of land throughout the City of Billings.

1) Is the new zoning designed in accordance with the Growth Policy?
The proposed zone change is consistent with the following guidelines of the 2016 Growth Policy and the West Billings Neighborhood Plan (2001):

The West Billings Neighborhood Plan goals and objectives stated the need to locate compatible uses and offer a range of housing choices and development
densities. The West Billings Plan adopted a number of Goals, Policies, and Implementation Strategies. The proposed MR-PND for Sweetgrass Creek is consistent
with the following adopted Policies of Planned Growth Goal 1: Establish Development Patterns that Use Land More Efficiently
Policy R "Encourage innovative land-use planning techniques to be used in building higher density and mixed-use developments as well as infill developments."
The proposed MR-PND is compatible with goals of the West Billings Neighborhood Plan. The proposed zone change and street layout will accommodate uses that
are compatible in a mixed-residential environment. The proposed development will also have good access to outdoor activities and is in proximity to a proposed
regional park - Cottonwood Park. 54th St West is an arterial street and neighborhood services are beginning to develop at the intersection of 54th St W and Grand Avenue.

Discussion

Commissioner White asked for explanation regarding allowable uses in M1 zoning areas. Staff explained it is residential, allowing up to 4 dwelling units.

Applicant Presentation

Chairman Larson called for presentation by the applicant.

Scott Worthington, 5948 Ironwood Drive, Billings, MT

The proposed zoning is compatible and consistent with existing zoning and usage. It is connected to existing neighborhoods with good walkability. It is an efficient and appropriate use of the land and will attract various families with various incomes.

Public Hearing: 4:50PM

Chairman Larson opened the public hearing and called for anyone wishing to speak in favor or against City Zone Change #998.

Dan Wells, 5847 Whispering Woods, Billings, MT 59106

Mr. Wells is in favor of the zone change. It has been agricultural ground. They have lifted the elevation approximately 3 feet and he is looking forward to annexation.

Mirna Clark, 2211 Stampede Drive, Gillette, WY 82718

Ms. Clark is opposed to the zone change stating she has concerns about the sale of the land, the flood plain status and how the run off will affect her land. She also stated it will be a traffic overload for Grand Ave. She feels no consideration is being given to the surrounding property owners.

Rebuttal

Scott Worthington stated statistics prove development increases the surrounding property values. Currently the traffic studies are being done. The dirt added to raise the elevation does not affect the flood plain as it is above and to the west.

Motion

Commissioner Brooks made a motion and Commissioner White seconded the motion to approve City Zone Change #998.

Discussion

Commissioner McCall appreciates the zoning. Chair Larson stated development pays for road improvement and infrustructures. Commissioner White likes the design.

COMMISSIONER	Yes	No	ABSTAINED	ABSENT
Mike Larson	X			
Daniel J. Brooks	X			
VACANT				
Greg McCall	X			
Trina White	X			

The Motion carried to approve City Zone Change #998 with a 4-0 vote.

Other Business: Next meeting review will include Marijuana Regulations in the City Limits. It may be a lengthy meeting. Ciity Council will review the limitations regarding sales and distribution in the City Limits. Applications are being received for Jack King's position on the Zoning Commission following his resignation.

Adjournment: The meeting adjourned at 5:11PM.

ATTEST: To be Approved by a motion October 5, 2021
--Robbin Bartley, Administrative Assistant

From: Karen Freeman <kafreeman2017@gmail.com>
Sent: Thursday, September 2, 2021 11:32 AM
To: Bartley, Robbin <bartleyr@billingsmt.gov>
Subject: [EXTERNAL] Zoning commission re: Sweetgrass Proposed Zoning

Dear Zoning Commission,
I am writing this letter on behalf of the Clark family, who currently have 20 acres for sale directly across the street on 54th.
They would like to oppose the zone change. They feel the zone change will adversely affect their property for sale and devalue it.
They feel the added traffic to 54th will make their land difficult to sell with the street access for this development almost directly across the street from theirs.
Submitted on behalf of the Clark family,
Karen Freeman
Century 21

Sent from Mail for Windows

COMMENTS TO BILLING METROPOLITAN PLANNING ORGANIZATION, 2825 3RD AVE. NORTH, BILLINGS MT 59101' 4TH FLOOR , P 406.247.8676, (NOTE I HAVE A THIRD PART INTEREST) IN THE PROPERTY AT (2447 54TH ST W), SOUTH WEST PART OF THE NOTIFICATION AREA.

IT IS REQUESTED THAT THESE COMMENTS BECOME PART OF THE RECORD FOR THE PUBLIC HEARING OF: 7 SEPTEMBER 2021, IN ACCORDANCE WITH REFERENCED LETTER BELOW.

REFERENCE (A) BILLINGS PLANNING & COMMUNITY SERVICE LETTER, DATED 13 AUGUST 2021 , CITY ZONE CHANGE 998, PROJECT NUMBER PZX-21-00205

ZONE CHANGE FROM (N4) TO A MIXED RESIDENTIAL PLANNED NEIGHBORHOOD DEVELOPMENT (MR-PND)

NX1 MIXED RESIDENTIAL 1

NX1 DISTRICT IS INTENDED TO CONTINUE THE CHARACTER OF THE FIRST NEIGHBORHOODS WITH SINGLE FAMILY,

TWO FAMILY

AND SMALL SCALE MULITIPLE FAMILY HOMES WITH 3- 4 UNITS.

MULTIPLE FAMILY HOMES ARE INTENDED TO MATCH THE SCALE OF THE NEIGHBORHOOD SINGLE FAMILY HOMES WITH CHARACTERISTICS SUCH AS:

BUILDING WIDTH, PARKING AND GARAGES LOCATION, ROOF DESIGN, AND DOORS AND WINDOWS ON THE FRONT FACADES.

HOW MANY PARKING SPACES PER UNIT? DOES GARAGE LOCATION MEAN WITH GARAGES OR WHAT?

WHAT IS ON THE BACK FACADES?

NX2 DISTRICT IS INTENDED FOR SMALL AND MID SCALE MULTIPLE FAMILY HOMES WITH 3 TO 8 UNITS, IN SMALL NEIGHBORHOOD NODES. THE BUILDINGS ARE ORIENTED TO THE STREETS IN BLOCKS THAT MAY BE WALKED, WITH DOOR AND WINDOWS ON THE FRONT FACADES AND PARKING /GARAGES LOCATED BEHIND THE BUILDINGS.
CRITERIA (3), (4)

HOW MANY STORIES? HOW MANY BEDROOMS, HOW MANY PEOPLE CAN COMFORTABLE LIVE IN EACH? HOW MANY PARKING SPACES PER UNIT, HOW MANY GARAGE PER LOCATION?

THE SAME QUESTIONS FOR N3

HOW MANY PEOPLE WILL ULTIMATELY BE THERE? HOW LONG WILL I HAVE TO WAIT AT TRAFFIC LIGHTS AT TRAIL CREEK DRIVE , AND SWEET GRASS CREEK DRIVE ON A TYPICAL MORNING AROUND 8 AM?

WHAT IS THE EXPECTED IMPACT TO SCHOOLS? AND SCHOOL TAXES?
CRITERIA (4)

WHAT IS THE EXPECTED IMPACTED TO WATER SEWAGE TAXES?
CRITERIA (4)

WILL THERE BE STREET LIGHTING?
CRITERIA (3)

NX3: MIXED RESIDENTIAL 3
INTENDED FOR LARGE SCALE MULTIPLE FAMILY HOMES IN LARGER NEIGHBORHOOD NODES.
MAY INCLUDE LARGER APARTMENT BUILDINGS WITH MORE THAN 8 UNITS PER STRUCTURE.
HOW MANY PEOPLE WILL ULTIMATELY BE THERE? CRITERIA (3), (10)
PARKING / GARAGES LOCATED BEHIND BUILDINGS,
THIS SOUND LIKE A PARKING LOT? WITH NO GARAGES CRITERIA (3),
CENTRAL GATHERING SPACES,
WILL THEY BE LIGHTED? HIGH-DENSITY LIVING AREAS ARE A BREEDING GROUND FOR TROUBLE, MISCHIEF, FIGHTS, STEELING, KILLINGS, DRUGS... HOW WILL THESE POSSIBILITIES BE PREVENTED?
DOES THIS MEAN THAT THERE WILL BE NO PARKING ON THE MAIN STREETS.
CRITERIA (3)

RMH RESIDENTIAL MANUFACTURED HOME PROVIDE STABLE ENVIRONMENTS FOR INDIVIDUAL MANUFACTURED HOMES, MANUFACTURED HOME PARKS, AND COMPATIBLE ACCESSORY USE.
THIS IS NOT ACCEPTABLE IN A WEST BILLINGS RESIDENTIAL DEVELOPMENT. IT WILL DEVALUE THE DEVELOPMENT PROPERTY AS WELL AS THE SURROUNDING PROPERTY. CRITERIA (9), (10)

I WOULD THINK THAT THE ANSWERS TO THE QUESTIONS ABOVE SHOULD BE ANSWERED AND AGREED TO PRIOR TO ANY APPROVAL. THIS MEANS DISAPPROVE TILL THEN.

I PRAY THAT THIS WILL BE A QUIET CHRISTIAN NEIGHBORHOOD IN LINE WITH THE MORALS AND TRADITIONS OF THE CHURCH YOU ARE SURROUNDING.

KEITH C. CLARK
187 CR 3363
PARADISE, TX 76073 / 2447 54 ST W, BILLINGS, MT
(1) 817-713-3455

Zoning Commission

Date:	October 5, 2021
Title:	City Zone Change 999 -733 S 31st St W- CMU1 to CMU2
Presented by:	Karen Husman
Department:	Planning & Community Services
Presentation:	Yes

Information

RECOMMENDATION
Planning staff is recommending approval based on the findings of the 10 criteria for Zone Change 999.

REQUEST
This is a request to change zoning on property located at 733 S 31st St W just north of the Mercedes Benz car dealership on King Avenue West. The existing zoning is CMU1 and the request zoning is CMU2 on Lot 4, Block 16A of Lampman Subdivision, a 62,464 square foot parcel of land. A pre-application neighborhood meeting was held on August 12, 2021, at 733 S. 31st Street. Presented by; Karen Husman, Planner I

APPLICATION DATA
OWNER: Patricia Harvey
AGENT: WWC Engineering, Greg Reid
LEGAL DESCRIPTION: Lot 4, Block 16A, Lampman Sub.
ADDRESS: 733 S 31st St W
CURRENT ZONING: CMU1
EXISTING LAND USE: Vacant
PROPOSED USE: Additional service building and parking
SIZE OF PARCEL: 62,464 sf

CONCURRENT APPLICATIONS
None

SURROUNDING LAND USE & ZONING
NORTH: Zoning: N2
Land Use: Residential
SOUTH: Zoning: CMU2
Land Use: Auto sales
EAST: Zoning: CMU1
Land Use: Vacant
WEST: Zoning: CMU1
Land Use: Hotel

BACKGROUND (Consistency with Adopted Plans and Policies, if applicable)
This is a zone change request from Corridor Mixed Use 1 (CMU1) to Corridor Mixed Use 2 (CMU2) to allow expansion of an existing auto dealership located on the property to the south of the subject property. The applicant intends to expand the existing auto sales and service business to provide secure storage for customer vehicles and to allow some minor repair and outfitting work on those vehicles. The development will consist of a service building and parking with security fencing. The proposed zoning would allow an existing thriving automobile sales and service operation to expand their operations and better serve the community. Utilizing a vacant parcel is an excellent infill development for the property directly north of the existing dealership. This expansion will promote the economic stability of the area as well as promote infill development in this commercial are of Billings.

The proposed zoning is compatible with the adjacent zoning and existing urban growth in the vicinity. Property west of the subject parcels is zoned CMU1 and used as a hotel. Property to the south is proposing to expand the existing CMU2 use to the subject property. The proposed zoning will allow the development of the property in a strong commercial corridor, and expanding an existing business is encouraging the most appropriate use of land in the district. Supporting local business expansion is beneficial to the economic growth for the City of Billings.

STAKEHOLDERS
The applicant conducted a pre-application meeting at the subject property on August 12, 2021. Fifteen surrounding property owners and interested parties attended the pre-application meeting. The synopsis of the meeting and the attendance list are attached to this report. There were questions on traffic through the area, lighting and fencing (buffering) of the proposed development.

ALTERNATIVES
The Zoning Commission may:

- Recommend Approval of the Zone Change and adopt the findings of the 10 review criteria; or,
- Recommend Denial of the Zone Change and adopt different findings of the 10 review criteria; or,
- Delay action on the zone change request for up to 30 days; or,
- Allow the applicant to withdraw the application

- Allow the applicant to withdraw the application.

FISCAL EFFECTS

Approval or denial of the proposed zone change should not have an effect on the Planning Division budget.

SUMMARY

Prior to any recommendation to the City Council, the Zoning Commission shall consider the following:

1. Is the new zoning designed in accordance with the Growth Policy?
The proposed zone change is consistent with the following guidelines of the 2016 Growth Policy:
Prosperity (promoting equal opportunity and economic advancement)
· Predictable, reasonable City taxes and assessments are important to Billings' taxpayers
· A diversity of available jobs can ensure a strong Billings' economy
· Successful businesses that provide local jobs benefit the community
· Community investments that attract and retain a strong, skilled and diverse workforce also attracts businesses
· Retaining and supporting existing businesses helps sustain a healthy economy

The proposed zoning would allow an existing thriving automobile sales and service operation to expand its operations and better serve the community. Utilizing a vacant parcel is an excellent infill development for the property directly north of the existing Mercedes dealership south of the subject property. This expansion will promote economic stability as well as promote infill development in this commercial sector.

2. Is the new zoning designed to secure from fire and other dangers?
The new zoning requires minimum setbacks, open and landscaped areas and building separations. The new zoning, as do all zoning districts, provides adequate building separations and density limits to provide security from fire and other dangers.

3. Whether the new zoning will promote public health, public safety and general welfare?
Public health and public safety will be promoted by the proposed zoning. The proposed zoning (CMU2) would allow the owner to ensure future development is not intrusive to neighboring property, and still allow compatible uses with the adjacent CMU1 zoning.

4. Will the new zoning facilitate the adequate provision of transportation, water, sewerage, schools, parks and other public requirement?
Transportation: The proposed zoning will increase post-development traffic volume. A traffic impact study (TIS) or an update to an existing TIS may be necessary at the time of development.
Water and Sewer: The City provides water and sewer to the property.
Schools and Parks: Schools and parks should not be negatively affected by the proposed zoning. The proposed development does not include residential uses.
Fire and Police: The subject property is served by city public safety services. The Police and Fire Departments had no concerns with the zone change.

5. Will the new zoning provide adequate light and air?
The proposed zoning provides for sufficient setbacks to allow for adequate separation between structures and adequate light and air.

6. Will the new zoning effect motorized and non-motorized transportation?
Traffic generation for an auto dealership expansion may significantly impact motorized transportation. The new development will have sidewalks and will connect to other sidewalks and pedestrian facilities in the neighborhood. The new zoning designation itself should not have any increase effect on the transportation system.

7. Will the new zoning promote compatible urban growth?
The proposed zoning is compatible with the adjacent zoning and existing urban growth in the vicinity. Property west of the subject parcels is zoned CMU1 and used as a hotel. Property to the south is proposing to expand the existing CMU2 use to the subject property. The proposed zoning is compatible with the adjacent zoning and existing land uses. The zoning to the north (N2) will require screening and buffering on this property in order to mitigate any possible compatibility issues.

8. Does the new zoning consider the character of the district and the peculiar suitability of the property for particular uses?
The proposed zoning does consider the character of the district and the suitability of the property for the proposed use. The proposed zoning will allow expansion of an existing commercial use.

9. Will the new zoning conserve the value of buildings?
The new zoning is not expected to alter the value of any buildings in the area. It is not known if its proximity to residential property in the area will affect the value of residential buildings. Any development of the property will need to meet the site development requirements in the zoning code, including landscaping, screening, building heights and setbacks.

10. Will the new zoning encourage the most appropriate use of land throughout the City of Billings?
The proposed zoning will allow the development of the property in a strong commercial area, expanding an existing business is encouraging the most appropriate use of land in the district. Supporting local business expansion is beneficial to the economic growth for the City of Billings.

Attachments

Zoning Map & Site Photos
Application & Applicant Letter
Pre Application Information
Chart of zoning history

Zoning Map



Site Photos







South



South



East



North



Northeast

APPLICATION FORM

CITY ZONE CHANGE **Billings Zone Change #** 999 **- Project #** PZX-21-00223

The undersigned as owner(s) of the following described property hereby request a Zone Change as outlined in the City of Billings Zoning Regulations.

Present Zoning: Corridor Mixed Use 1 (CMU1)

Proposed Zoning: Corridor Mixed Use 2 (CMU2)

TAX ID# A290320 CITY ELECTION WARD 5

Legal Description of Property: Lot 4, Block 16A of Amended Lot 1, Block 16A, Lampman Subdivision

Address or General Location (If unknown, contact City Engineering): 733 S 31st Street W

Size of Parcel (Area & Dimensions): 294'x213' = 62,464 sqft

Present Land-Use: Vacant

Proposed Land-Use: Additional service building and parking for existing Mercedes dealership

Covenants or Deed Restrictions on Property: Yes_____ No X

If yes, please attach to application

*** Additional information may be required as determined by the Zoning Coordinator in order to fully evaluate the application.

Owner(s): Patricia Harvey

(Recorded Owner) 841 Remington Boulevard, Bolingbrook, IL 60440

(Address) 630-967-4956 pharvey@weathertech.com

(Phone Number) (email)

Agent(s): WWC Engineering - Greg Reid

(Name) 550 S. 24th Street W, Billings, MT 59102

(Address) 406-894-2210 greid@wwcengineering.com

(Phone Number) (email)

I understand that the filing fee accompanying this application is not refundable, that it pays for the cost of processing, and that the fee does not constitute a payment for a Zone Change. Also, I attest that all the information presented herein is factual and correct.

Signature: Patricia Harvey Date: 8/26/2021

(Recorded Owner)

8/27/21

Applicant Letter

(1) Whether the new zoning is designed in accordance with the growth policy;

The 2016 City of Billings Growth Policy, states that growth will be managed by "encouraging development within and adjacent to the existing City limits, but preference will be given to areas where City infrastructure exists or can be extended within a fiscally constrained budget and with consideration given to increased tax revenue from development." The proposed zone change would provide additional tax revenue to the city and provide an expansion of an existing business onto the adjacent infill lot that is already provided city services.

(2) Whether the new zoning is designed to secure from fire and other dangers;

The change of CMU1 to CMU2 zoning would not create any dangers within the neighborhood. With the zone change, the developer intends to fence the property to encompass it with the existing Mercedes dealership and service center to the south. The business expansion will eliminate a vacant property with deferred maintenance. There is an existing fire hydrant installed on the southwest corner of the intersection of South 31st Street W and Henesta Drive in addition it is anticipated that the new development will include fire sprinklers within the building due to the expected size of the building, therefore there are no anticipated dangers of fire protection with the development.

(3) Whether the new zoning will promote public health, public safety and general welfare;

The proposed zone change from CMU1 to CMU2 would allow for the developer to expand the existing Mercedes dealership and service center to the property. The developer will be required to improve existing infrastructure adjacent to the property and install new infrastructure such as water, sewer, stormwater retention, and landscaping. The required improvements also will include curb/gutter, sidewalk, and widening of South 31st Street W along the subject property. The expansion will improve the property value in the neighborhood and eliminate a vacant lot within the city limits. The vacant lot is also an unlighted lot with vehicles for service stored on it for the dealership. This scenario attracts vandalism at night. The proposed development may include lighting and security fence to remove the allure to this neighborhood at night for vandalism, decreasing police calls to the area.

(4) Whether the new zoning will facilitate the adequate provision of transportation, water, sewerage, schools, parks and other public requirements;

The proposed zone change from CMU1 to CMU2 will have minimal impact on transportation surrounding the property. Currently, the two roadways providing access to the parcel (South 31st Street W and Henesta Drive) are improved and maintained with connectivity to King Avenue W and Rosebud Drive.

The City of Billings was contacted regarding capacity of the water and sewer mains in the area of the proposed project. It was noted that the proposed project would have adequate capacity by the existing facilities. Each of the two roads that access the property has a water, sewer, and storm main within the roadway. Given that the property will have a commercial development, there will be minimal impact on the water and sewer main. A requirement with commercial development is that the site needs to have the capacity to handle a 50 year storm event. As this is intended as an expansion of the existing business to the south, the storm service for that facility may be utilized to limit additional connections to the City storm mains.

Since the development will be commercial, the neighborhood schools and parks will not be impacted by this zone change.

(5) Whether the new zoning will provide adequate light and air;

In comparison of CMU1 development to CMU2 development, it is not anticipated that air pollution will be changed. A CMU1 zoned property has a number of available permitted use types from gas stations to restaurants to boarding kennels similar to CMU2 zoning. With the commercial development and vandalism that has previously occurred on the unlighted property, adequate lighting will be necessary on the property.

(6) Whether the new zoning will effect motorized and nonmotorized transportation;

The proposed zoning will not have a negative effect on motorized and nonmotorized transportation. The motorized transportation will be entering the property thru the existing service center or from the existing approach along South 31st Street W. As part of the commercial development requirements, the portion of South 31st Street W along the subject property will need to be widened with installation of new curb/gutter and sidewalk. Those improvements will allow nonmotorized transportation to travel safely outside the property.

(7) Whether the new zoning will promote compatible urban growth;

The proposed zoning will allow the developer to expand the Mercedes dealership and service center to meet the needs of local and regional customers. The development will be required to satisfy the City of Billings regulations for commercial development on the street, sidewalks, water, sewer, stormwater, fencing, and lighting. The business expansion will eliminate a vacant lot within a commercial and residential neighborhood. Development of an infill property is encouraged within the city limits. The required property improvements will increase the value of property within that area.

(8) Whether the new zoning considers the character of the district and the peculiar suitability of the property for particular uses;

The character of the district surrounding the subject property, is a mix of residential and commercial businesses. The proposed zone change from CMU1 to CMU2 would allow the property to stay consistent with the adjacent property to the south which is also zoned for CMU2. For expansion of the existing business, the developer will be required to comply with the requirements for commercial development such as (but not limited to) infrastructure improvements and landscaping.

(9) Whether the new zoning will conserve the value of buildings; and

Immediately adjacent to the proposed development is an existing CMU2 development. As such, this development would not be changing the type of commercial development that exists within the neighborhood. Further, the vacant property will be developed by changing the zoning to allow the extension of the existing business, which will remove an unmaintained lot from the area and improve it to maintained landscaping and buildings with fully widened roadways and sidewalks in the public right-of-way adjacent to the property.

(10) Whether the new zoning will encourage the most appropriate use of land throughout the City of Billings.

Given the growth of commercial development and businesses within Billings, this proposed zone would allow the developer to provide additional resources and services to meet the needs of their clients. The infill development of commercial business would generate a return on investment for the City of Billings. The requirements for commercial development of CMU2, will require street and city service improvements adjacent to the property and landscaping.

This zone change is necessary for the dealership to expand their business within their current footprint. Alternatively, the dealership would be required to purchase vacant land on the outskirts of the City and expand their business there, leaving this property and the existing dealership to sit unused for an indeterminate time into the future.

Pre-Application Statement of Owner(s) or Agent(s)

The owner(s), contract purchasers (if any) and agents (if any) are required to submit this completed form and any attachments along with a completed zone change application packet, including any required fees, for a zone change to be processed by the Planning Division.

1. **Present Zoning**: Corridor Mixed Use 1 (CMU1)
2. **Written description of the Zone Change Plan** including existing and proposed new zoning:

The existing zoning is Corridor Mixed Use 1 (CMU1) and the proposed zoning for the property is Corridor Mixed Use 2 (CMU2).

3. **Subject Property Map**: See attached
4. **Legal Description of Property**: Lot 4, Block 16A of Amended Lot 1, Block 16A, Lampman Subdivision
5. **Neighborhood Task Force Area**: [Yes] /// No . If Yes, Name of Task Force and mailing address of Chairperson: Tina Volek, 3214 Horton Smith Lane, Billings, MT 59106
6. **Roster of persons who attended the pre-application neighborhood meeting**: See attached
7. **A copy of the meeting notice.** See attached
8. **A brief synopsis of the meeting results including any written minutes or audio recording.** See attached
9. **The undersigned affirm the following:**
   1) The pre-application neighborhood meeting was held on the 12th, day of August, 2021.
   2) The zone change application is based on materials presented at the meeting.

Owner (s): Patricia Harvey Telephone: 630-967-4956

Address: 841 Remington Boulevard, Bolingbrook, IL 60440 Email: pharvey@weathertech.com

Agent (s): WWC Engineering Telephone: 406-894-2210

Address: 550 S. 24th Street W, Billings, MT 59102 Email: greid@wwcengineering.com

WeatherTech Zone Change Pre-Application Neighborhood Meeting

August 12th, 2021 at 6:00pm

Attendance:

Greg Reid – WWC Engineering

Aaron Redland – WWC Engineering

Dave Fricano – Mercedes, General Manger

See attached sign-in sheet

The meeting was opened by WWC Engineering (WWC) giving a description of the current zoning and the proposed zoning. WWC also explained the zone change process along with the Zoning and Council meetings that are required for the zone change to be completed. Dave provided information on owner and portions of the site development plan.

The area residents were then asked to provide comments or concerns regarding the zone change. The following list summarizes the comments received:

- Is the development anticipated to increase of traffic thru South 31st Street West and Henesta Drive or increase timeframes of semi offloading at the site?
- What are the type and height of fence that will be installed on the perimeter of the property?
- Will the type of lighting that will be installed on the developed site throw light on the adjacent neighbors?

Pre-Application Neighborhood Zone Change Meeting - DMN Real Estate Holdings, LLC
August, 12, 2021 at 6:00 pm

	Name	Address	Phone no.
1	Paul & Beth Crockett	3105 Heneste Dr	406-489-1878
2	Denise Krall	3117 Heneste DR.	406-861-7872
3	Ronnie & Janice Wooten	3115 Heneste Dr	406-561-8428
4	Barb Baxter	3121 Heneste Dr	406-656-3367
5	Libby & Judy Kralik	3123 Heneste Dr	406-281-3198
6	Anita & Jacob Hall	3161 Heneste Dr	406-534-3045
7	Josie Davis	3175 Heneste Dr.	406-431-7379
8	[illegible]	3157 Heneste Dr	
9	Glen Hubbard	5500 Mole Rd	406-860-1870
10	Valley Credit Union	Casey + Scott	406-655-5019
11	Tina Vinek	3214 Heneste Dr	406-698-0665
12	Richelle Selleck	~~2972~~ 3163 Heneste	406-698-7466
13			
14			
15			

SUBJECT PROPERTY	Zone Change #	DATE	FOR	APPROVED (Y/N)	ADDITIONAL DATA
733 S 31st Street	**none**				Pre Recode zoning CC
SURROUNDING PROPERTY	**Zone Change #**	**DATE**	**FOR**	**APPROVED (Y/N)**	**ADDITIONAL DATA**
Lt 5&6, Blk17 Lampman	**124**	6/7/77	R96 to RP	Y	
Lt7, Blk 17 Lampman	**261**	12/31/79	R96 to RP	Y	
Lt. 1-8 Blk 1 Lampman	**340**	5/8/83	R96 to HC	WD	
Lt. 1-8 Blk 1 Lampman	**343**	7/20/83	R-96 to RMF	N	
Lt. 5-8 Blk 17 Lampman	**383**	7/25/85	RP to R96	WD	
Lt. 5-8 Blk 17 Lampman	**393**	2/20/86	RP & R96 to NC	WD	
Lt. 5-8 Blk 17 Lampman	**502**	6/9/86	RP & R96 to NC	N	
Lt. 1-6 Blk 15 Lampman	**512**	5/4/87	R-96 to CC	Y	
Lt.1-12 Blk 18	**512**		R-96 to R60	Y	
Lt. 5-6 Blk 17	**512**		RP to CC	Y	
2902 Henesta	**674**	3/26/01	R-96 to CC	N	
Lt. 2-6 Blk 14 Lampman	**697**	6/10/02	R-96 to R-80	Y	
2902 Henesta	**700**	8/12/02	R-96to CC	Y	
Lts 4-6 Blk 19 Lampman	**836**	4/29/08	R-80 to RP	N	

Zoning Commission

Date:	October 5, 2021
Title:	City Zone Change 1000- 436 Wicks Lane- N2 to NO
Presented by:	Karen Husman
Department:	Planning & Community Services
Presentation:	Yes

Information

RECOMMENDATION

Planning Staff recommends approval of Zone Change 1000 and adoption of the findings of the 10 criteria.

REQUEST

City Zone Change 1000- 436 Wicks Lane- From N2 to NO - A zone change request from Mid Century Neighborhoods (N-2) to Neighborhood Office (NO), on Lot 10, Block 1 of Arrowhead Subdivision, a .288 acre parcel of land. A pre-application neighborhood meeting was held on August 25, 2021, via Zoom virtual meeting. Presented by: Karen Husman, Planner I.

APPLICATION DATA

OWNER: Laighton D. Jones, DMD
AGENT: Scott Aspenlieder, Performance Engineering
LEGAL DESCRIPTION: Lot 10, Block 1 of Arrowhead Subdivision
ADDRESS: 436 Wicks Lane
CURRENT ZONING: N2
EXISTING LAND USE: Residential
PROPOSED USE: Dental Office expansion
SIZE OF PARCEL: .288 acres

CONCURRENT APPLICATIONS
None

SURROUNDING LAND USE & ZONING
NORTH: Zoning: N2
Land Use: Residential
SOUTH: Zoning: N2
Land Use: Residential
EAST: Zoning: NO
Land Use: Commercial Dental Office
WEST: Zoning: N2
Land Use: Residential

BACKGROUND (Consistency with Adopted Plans and Policies, if applicable)

The Planning Division has reviewed this application and is recommending approval based on the attached ten (10) criteria for zone changes. The subject property is adjacent to commercial uses to the east. Uses allowed in the NO zoning are compatible with the surrounding zoning and neighborhood character. Any development or re-development of the property requires compliance with the new zoning and the ability to meet site development requirements and traffic safety standards. The Growth Policy and the Billings Heights Neighborhood Plan encourage predictable land use decisions that are consistent with neighborhood character and land use patterns. The proposed redevelopment and proposed zoning are consistent with this neighborhood and land use pattern.

The proposed zone change will allow an existing dental office located east of the subject property to renovate and expand the business. The development plan is to extend the existing NO zoning for the Jones Dental Facility directly adjacent to the east so the older residential building and office structure can be demolished and a new larger facility can be built on the existing lots and the subject property. The proposed change will result in reduction of traffic by eliminating the existing residential house and consolidating the lots for an improved dental facility. This will improve the quality of the neighborhood by removing an aged deteriorating residential house and constructing a new modern facility.

STAKEHOLDERS

The pre application neighborhood meeting was conducted via virtual Zoom meeting. The meeting was hosted by Scott Aspenlieder. There were no attendees, and no other comments were received.

ALTERNATIVES

The Zoning Commission may:

- Recommend approval of the Zone Change and adopt the findings of the 10 review criteria; or
- Recommend Denial of the Zone Change and adopt the different findings of the 10 review criteria; or
- Delay action on the zone change for up to 30 days; or,

- Allow the applicant to withdraw the application

FISCAL EFFECTS
Approval or denial of the proposed zone change should have no effect on the Planning Division budget.

SUMMARY
Prior to any recommendation to the City Council, the Zoning Commission shall consider the following:

1. Is the new zoning designed in accordance with the Growth Policy and neighborhood plans?
The proposed zone change is consistent with the following guidelines of the 2016 Growth Policy:
Prosperity (promoting equal opportunity and economic advancement)
· Predictable, reasonable City taxes and assessments are important to Billings' taxpayers
· A diversity of available jobs can ensure a strong Billings' economy
· Successful businesses that provide local jobs benefit the community
· Retaining and supporting existing businesses helps sustain a healthy economy

The proposed zoning would allow an existing dental office to upgrade and modernize the practice. The proposed zone aligns with allowed continued light commercial development along a busy arterial. The NO district allows neighborhood services and the proposed project will bring new construction improving the aesthetic of the neighborhood.

2. Is *the new zoning designed to secure from fire and other dangers?*
The new zoning requires minimum setbacks, open and landscaped areas and building separations. The new zoning, as do all zoning districts, provides adequate building separations and density limits to provide security from fire and other dangers.

3. Whether the new zoning will promote public health, public safety and general welfare?
Public health and public safety will be promoted by the proposed zoning. The proposed NO zoning would allow the owner to ensure future development is not intrusive to neighboring property, and still allow compatible uses with the adjacent zoning. Removal of an older deteriorating residential structure and an older office building and replacing with a newer more efficient facility will be beneficial for general health and welfare of the district.

4. *Will the new zoning facilitate the adequate provision of transportation, water, sewerage, schools, parks and other public requirement?*
Transportation: The proposed zoning will decrease residential traffic, however may increase post-development traffic volume. A traffic impact study (TIS) or an update to an existing TIS may be necessary at the time of development.
Water and Sewer: The City provides water and sewer to the property. City Utilities Department voiced no concerns.
Schools and Parks: Schools and parks should not be negatively affected by the proposed zoning. The proposed development does not include residential uses.
Fire and Police: The subject property is served by city public safety services. The Police and Fire Departments had no concerns with the zone change.

5. Will the new zoning provide adequate light and air?
The proposed zoning provides for sufficient setbacks to allow for adequate separation between structures and adequate light and air.

6. Will the new zoning effect motorized and non-motorized transportation?
The dental office expansion will have sidewalks and will connect to other sidewalks and pedestrian facilities in the neighborhood. The new zoning designation itself should not have any increase effect on the transportation system.

7. Will the new zoning promote compatible urban growth?
The proposed zoning is compatible with the adjacent zoning and existing urban growth in the vicinity. Property east of the subject parcels is zoned NO and the dental office proposing the expansion that triggered the request for a zone change on the subject property.

8. Does the new zoning consider the character of the district and the peculiar suitability of the property for particular uses?
The proposed zoning does consider the character of the district and the suitability of the property for the proposed use. The proposed zoning will allow expansion of an existing commercial dental office use.

9. Will the new zoning conserve the value of buildings?
The new zoning is not expected to alter the value of any buildings in the area. It is not known if its proximity to residential property in the area will affect the value of residential buildings. Any development of the property will need to meet the site development requirements in the zoning code, including landscaping, screening, building heights and setbacks.

10. Will the new zoning encourage the most appropriate use of land throughout the City of Billings?
The proposed zoning will allow the development of the property in a mixed residential area, expanding an existing business is encouraging the most appropriate use of land in the district. Supporting local business expansion is beneficial to the economic growth for the City of Billings.

Attachments

Zoning Map & Site Photos
Application & Applicant Letter
Pre Application Information
Chart of zoning history

Zoning Map



Site Photos




ZONING
REQUEST
ZONE CHANGE
1000
SPECIAL REVIEW
VARIANCE


LEFT
CENTER

Southwest



East



Northeast



West



Northwest

APPLICATION FORM

CITY ZONE CHANGE **Billings Zone Change #** 1000 **- Project #** PZX-21-00231

The undersigned as owner(s) of the following described property hereby request a Zone Change as outlined in the City of Billings Zoning Regulations.

Present Zoning: N2 - Mid-Century Neighborhood

Proposed Zoning: NO

TAX ID# A02533A CITY ELECTION WARD 2

Legal Description of Property: Lots 10, Block 1 of Arrowhead Subdivision

Address or General Location (If unknown, contact City Engineering): 436 Wicks Lane, Billings, MT

Size of Parcel (Area & Dimensions): 0.288 Acres

Present Land-Use: Residential

Proposed Land-Use: Neighborhood Office - Dental

Covenants or Deed Restrictions on Property: Yes_____ No X

If yes, please attach to application

*** Additional information may be required as determined by the Zoning Coordinator in order to fully evaluate the application.

Owner(s): Laighton D. Jones, DMD

(Recorded Owner) 502 Wicks Lane, Billings, MT 59105

(Address) 406-248-7868

(Phone Number) (email)

Agent(s): Scott Aspenlieder - Performance Engineering, LLC

(Name) 608 N 29th St, Billings, MT 59101

(Address) (406) 384-0080 scott@performance-ec.com

(Phone Number) (email)

I understand that the filing fee accompanying this application is not refundable, that it pays for the cost of processing, and that the fee does not constitute a payment for a Zone Change. Also, I attest that all the information presented herein is factual and correct.

Signature: _____ Date: 9-14-21

(Recorded Owner)

PERFORMANCE ENGINEERING
608 North 29th Street, • Billings, MT 59101 • (406) 384-0080

Laighton Jones Dental – Zone Change Questions

A. In what ways is your proposal consistent with the goals and policies of the adopted Growth Policy?

The tract of land of interest is currently zoned N2 – Mid-Century Neighborhood. The land surrounding the property generally residential to the west, both behind the lot and across Wicks Lane and then commercial to the east of the lot, both directly adjacent and across Wicks Lane. The Growth Policy has several goals that would be met by changing the zoning of the property from N2 to NO under the new Zone Ordinance. The issues that will be addressed are described below.

The proposed change will continue to provide the local neighborhood with services based on the NO zoning. The development plan is to extend the existing NO zoning for the Jones Dental Facility directly adjacent to the east so the older building and office can be demolished and a new larger facility can be built on the existing lots and lot affected by the zone change. The proposed change will result in a reduction in traffic by eliminating the existing residential house and consolidating lots for an improved dental facility to be rebuilt. This project will also serve to improve the quality of the neighborhood and values by removing an aged and deteriorating house and building and constructing a new, modern facility meeting the current zoning and building codes.

B. Meets the 10 criteria for a zone change.

1. Is the new zoning designed in accordance with the Growth Policy?
    a. The proposed change consolidates lots and buildings to allow for redevelopment of the area to help rejuvenate a portion of the Heights. The proposed zone changes aligns with allowing continued light commercial use along a busy arterial road. The NO zoning continues to provide neighborhood services to the area while bringing new construction into compliance with new zoning regulations and construction requirements.
2. Is the new zoning designed to secure from fire and other dangers?
    a. The new zoning requires minimum setbacks and landscaped areas with building separation. These zonings will provide adequate building separation and density limits to provide security from fire and other dangers.
3. Whether the new zoning will promote public health, public safety, and general welfare?
    a. Public health and safety will be promoted through the consolidation of the properties and new construction which in turn adds to the rate payer base for the City and increase property taxes revenue.
4. Will the new zoning facilitate the adequate provision of transportation, water, sewage, schools, parks and other public improvements?
    a. Transportation: The proposed zoning will reduce density and therefore reduce transportation impacts on the area through removal of the residential house and consolidation of the lots.
    b. Water and Sewer: The City currently provides water and sewer to the area through existing infrastructure.
    c. Schools and Parks: Neither should be impacted by the development as it proposes to reduce the density of residential houses in the area.
    d. Fire and Police: The area is served by the City public safety services.

5. Will the new zoning provide adequate light and air?
    a. The proposed new zoning and building regulations require setbacks for vertical construction that will provide for adequate separation between buildings.
6. Will the new zoning effect motorized and non-motorized transportation?
    a. Trip generation for the area will be reduced from the original zoning through elimination of the residential house and consolidation of the lots for a single building/facility. The proposed zoning should not have any negative impacts on the planned trip generation for this area.
7. Will the new zoning promote compatible urban growth?
    a. The proposed zoning will allow for redevelopment of an aged area of the community through consolidation of buildings into a new facility to help rejuvenate this part of the City.
8. Does the new zoning consider the character of the district and the peculiar suitability of the property for particular uses?
    a. The proposed zoning will eliminate an aging residential building and allow for consolidated use of the lots for a new facility following current zoning requirements, meeting the character of the district.
9. Will the new zoning conserve the value of buildings?
    a. The proposed zoning will eliminate an aging residential house and commercial building to allow for construction of a new commercial building and require construction to meet the new zoning standards which will add value to the area.
10. Will the new zoning encourage the most appropriate use of land throughout the City of Billings?
    a. The proposed zone changes encourages commercial use along Wicks Lane while still ensuring the new construction aligns with neighborhood style building and construction. This approach will be the most appropriate use of the property.

C. Explain how the new zoning will fit in with the existing zoning and land uses of the immediate area.

The proposed development plan is to remove the residential house on the subject property along with the existing Jones Dental facility adjacent to the east and consolidate them into one new office for Laighton Jones Dental. The NO zone will allow the property to be redeveloped into an attractive and appropriately sized facility that fit within the local neighborhood. The land surrounding the property east is stepped down commercial uses which align with the growth policy. The developer is requesting this zone change to align with the timeline of redevelopment of the property in 2022.

Pre-Application Statement of Owner(s) or Agent(s)

The owner(s), contract purchasers (if any) and agents (if any) are required to submit this completed form and any attachments along with a completed zone change application packet, including any required fees, for a zone change to be processed by the Planning Division.

1. **Present Zoning**: N2 -Mid-Century Neighborhood

2. **Written description of the Zone Change Plan** including existing and proposed new zoning:

   Change from N2 Zoning to NO zoning

3. **Subject Property Map**: please attach to this form

4. **Legal Description of Property**:
   Lot 10, Block 1 of Arrowhead Subdivision
   Section 22, Township 01N, Range 26E

5. **Neighborhood Task Force Area**: Yes / No If Yes, Name of Task Force and mailing address of Chairperson:

6. **Roster of persons who attended the pre-application neighborhood meeting**: please attach to this form

7. **A copy of the meeting notice.** please attach to this form

8. **A brief synopsis of the meeting results including any written minutes or audio recording.** please attach to this form

9. **The undersigned affirm the following:**
   1) The pre-application neighborhood meeting was held on the 25 , day of August, 2021.
   2) The zone change application is based on materials presented at the meeting.

Owner (s): Laighton D. Jones, DMD Telephone: (406) 248-7868
Address: 502 Wicks Lane, Billings, MT 59105 Email:

Agent (s): Scott Aspenlieder - Performance Engineering Telephone: (406) 384- 0080
Address: 608 N 29th St. Billings, MT 59101 Email: scott@performance-ec.com

PERFORMANCE ENGINEERING
608 North 29th Street, • Billings, MT 59101 • (406) 384-0080

August 16, 2021

Dear Interested Neighbor,

On behalf of Laighton D. Jones, DMD, *Performance Engineering, LLC* is writing to inform you of a special review pre-application neighborhood meeting being held on **Wednesday, August 25th**, at **6:00 p.m.** Due to recent concerns surrounding public health and safety regarding COVID-19, **the special review neighborhood meeting will be held online via Zoom.**

Please see the following information below for access the Zoom meeting:

Go to the following Website: **zoom.us/join**
Meeting ID: **820 7938 5292**
Password (Case Sensitive): **6VSp9B**

The owner is requesting that the property shown on the attached exhibit (Exhibit 1) and described below be re-zoned to accommodate future development:

> **Arrowhead Subdivision, Section 22, Township 01 North, Range 26 East, Block 1, Lot 10, located in Billings, Montana. The parcel is a total of 0.288 Acres, more or less, located on the south side of Wicks Lane between Navajo Street and Main Street.**

The intent of the meeting is to make neighboring property owners aware of the proposed zoning change for the subject property, discuss the potential for redevelopment, and to answer questions about the project. The property is currently zoned as N2 – Mid-Century Neighborhood. The zoning proposal to be presented to the City of Billings will be to change the zoning of the land described above to NO – Neighborhood Office under the existing zone ordinance to accommodate future development. A total of 0.288 acres is included in the proposed zone change.

Representatives for *Performance Engineering, LLC* will be on the Zoom meeting to answer questions from those who attend. For those unable to attend the Zoom meeting, written letters can be directed to Performance Engineering at **608 North 29th Street, Billings, MT 59101**, attention Scott Aspenlieder, PE, or emails may be sent to scott@performance-ec.com. We look forward to discussing the proposed zoning change with you and hope to see you on **August 25th.**

Sincerely,

Scott Aspenlieder, PE
Principal

PERFORMANCE ENGINEERING
608 North 29th Street, • Billings, MT 59101 • (406) 384-0080

Laighton Jones Dental – Zone Change Neighborhood Meeting Notes

The meeting began at 6:00 pm on August 25, 2021 via a virtual Zoom meeting. The meeting was hosted by Scott Aspenlieder (Performance Engineering).

No one attended the meeting therefore there were no comments or questions presented. No further questions or comments were received through email or phone on the project.

SUBJECT PROPERTY	Zone Change #	DATE	FOR	APPROVED (Y/N)	ADDITIONAL DATA
436 Wicks Lane					Pre Recode zoning
SURROUNDING PROPERTY	**Zone Change #**	**DATE**	**FOR**	**APPROVED (Y/N)**	**ADDITIONAL DATA**
Lt. 7, Blk3 Arrowhead Sub	**439**	8/27/84	R72 to HC	WD	
Lt. 14, Blk 2 Arrowhead	**456**	1/29/85	R72 to NC	N	
Lt. 14, Blk 2 Arrowhead	**467**	5/6/85	R72 to RP	Y	
Lt. 9-10, Blk 1 Arrowhead	**560**	1/25/93	NC to RP	Y	
L 27A, Blk1	**567**	7/12/93	R70-HC	N	
519 Crow Lane	**876**	7/11/11	R70-RMF-R	Y	

Zoning Commission

Date:	October 5, 2021
Title:	Zone Change 1001 - Text Amendment for Marijuana Businesses
Presented by:	Nicole Cromwell
Department:	Planning & Community Services
Presentation:	Yes

Information

RECOMMENDATION

The Planning Division recommends the Zoning Commission conduct a public hearing and make a recommendation to the City Council for approval of the text amendment for marijuana businesses, based on the proposed findings of the 10 review criteria.

BACKGROUND (Consistency with Adopted Plans and Policies, if applicable)

In November 2020, the ballot issue (I-190) was approved by the voters to allow "adult use" of marijuana on a state-wide basis. During the 2021 legislative session, the state adopted a bill - HB 701 - that amended the existing laws to accommodate this new marijuana use approved by the voters. The law explicitly allowed local jurisdictions to adopt more stringent local controls, including the allowance for counties where the ballot initiative did not pass, to adopt local prohibitions. Yellowstone County and the City of Billings both passed the 2020 ballot initiative.

Prior to November 2020, medical use marijuana was allowed by the state. This was approved by another ballot initiative in November 2004. Billings did not adopt any local land use controls for medical use marijuana businesses after the passage of the 2004 initiative. The number of registered patients and caregivers was low until late 2009 when the U.S. Justice Dept. issued a directive to US Marshals and US Attorneys that marijuana possession and use should not be prosecuted in states that permit the use of medical marijuana and as long as individuals comply with those laws. Soon thereafter, Council members began receiving constituent contacts, expressing concerns about medical marijuana businesses being established across the city. The Medical Marijuana Act did not specify if or how cities could regulate these businesses but the most common approach taken by other Montana cities at the time was to establish zoning rules that limited the impacts these businesses may have had on their surroundings.

In February 2010, the Council created the Medical Marijuana Ad-Hoc Committee to develop proposals for how the City should zone for these businesses. Subsequently, more than 100 new medical use marijuana dispensaries opened within the city limits. Locations included commercial areas as well as temporary buildings in parking lots and home occupations. The city adopted an emergency moratorium in May 2010 to stop the rush by medical use providers to continue opening businesses within the city limits. At the same time, the state legislature was considering regulations and laws to better guide the medical use marijuana industry. The Ad Hoc Committee reviewed and considered several iterations of zoning regulations for medical use marijuana dispensaries. These draft regulations are very similar to the proposed zoning regulations for this text amendment and included required separation distances, limitation on zone districts where the businesses could location and considerations for sign code regulations. Ultimately, the state legislature took up the issue, and passed a new law in 2011 (SB 423) that limited medical marijuana dispensaries and providers in a strict manner. In Billings, this resulted in dropping zoning regulations and adopting two sections on Medical Marijuana for business regulations - Section 7-1700, Medical Marijuana Storefronts and Section 13-432, Business Licensing. These two ordinances are still active in the city codes.

Medical Marijuana providers and dispensary owners sued the state over certain provisions in the 2011 law and prevailed on most issues in late 2015 and early 2016. These court decisions set in motion additional activity on the local level to ensure the previously adopted business licensing ordinances were in compliance as well as refining and adopting zoning regulations for medical marijuana dispensaries. In 2017, the City Council initiated these amendments to the city code. Prior to first reading by the City Council in September 2017, Montana Advanced Caregivers (M.A.C.) filed suit and was granted a restraining order by the District Court to halt the adoption of those regulations and to stop any enforcement of the existing city regulations against M.A.C. This lawsuit is on-going.

The passage of I-190 and the adoption of HB 701, has prompted the City to again examine and propose regulations that will now apply to both Adult Use and Medical Use marijuana businesses. The zoning regulations proposed are similar to the regulations proposed in 2010 and 2011 but were not adopted. The proposed regulations address concerns with public health, safety and welfare as a primary basis for the regulations. The regulations separate the different types of marijuana businesses and allow them in particular zone districts. These are generally zones that are not close to neighborhoods such as Heavy Commercial (CX), Light Industrial (I1) and Heavy Industrial (I2). In addition, staff has drafted a minimum separation distance to residential zones, schools, public parks with playgrounds, religious institutions, day care centers and youth centers of at least 1,000 feet. One thousand feet will be protective of those uses that are closer to the three zone districts.

The separation requirement will apply to dispensaries, cultivators, processors and manufacturers but not from testing laboratories or transporters. Currently, the marijuana businesses throughout Montana are "vertically" integrated so most dispensaries are also cultivation, processing and manufacturing marijuana edibles. Currently, transportation of marijuana is generally limited by dispensaries that provide delivery to cardholders for medical use. In the future, transportation may become a viable "stand alone" service business for marijuana businesses.

The proposed draft also requires a minimum setback of 150 feet from an arterial street for any new dispensary - Adult Use or Combined Use. This setback would not apply to Medical Use only. There was a concern the zone districts and the required separation distance could concentrate these businesses along major transportation corridors that serve as entryways to the city. Requiring a minimum setback from these entryways will diminish the concentration effect of these separation distances.

City legal staff is assisting the Marijuana Regulation Committee (includes the Mayor, City Council Members, and City staff) to draft new business license regulations for marijuana dispensaries and related businesses. Part of this discussion includes research into the experience of similar communities in other states with similar marijuana laws and peer-reviewed journals and professional articles on the effect of marijuana businesses in the community and in law enforcement. This background and basis information is attached to this report. The City Council is considering a lottery system to award business licenses for marijuana dispensaries and a cap on the number of dispensaries within the city limits.

The state of Montana currently lists 29 licensed dispensaries within Yellowstone County and two of those are within the city limits. Only one of those two locations is in "good standing" with the city - M.A.C. The other location on Grand Avenue does not have a city business license and is not considered in good standing with the city at this time. On January 1, 2022, the state will allow any existing medical use dispensary in good standing with the local government to start selling adult use marijuana to consumers 21 years of age and over.

Planning staff has received some comment from city agencies in particular the Fire Department. There is a concern that manufacturing - distilling, and extraction - of oils and other botanical but volatile elements from marijuana is not adequately regulated by the adopted 2012 Fire Code (IFC) in Montana or in the city. The Fire Marshal would like to insert language that ensures any manufacturing that involves distillation of cannabis oil to comply with Chapter 39 of the 2021 IFC (or later edition) as the case may be. The city must wait for the state to adopt a new Fire Code to adopt the entire new IFC for the city. This reference to the 2021 IFC Chapter 39 would pre-date the formal adoption by the state and city, but the Fire Marshal believes it is essential to protection of public health and safety. The extraction process for cannabis oil is hazardous and the newer Fire Codes will help minimize these hazards for this new business type. Inclusion of this language is being considered for the City's marijuana business licensing process and may also be helpful to reference in the new zoning code as we do for other codes that must be followed when developing property in the City.

Planning staff is working with city Geographic Information Systems (GIS) staff to provide maps that depict generally where marijuana dispensaries, cultivators and processing facilities might locate based on the proposed regulations. These maps are only general and cannot with absolute certainty show whether a particular property will or will not meet he proposed regulations for separations or setbacks. Most of the area that will be open for these businesses will be along the I-90 interstate corridor where most of the CX, I1 and I2 zoning is located. The separation distances will be measured in the same way we measure separations for bars and casinos - from the exterior of the building where the marijuana business is located to the property line of the protected use. Since we don't know where new businesses will locate yet, the maps show a property line to zone district buffer. The maps are attached to this report.

The draft regulations also prohibit marijuana businesses of any type as a Home Occupation and require the business to provide documentation a proposed sign meets the state regulations when submitted for city permitting.

STAKEHOLDERS

The Planning staff sent the draft regulations out to Neil Kiner, owner of the Green Bee and medical use dispensary outside the city limits. In addition, Planning staff sent the draft regulations to the Montana Cannabis Guild, published the draft on the City Webpage (https://www.billingsmt.gov/2361/Current-Zoning-Applications) and published a legal advertisement as required by Section 27-1628 of the BMCC.

Text amendments are processed in a similar manner to zoning map amendments, require legal notification and a review of the 10 criteria for zone changes. As of the completion of this report, we have not received any comments back from the public on the draft regulations. The Billings Industrial Revitalization District (B.I.R.D.) board may provide information to the Commission on what zone districts in the East Billings Urban Renewal District they would like to include for consideration of marijuana dispensaries or other marijuana businesses. Several marijuana business owners have been attending the City Council work sessions on this topic, but none have provided comment to the Planning staff on these draft regulations.

ALTERNATIVES

The Zoning Commission may:

- Adopt the findings of the 10 review criteria and recommend approval to the City Council; or,
- Adopt the findings of the 10 review criteria and recommend approval with changes to the draft to the City Council; or
- Adopt different findings of the 10 review criteria and recommend denial of the proposed regulation to the City Council.

FISCAL EFFECTS

A recommendation of approval or denial will not have any appreciable effect on the Planning Division budget.

SUMMARY

Prior to making a recommendation to the City Council on the draft regulations, the Zoning Commission shall consider, among other things, the following findings:

1. *Is the new zoning designed in accordance with the Growth Policy*?

The proposed amendment is consistent with 2016 Growth Policy.

Essential Investments:

- Infill development and development near existing City infrastructure may be the most cost-effective.
- Neighborhoods that are safe and attractive and provide essential services are much desired.

Strong Neighborhoods:

- Neighborhoods that are safe and attractive and provide essential services are much desired.
- Zoning and subdivision regulations that utilize Crime Prevention Through Environmental Design (CPTED) strategies result in safer neighborhoods.

Community Fabric:

- Attractive street scapes provide a pleasant and calming travel experience in urban and suburban neighborhoods.

Home Base:

- Common to all types of housing choices is the desire to live in surroundings that are affordable, healthy and safe.

Prosperity:

- A diversity of available jobs can ensure a strong Billings' economy.
- Successful businesses that provide local jobs benefit the community.
- Community investments that attract and retain a strong, skilled and diverse workforce also attracts businesses.

The proposed amendment allows a new type of business within the city limits. New businesses can create unpredictable effects within an existing community. The proposed regulations are intended to prevent some predictable consequences of allowing a business that is still considered illegal in many states. It is likely there will be a high demand for this product due to the regional nature of the Billings retail market and due to the fact the states adjacent to eastern Montana have not legalized marijuana. Colorado is the closest state to Montana where both medical use and adult use marijuana is legal. Expansion from medical use to adult use marijuana will increase demand generally. Allowing these businesses in areas where similar types of business already exist - processing, manufacturing, cultivation, warehousing, transportation terminals - will make this use predictable in those areas. Expanding the types of districts to Mixed Use districts would bring these businesses too close to neighborhoods, schools, public parks and other sensitive land uses where protection from odors and noise is a primary concern and businesses with high security demands are not compatible. The regulations require an arterial setback for adult use or combined use dispensaries so the separation requirements and the district limitations do not combine to create a cannabis corridor along entryways to the city.

2. Is *the new zoning designed to secure from fire and other dangers?*

The new zoning may increase the danger from fire for new manufacturing and processing facilities that extract cannabis oil. The Fire Marshal has suggested insertion of language to require compliance with Chapter 39 of the 2021 IFC that is not yet in effect in Montana. In general, the proposed zone districts for this use is in proximity to similar uses and will not be close to neighborhoods, public parks or schools where danger from fire or explosion is a higher

risk.

3. *Whether the new zoning will promote public health, public safety and general welfare?*
The proposed regulations limit the effect of locating these businesses within the city limits by providing separation distances from sensitive uses and limiting the businesses to compatible zone districts such as CX, I1 and I2.

4. *Will the new zoning facilitate the adequate provision of transportation, water, sewerage, schools, parks and other public requirements?*

Transportation: It is not known whether the number of businesses within the proposed three zone districts will affect the overall transportation system. In some jurisdictions, high security transportation of marijuana was required. If Billings becomes a regional cultivation, processing or manufacturing center for Montana, evaluation of local transportation will be needed on a site by site basis through a Traffic Impact Analysis by the proposed business.

Water and Sewer: This text amendment affects properties within the City of Billings which are served by city water and sewer. Cultivation and processing will increase demand on water and waste water services, but the system is expected to provide those services.

Schools and Parks: Schools should not be significantly affected by the proposed zoning. The draft regulations propose a 1,000-foot separation to schools (primary and secondary, public or private) and public parks with playgrounds or playing fields. This should help protect these two sensitive land uses.

Fire and Police: The CX, I1 and I2 zones within the City of Billings will be served by City Fire and Police Departments. The Fire Marshal's concern with cannabis oil production is noted above in criteria 2. It is likely dispensaries will employ complicated security systems for their locations. The Police and Fire Departments will be involved in reviewing licenses and building permits for any new locations.

5. *Will the new zoning provide adequate light and air?*
Not applicable.

6. *Will the new zoning effect motorized and non-motorized transportation?*
T*he proposed zoning may have unknown impacts on the transportation network*. Individual business may need to provide traffic impact reports when establishing a new location.

7. *Will the new zoning will promote compatible urban growth?*
The zoning amendment promotes compatible urban growth in the areas of the City that are zoned CX, I1 and I2. The intended use is not an intrusion to these zone districts and the proposed separation requirements will provide buffering to any sensitive land uses.

8. *Does the new zoning consider the character of the district and the peculiar suitability of the property for particular uses?*
The zoning amendment considers the character of the CX, I1 and I2 districts and the suitability of the property for the proposed uses. Testing Laboratories will be allowed in additional zone districts - Downtown Support (DX) and Central Business District (CBD) since no sales or production of marijuana would occur at these facilities. DX and CBD allow all other research and testing laboratories.

9. *Will the new zoning conserve the value of buildings?*
Not applicable

10. *Will the new zoning encourage the most appropriate use of land throughout the City of Billings?*
The proposed zoning may encourage the most appropriate use of some CX, I1 and I2 zoned land in Billings.

Attachments

Draft Zoning Regulations Marijuana Businesses
APA Journal Article Winter 2021
American Journal of Public Health Retail Marijuana Access
Cannabis in Medicine - collection of journal articles
Letter of Comment Neil Kiner to City Council
Public Health Article on CO and WA marijuana access

Crash Fatality Rate Study 2017
Journal of Criminal Justice on mairjuana legalization 2021
AHA - Marijuana smoke impact on heart health

NIDA marijuana research report
RMHIDTA Marijuana Report Sept 2021
APA Zoning Practice Marijuana Aug 2016

ORDINANCE NO. 21-_____

AN ORDINANCE OF THE CITY OF BILLINGS, PROVIDING THAT THE BILLINGS, MONTANA CITY CODE BE AMENDED BY REVISING SECTION 27-1000 – USES AND USE STANDARDS; SECTION 27-1005 – COMMERCIAL USE STANDARDS; SECTION 27-1006 - INDUSTRIAL, WHOLESALE AND STORAGE USE STANDARDS; SECTION 27-1400 – SIGNS; SECTION 27-1008 – ACCESSORY USES; SECTION 27-1800 - DEFINITIONS - TO ADD LANGUAGE RELATED TO MEDICAL AND ADULT USE MARIJUANA BUSINESSES WITHIN THE CITY OF BILLINGS AND ADOPT THE REVISION AS AN AMENDMENT TO THE ZONING REGULATIONS AND SET A TIME PERIOD FOR THE REGULATION TO BE EFFECTIVE.

BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF BILLINGS, MONTANA:

1. RECITALS. *Title 76, Chapter 2, Part 3, MCA,* and Section *27-1628, BMCC,* provide for amendment to the City Zoning Regulations from time to time. The City Council initiated the amendment to the City Zoning Regulations and the City Zoning Commission and staff have reviewed the proposed zoning regulations hereinafter described. The recommendations of the Zoning Commission and staff have been submitted to the City Council, and the City Council, in due deliberation, has considered the proposed amendments to the City Zoning Regulations.

2. DESCRIPTION. The zoning regulation shall apply to all land within the City of Billings.

3. ZONE AMENDMENT.

A. SECTION 27-1000 – USES AND USE STANDARDS.

Add the following uses to the Primary Use Table (Table 27-1000.1) under the COMMERCIAL Use Category – Retail Sales

i. Marijuana Dispensary – Medical Use
ii. Marijuana Dispensary – Adult Use
iii. Marijuana Dispensary – Combined Use

Allow these uses as designated with a letter “PR” in the Heavy Commercial (CX), Light Industrial (I1) and Heavy Industrial (I2) zone districts

The amended table shall read as follows:

C. *Table 27-1000.1 Billings Primary Use Table.*

Table 27-1000.1: Permitted Primary Uses	Residential							Mixed-Use and Commercial						Indust.		EBURD					Public					
	Key: P = Permitted, PL = Location Limits in Zone District, PR - Applicable Use Restrictions, SR = Special Review																									
Use Table	N3	N2	N1	NX1	NX2	NX3	RMH	NO	NMU	CMU1	CMU2	DX	CBD	CX	I1	I2	RSV MS	RSV	CW	I3	IS	P1	P2	P3Civ	P3 Ed	P3 Med	Additional Standards
Retail Sales																											
Agricultural														P	P				P	P	P						
Commercial Greenhouse/Nursery									SR	P	P			P	P		P	P	P	P	P						
Liquor Sales									P	P	P	P	P	P	P		P	P	P	P	P						
Retail, Limited with drive-thru									SR	P	P			P				P	P	P	P						27-1009
without drive-thru									P	P	P	P	P	P			P	P	P	P	P			P	P	P	
Retail, General with drive-thru									SR	P	P			P				P	P	P	P						27-1009
without drive-thru										PR	P	P	P	P			P	P	P	P							
Retail, Large-Format											P			P				P	P	P	P						
Marijuana Dispensary – Medical Use														PR	PR	PR											27-1005
Marijuana Dispensary – Adult Use														PR	PR	PR											27-1005
Marijuana Dispensary – Combined Use														PR	PR	PR											27-1005

Add the following uses to the Primary Use Table (Table 27-1000.1) under the COMMERCIAL Use Category - Office

Marijuana Testing Laboratory

Allow this use as designated with a letter “P” in the Downtown Support (DX), Central Business District (CBD), Heavy Commercial (CX), Light Industrial (I1) and Heavy Industrial (I2) zone districts

The amended table shall read as follows:

Table 27-1000.1: Permitted Primary Uses	Residential							Mixed-Use and Commercial							Indust.		EBURD					Public					
	Key: P = Permitted, PL = Location Limits in Zone District, PR - Applicable Use Restrictions, SR = Special Review																										
Use Table	N3	N2	N1	NX1	NX2	NX3	RMH	NO	NMU	CMU1	CMU2	DX	CBD	CX	I1	I2	RSV MS	RSV	CW	I3	IS	P1	P2	P3Civ	P3 Ed	P3 Med	Additional Standards
Office																											
Business or Professional								P	P	P	P	P	P	P			P	P	P	P	P			P	P	P	
Research and Testing Laboratories											SR	P	P	P	P	P			P		P			P	P	P	
Marijuana Testing Laboratory												P	P	P	P	P											27-1006

Add the following uses to the Primary Use Table (Table 27-1000/.1) under the INDUSTRIAL, WHOLESALE AND STORAGE Use Category – Manufacturing, Assembly, or Processing

Marijuana Cultivation
Marijuana Processing/Manufacturing

Allow these uses as designated with a letter "PR" in the Heavy Commercial (CX), Light Industrial (I1) and Heavy Industrial (I2) zone districts

The amended table shall read as follows:

Table 27-1000.1: Permitted Primary Uses	Residential							Mixed-Use and Commercial							Indust.		EBURD					Public					
	Key: P = Permitted, PL = Location Limits in Zone District, PR - Applicable Use Restrictions, SR = Special Review																										
Use Table	N3	N2	N1	NX1	NX2	NX3	RMH	NO	NMU	CMU1	CMU2	DX	CBD	CX	I1	I2	RSV MS	RSV	CW	I3	IS	P1	P2	P3Civ	P3 Ed	P3 Med	Additional Standards
Manufacturing, Assembly, or Processing																											
Artisan/Craft									PL	PL	PL	P	P	P	P	P	PR PL	PR PL	PR PL	PR PL	PR PL						27-1006
Limited - Special Order												P	P	P	P	P			P	P	P						
General														P	P	P			P	P	P						
Heavy															SR	P					PR						27-1006
Marijuana Cultivation (Indoor Only)														PR	PR	PR											27-1006
Marijuana Processing/Manufacturing														PR	PR	PR											27-1006

Add the following uses to the Primary Use Table (Table 27-1000/.1) under the INDUSTRIAL, WHOLESALE AND STORAGE Use Category – <u>Warehousing and Storage Services</u>

Marijuana Transportation and Temporary Storage

Allow this use as designated with a letter “P” in the Heavy Commercial (CX), Light Industrial (I1) and Heavy Industrial (I2) zone districts

The amended table shall read as follows:

Table 27-1000.1: Permitted Primary Uses	Residential							Mixed-Use and Commercial						Indust.		EBURD		Public							
	Key: P = Permitted, PL = Location Limits in Zone District, PR - Applicable Use Restrictions, SR = Special Review																								
Use Table	N3	N2	N1	NX1	NX2	NX3	RMH	NO	NMU	CMU1	CMU2	DX	CBD	CX	I1	I2	RSV MS	RSV	CW	13	IS	P1	P2	P3Civ	P3 Ed	P3 Med	Additional Standards
Warehousing and Storage Services																											
Outdoor Storage														PR	P	P		P	P	P	P						27-1006
Personal Self-Service Storage										PR PL	PR PL	PR		P	P	P		PR	PR	PR	PR						27-1006
Trucking and Transportation Service														P	P	P			P		P						
Warehouse														P	P	P		PL	PL	PL	PL						27-1006
<u>Marijuana Transportation and Temporary Storage</u>														<u>P</u>	<u>P</u>	<u>P</u>											<u>27-1006</u>
Wholesale and Distribution (general)														P	P	P		P	P	P	P						
Agricultural Products														P	P	P		P	P	P	P						
Chemical Products															SR	P											
Petroleum Products																P											

B. Add the following section to 27-1005 - Standards for commercial uses:

R. Marijuana Dispensaries: The following standards apply to all marijuana dispensaries within the city limits.
1. Separation distances.
(a) All marijuana dispensaries shall be separated by 1,000 feet from religious institutions, primary and secondary educational facilities, public parks that contain a children's playground or playfield, day care centers, youth centers, and neighborhood residential zones ("protected use" as defined in subsection 27-1802.G) as measured from the exterior of the occupied building space of the marijuana dispensary to the property line of the protected use. A neighborhood residential zone includes any Planned Development zone district that allows residential uses.

2. Combining Marijuana Uses.
(a) A marijuana dispensary may not be combined with another marijuana use, such as a transportation, cultivation, testing laboratory or processing facility, unless the required separation distances can be met for the dispensary use.
(b) All marijuana uses are considered Primary Uses for the purposes of zoning.

3. Marijuana Businesses - The definitions contained in Titles 15, 16, and 50, MCA, shall apply to this Chapter except where the ordinance provides a different definition in Section 27-1803, or the context of this Chapter makes it clear that the statutory definition does not apply.

4. Setback from arterial street property lines.

The occupied building space for all Adult Use marijuana dispensaries and Combine Use marijuana dispensaries shall be setback from an arterial street by at least 150 feet. Medical Use marijuana dispensaries are not required to comply with this setback.

C. Add the following section to 27-1008.M.4 – Home Occupations (Accessory Uses).

M. Home occupations. The planning division recognizes that the restrictions set forth in this section do not anticipate all possible types of home occupations. Therefore, the following policies have been adopted to guide the planning division in the enforcement of this section:
……

4. Prohibited uses. The following types of uses will not be approved as home occupations:
(a) Uses involving large or oversized goods or materials;
(b) Automobile, lawn mower, or other engine repair, welding, or machine shops unless the service is offered only at the customer's location (mobile service);
(c) Uses where other employees visit the site, such as operating/dispatch offices for contractors, offices for businesses having employees who are not occupants;

(d) Uses involving more than household quantities of volatile liquids or materials;
~~or~~
(e) Uses involving the grooming, breeding, or boarding of animals~~.~~ ;
or
(f) Uses involving marijuana including but not limited to the dispensaries, sales, cultivation, testing, manufacturing, transporting or temporary storage of marijuana.

D. Add the following section to Sec. 27-1006 Use Standards for INDUSTRIAL, WHOLESALE AND STORAGE

F. Marijuana Cultivation, Processing/Manufacturing & Transporters.
1. Separation distances.
(a) All marijuana cultivation, processing and manufacturing facilities shall be separated by 1,000 feet from neighborhood residential zones ("protected use" as defined in subsection 27-1802.G) as measured from the exterior of the occupied building space of the marijuana cultivation operation or marijuana processing/manufacturing to the property line of the protected use. A neighborhood residential zone includes any Planned Development zone district that allows residential uses.

2. Enclosed structure required.
(a) All marijuana cultivation shall be done inside of an enclosed structure and not outdoors. Such structure will be outfitted with the best available odor control technology.
(b) All marijuana manufacturing and processing shall be done within an enclosed structure. Such structure will be outfitted with the best available odor control technology.
3. Transporters and Storage.
(a) Marijuana transporters are allowed to store in transit shipments of marijuana for short periods of time, not to exceed 30 days. Products may be temporarily stored either in secured vehicles/trailers or within an enclosed structure or warehouse.
4. Marijuana Businesses - The definitions contained in Titles 15, 16, and 50, MCA, shall apply to this Chapter except where the ordinance provides a different definition in Section 27-1803, or the context of this Chapter makes it clear that the statutory definition does not apply.

E. Amend section 27-1402.B to add language as follows:

27-1402.B. Sign permit required.
1. New signs. A sign permit shall be required to erect, place, modify the size or shape, allow the continued placement, or convert any portion of a sign, including a conversion from temporary to permanent or from non-EMD to EMD unless otherwise provided in this article. Permits submitted for marijuana businesses shall provide proof of compliance with state sign regulations along with a completed city sign permit application.
2. Existing signs. Changes to existing signs that are made nonconforming by the 2020 zoning code update require a sign permit and are subject to section 27-

1403, Nonconformities. Changes to existing signs for marijuana businesses shall comply with state sign regulations.

3. Sign permit exemptions. The following activities shall not require a sign permit, provided that these exemptions shall not be construed as relieving the owner from the responsibility to comply with the provisions of this zoning code or any other law or ordinance, including the city's adopted building code(s), and any related state sign regulations:

(a) Changing of the advertising copy or message on an existing approved painted or printed sign, marquee, changeable copy sign or a similar approved sign whether electrical, illuminated, electronic changing message display or non-illuminated painted message which are all specifically designed for the use of replaceable copy;

(b) Painting, repainting, cleaning or other normal maintenance and repair of a sign not involving structural changes. Replacement of or a change of a plastic sign face will be included as an exempt operation;

(c) Changes in the content of show window displays and permitted temporary signs.

F. Amend Section 27-1402.C to add the following language:

Section 27-1402.C.4

Exemptions. The following signs, items, and operations shall not require a sign permit, but shall be undertaken in conformance with this article, and all adopted building code(s):

……

4. Public signs.

(a) Official public signs approved by a governmental body with jurisdiction over issues such as traffic safety, pedestrian safety, schools, railroads, or public notice, as well as signs required by the Manual of Uniform Traffic Controls.

(b) Signs and notices required to be displayed, maintained, or posted by law or by any court or governmental order, rule, or regulation, including any notices required for marijuana businesses.

(c) Government signs and notices provided for the convenience and safety of the community.

(d) Bench signs. Bench signs on benches located on active, fixed bus routes, controlled or authorized by the Billings MET. The benches must be located on active, fixed routes. Signs shall be removed from or prohibited on benches located in prohibited sign locations or where the bench is not associated with an active, fixed route.

G. Amend Section 27-1803.M to add the following language:

M: *M terms*: Add the following after “Manufacturing” terms and before “Marquee”

Marijuana: means all plant material from the genus Cannabis containing tetrahydrocannabinol (THC) or seeds of the genus capable of germination.

Marijuana Cultivation: means a location where growing, harvesting and drying marijuana occurs and where marijuana is packaged and labelled in a natural or naturally dried form that has not been converted, concentrated, or compounded.

Cultivated marijuana is for sale to dispensaries but not for direct sale to consumers.

Marijuana Dispensary – Medical Use: means a location or premises from which a medical marijuana provider or marijuana products provider is approved by the state and local government to dispense marijuana or marijuana products solely to a registered cardholder.

Marijuana Dispensary – Adult Use: means a location or premises from which an adult-use provider or adult-use marijuana products provider is approved by the state and local government to dispense marijuana or marijuana products to a consumer.

Marijuana Dispensary – Combined Use: means a premises from which a medical marijuana provider or medical marijuana products provider and adult-use provider or adult-use marijuana products provider is approved by the state and local government to dispense marijuana or marijuana products to a registered cardholder or to a consumer.

Marijuana Product: means a product that contains marijuana and is intended for use by a consumer by a means other than smoking. The term includes but is not limited to edible products, ointments, tinctures, marijuana derivatives, and marijuana concentrates.

Marijuana Processing/Manufacturing: means the conversion or compounding of marijuana into marijuana products, marijuana concentrates, or marijuana extracts and packaging, repackaging, labeling, or relabeling marijuana products for sale to dispensaries but not for direct sale to consumers.

Marijuana Testing Laboratory: means a location that provides 1) testing of representative samples of marijuana and marijuana products and 2) provides information regarding the chemical composition, the potency of a sample, and the presence of molds, pesticides, or other contaminants in a sample.

Marijuana Transportation: means the packaging, transportation and delivery of processed marijuana, or marijuana products to or from marijuana dispensaries, testing laboratories, or cultivation facilities. This definition does not include any transportation from a dispensary to its consumers or cardholders.

Y: *Y Terms* Add the following after “Yard sign” terms and before “Youth foster home”

Youth Center: means any public or private facility that is primarily used to host recreational or social activities for minors, including, but not limited to, private youth membership organizations or clubs, or social service teenage club facilities. Examples, of youth centers are Boys and Girls Clubs, Audubon Centers, zoos, children’s museums and similar facilities.

4. REPEALER. All ordinances or parts of ordinances in conflict herewith are hereby repealed.

5. EFFECTIVE DATE. This ordinance shall be effective from and after final passage and as provided by law.

PASSED by the City Council on first reading _____, 2021

PASSED, ADOPTED AND APPROVED on second reading _____, 2021.

CITY OF BILLINGS:

BY:_____
William A. Cole, Mayor

ATTEST:

BY: Denise Bohlman, City Clerk

Marijuana Zoning Regulations

Greenlighting Cannabis — What Every Planning Department Needs to Know

Momentum for cannabis legalization is growing nationwide. For communities in states that might be next, the best time to start preparing is now.



In Denver, cannabis production facilities, including the warehouse pictured above, are only allowed in areas zoned for industrial land use. Photo by David Kidd/Governing

By Daniel C. Vock

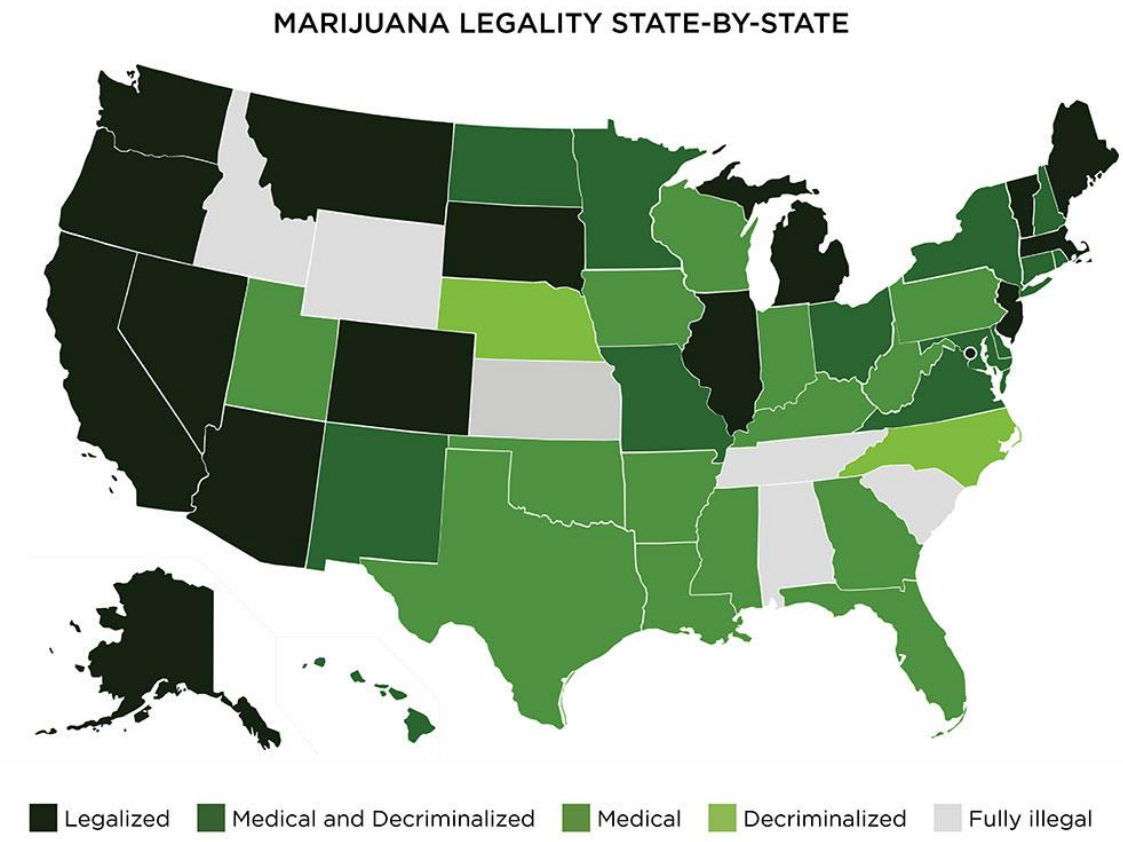
The heart of Denver's legal-cannabis production is in dozens of unmarked warehouses, ringed with barbed wire and security cameras, and located amid factories, railyards, construction rental lots, and other industrial buildings. Sometimes these pot-producing facilities sit quite near, and in some cases across the street from, rows of modest single-family houses in predominantly Black and Hispanic neighborhoods.

The reason? Denver recreational cannabis regulations limit cultivation facilities to areas that are already zoned for industrial use. That essentially pushes all the growing activity into a few areas of town — and neighborhoods. The highest concentration of cannabis growing facilities in Denver, for example, is in the predominantly Hispanic neighborhood of Elyria-Swansea on the

north side of the city. Its streets are choked with semi-trucks making their way to and from a hulking viaduct carrying Interstate 70, a highway the state is now expanding.

"We basically let marijuana come into Denver without really having a good plan of how to regulate it," said Candi CdeBaca, a city council member from Elyria-Swansea who can see four cannabis growing facilities from her house. There were 54 cultivation facilities in that neighborhood and 43 in neighboring Northeast Park Hill, a majority Black neighborhood, according to a 2016 analysis by the *Denver Post*. The city's approach to regulating land use for cannabis operations has led to many hard-to-solve problems for neighborhoods like Elyria-Swansea — and could serve as a cautionary tale for planners in other states that could soon legalize the recreational use of cannabis.

Nationwide momentum for legalization is growing. In 2014, Colorado was one of the first two states to start allowing pot sales, but just last November, five states passed ballot measures to legalize recreational cannabis — including Montana and South Dakota — two largely rural states on a list otherwise dominated by states with large urban centers. All told, 15 states and the District of Columbia have approved legalizing recreational cannabis. As of this writing, Virgina was poised to become the 16th. Both chambers have passed bills to legalize cannabis, but they have to reconcile their differences before it can become law.



Recreational cannabis is currently legal in 15 states. Cannabis is only fully illegal in a total of six states; all others have decriminalized it, allow it for medical use, or have legalized it entirely. Source: Disa Global Solutions, Inc. Data as of January 2021.

Many other states have decriminalized the drug or authorized its use for medical purposes. Democratic governors in states such as Connecticut, Kansas, Pennsylvania, and Wisconsin are pushing for legalization in their states, too. Meanwhile, in December — for the first time ever — the U.S. House of Representatives passed a cannabis legalization bill. Now that Democrats control both chambers of Congress and the White House, the prospects of similar proposals becoming law has increased, but is by no means certain.

With that kind of trajectory, policy experts say communities everywhere should be thinking about and planning for the eventuality of legalized recreational cannabis. Fortunately, they can look to local jurisdictions in states that have gone before them for lessons on what works — and what doesn't.

Regulatory roulette

From the land-use side, each state has handled the transition differently, giving municipalities different powers to control the placement of the new facilities. Some, like California, allow cities to ban the facilities outright. Others have curbed the powers of local governments, to make sure the new industry is allowed to thrive.

Alan Weinstein, a law professor at Cleveland State University who specializes in land use, says cannabis facilities raise some of the same land-use questions as drug stores or liquor stores.

But there are unique aspects to the cannabis industry as well. One of the biggest is that nobody worries about the crops — like grains or potatoes — that produce alcoholic beverages, but people do have concerns about how and where cannabis plants are cultivated. The fact that cannabis is still illegal at the federal level also means that retail facilities that sell cannabis products by and large cannot use credit cards or anything tied with traditional banks, so they operate almost entirely in cash. While there is little evidence that pot dispensaries have higher crime rates than other types of retail establishments, many localities have required them to install more security features, such as fences and cameras, to prevent crime in the area.

Overall, though, Weinstein says the owners of cannabis businesses are willing to agree to many conditions about where they can locate and what features their facilities must have. That's because many are trying to get a toehold in places where the industry is not already established. They will compete for the ability to set up a medical dispensary knowing that companies that have licenses for medical cannabis are often first in line when a state expands to allow recreational use.

"They're willing to go along with pretty much anything, as long as it isn't going to sort of drive them totally out of business or make it unreasonably impractical to operate," Weinstein says.

At the ready

On the other hand, local planners in places where recreational cannabis is coming need to prepare for a big surge in applications. Planning departments need to be ready to accept, review, and process applications. They need to develop a way to renew and transfer licenses. They need to write their requirements for the building, set up inspection teams, prepare for hearings, and consider what local fees and taxes they can implement.

"The local government has to be prepared to take on a whole new regulatory regime," Weinstein warns. "And yes, you can use the new [tax and fee] dollars to help offset the costs of the administration, but the costs are going to lead the revenue."

Corinne Celko, a land-use attorney for Emerge Law Group in Portland, Oregon, says the spread of the cannabis industry presents a unique challenge for planners and localities.

"If I went on *Shark Tank* today because I had invented a gadget and it was successful, and I wanted to go ahead and sell the gadget and make more of the gadget, it would just fit within local jurisdictions' existing development codes and their use categories," she says. "This is the first time in my career where many local jurisdictions treated cannabis as a completely, totally new use."

Not every jurisdiction has taken that approach, but those that do want to create whole new use categories need to understand how the cannabis industry actually works.



There are 54 cannabis production facilities in the Elyria-Swansea, a primarily Hispanic neighborhood of Denver. Most are unmarked warehouses, ringed with fencing and security cameras, some just across the street from residential homes. Photo by David Kidd/Governing.

For example, if a local government wanted to zone an area for agricultural use to grow cannabis, officials and planners should anticipate warehouses and greenhouses, not fields of row crops. That might make it a better fit for industrial zones in addition to farming areas. One locality where Celko was working wanted to allow the manufacture of cannabis edibles and topicals, but it wanted to prohibit extract processing. Celko had to explain to the planning director that banning extract processing would effectively ban companies from making edibles. "Nobody wants to pick out pieces of grass from their teeth," she says.

But — apart from use designation — planners do have plenty of tools to ensure a smooth rollout, Celko notes. For example, they can work on restrictions on how and when properties are used, such as "dark sky" rules to reduce light pollution in rural areas or odor control regulations that require filtering systems.

Local officials should also be willing to revise policies that aren't working how they intended. One Oregon county, for example, wanted to block cannabis farms from being located near "youth activity centers." But the county did not define what that meant and did not amend the code to provide more clarity. Instead, the Deschutes County Board of Commissioners fought the applicant — one of Celko's clients, a grower — and lost at the Oregon Land Use Board of Appeals and at the Oregon Court of Appeals.

In California, attorney Joanna Hossack says, the rollout of recreational cannabis has been slowed by municipalities that chose not to allow cannabis businesses within their borders. Meanwhile, many business licenses have stalled in cities with long approval processes, especially ones that involve public hearings rather than just administrative decisions, she says. And state environmental reviews have taken longer than expected.

There have been bright spots in the rollout, Hossack notes. San Francisco has done a good job helping stores open quickly, and, across the bay, Oakland has helped businesses get licensed quickly, even as it dedicates half of its licenses for equity applicants who have either lived in certain parts of the city or been convicted of a cannabis-related crime in Oakland.

But across the state, 70 percent of municipalities have opted not to license cannabis businesses, creating large "dry pockets" outside of urban areas like Los Angeles County and the Bay Area, she says. That means even patients who use medical cannabis in those areas now have to drive long stretches to find cannabis products. "That is a shame," Hossack says. "Given that California is a leader, you would think we would have more cities that are online.... Prohibiting it isn't reaching the goals people want, and prohibition doesn't work."

One key for successfully introducing a recreational cannabis facility in Evanston, Illinois, says Johanna Nyden, the city's community development director, was educating the general public about the changes that were afoot. Residents had many worries about the implications of legalizing recreational cannabis, such as whether it would lead to an increase in crime or long lines outside the downtown dispensary that would go from selling medical cannabis to selling recreational cannabis. (Neither of those things happened.) City officials tried to share information before rumors could take hold, Nyden says, and many of the state lawmakers from

the area who authored Illinois's recreational cannabis law appeared at community events to answer questions.

"As planners, we are often focused on the zoning and entitlement process, but we often miss the parts that result in the knee-jerk reactions," says Johanna Nyden, community development director in Evanston, Illinois.

"As planners, we are often focused on the zoning and entitlement process, but we often miss the parts that result in the knee-jerk reactions," Nyden says.

Evanston, a Chicago suburb that is home to the main campus of Northwestern University, has only one dispensary, and it's on city property. The store sits across from an art supply store and a movie theater, and is so "innocuous" that you might not even notice it, she says.

But Evanston did attract national attention for how it plans to use its tax revenues on cannabis sales — by using up to $10 million as reparations for the Black community that had been disproportionately harmed by the war on drugs. City officials have not yet decided how to use the money, but possibilities include grants to help Black residents who lived in Evanston between 1919 and 1969 (or descendants of those residents) buy homes or building a new school in the historically Black area of town.

While the reparations proposal came after the land-use changes, Nyden says it has been a good way to acknowledge some of the "inherent hypocrisy" in allowing cannabis use now after decades of punishing people, especially Black residents, for possessing small amounts of the drug.

Unintended consequences

Back in Denver, city council member CdeBaca says many of the current problems with industrial cannabis sites were the result of poor planning early on. The city has put restrictions on where facilities can be located, but many of the sites in Elyria-Swansea don't conform to those rules because the structures predate them. What's more, the licenses of nonconforming sites can be transferred to new owners and continue to operate, so there's no easy way to reduce the number of facilities in the area.

The saturation of sites did eventually lead the city to stop issuing new licenses in 2016. Before it starts giving out new ones, CdeBaca hopes to pass legislation that will encourage more Black and Hispanic people to get those licenses, because the current owners are overwhelmingly white.



City council member Candi CdeBaca can see four industrial cannabis grow operations from her house in the Elyria-Swansea neighborhood of Denver. Photo by David Kidd/Governing.

In fact, Denver's excise and license department is preparing the biggest update to its cannabis licensing regulation since Colorado's first cannabis retailers opened in 2014. The "Marijuana 2.0" revisions are expected to come before the council in March. They include new regulations to allow delivery services and hospitality sales (where customers can use cannabis on their premises), says department spokesperson Eric Escudero. Those regulations will also try to address equity concerns, he says. "People who were most disproportionately negatively impacted by marijuana prohibition should benefit from legalization," he says. "That means creating a market where more people get benefit, whether through ownership or management or employment opportunities."

The rules would also try to prevent further saturation of neighborhoods with cannabis businesses by not allowing any more licenses in the five most saturated areas of the city.

But the issue of concentration of existing facilities is complicated by Denver's approach to treat cannabis as just another industry in terms of zoning. From a land-use perspective, you can currently grow cannabis plants anywhere in the city where you can grow tomato plants. Any special requirements regarding signage or security are part of the city's cannabis licensing process, not its zoning process.

"In terms of control and management, there's a lot of upside to regulating the business, as opposed to the land use," says Tina Axelrad, the zoning administrator for the City and County of Denver. She called the approach "brilliant," because it helps government agencies keep track of who owns the businesses and whether they are fit for that role. It also easier to make sure that businesses comply with regulations the city wants to impose, because business owners tend to react more quickly when their annual license is at stake than when they have been cited for zoning violations.

"Zoning is just a tool to implement policy," Axelrad says, "and if policy changes regarding where marijuana growers should be located or should not be located in the city, the zoning will be adjusted." But she says that the problems with the cannabis facilities are located are just part of a bigger problem of how industrial activities affect some residential neighborhoods much more than others.

"Industrial zones, just like anywhere else in the U.S., tend to be a dumping ground for a lot of things that we don't want in our commercial corridors," she says.

Escudero, from the licensing agency, says Denver's regulatory scheme focused primarily on public safety, whether that was ensuring that youth weren't exposed to cannabis or making sure that the possibility of fires from manufacturing cannabis products was limited to industrial areas. "We're proud of our success in doing that," he says, "because if Denver would have screwed this up, you would not have seen legalization spreading to other communities across the U.S."

In the meantime, CdeBaca says the concentration of industry sites in her neighborhood is causing all sorts of issues. The warehouses themselves "look like jails." With all the security features, residents rarely interact with the people who work in the grow houses, and the owners of the facilities are rarely around.

"It's a little dystopian in some sense, because it's this neighbor that we never meet," she said. "It's like a fortress, but an ugly one."

As unsightly as the warehouses are, they are also driving up the price of the land that they sit on, because there are limited areas within the city where those types of facilities can be located. The more expensive land makes it harder to attract other kinds of businesses to the area and leads to higher property taxes for nearby residents, which fuels displacement, CdeBaca says.

"Our property values are being driven up very high very fast, without the typical, visible gentrification improvements," she says. "It looks exactly the same."

She says it's unfair to burden Black and Brown neighborhoods with the costs of hosting the industry for the whole city or region. "Whiter, wealthier people want to buy their edibles, but they just don't want the grows in their neighborhood," CdeBaca says.

She believes Denver should assess impact fees on the industry to improve the neighborhoods its facilities are located in. "We're carrying this industry on our back, and it's creating such a revenue stream, but we don't [get funds for the neighborhood]. It goes to the whole city to use how they want, when only a small slice of the city is carrying the burden," she says.

That, she stressed, is an important factor for planners to keep that in mind as they decide where facilities ought to be located as the cannabis industry expands.

"Don't layer on to the legacies of redlining," she says.

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Post-Legalization Opening of Retail Cannabis Stores and Adult Cannabis Use in Washington State, 2009–2016

Erik M. Everson, MPH, Julia A. Dilley, PhD, Julie E. Maher, PhD, and Curtis E. Mack, BA

Objectives. To assess the relationship between adult cannabis use and time-varying local measures of retail cannabis market presence before and after legalization (2012) and market opening (2014) in Washington State.

Methods. We used 2009 to 2016 data on 85 135 adults' current (any) and frequent (20 or more days) past-month cannabis use from the Washington Behavioral Risk Factor Surveillance System linked to local retailer proximity and density. Multilevel models predicted use over time, accounting for nesting within communities.

Results. Current and frequent cannabis use grew significantly between 2009 and 2016; use did not significantly change immediately after legalization but increased subsequently with greater access to cannabis retailers. Specifically, current use increased among adults living in areas within 18 miles of a retailer and, especially, within 0.8 miles (odds ratio [OR] = 1.45; 95% confidence interval [CI] = 1.24, 1.69). Frequent use increased among adults living within 0.8 miles of a retailer (OR = 1.43; 95% CI = 1.15, 1.77). Results related to geospatial retailer density were consistent.

Conclusions. Increasing cannabis retail access was associated with increased current and frequent use.

Public Health Implications. Policymakers might consider density limits as a strategy for preventing heavy cannabis use among adults. (*Am J Public Health.* 2019;109:1294–1301. doi:10.2105/AJPH.2019.305191)

See also Johnson and Doonan, p. 1165.

Washington and Colorado were the first US states to legalize the production, sale, and adult use of retail ("recreational" or nonmedical) cannabis in 2012. This change followed many states' decriminalization of cannabis, beginning in the 1970s when Oregon and then 11 other states reduced penalties for possession of up to 1 ounce.[1] Starting with California in 1996, numerous states also legalized the possession or distribution of cannabis for specific medical purposes (including Washington in 1998).[2]

Whether potential increased adult use of a now-legal product (cannabis) is a "problem" has been a subject of much debate. Increasing adult cannabis use may lead to a variety of adverse public health effects, including cannabis dependence, traffic crashes, hospitalizations, and potentially some long-term health outcomes. Although cannabis has long been a commonly used substance, recent major systemic reviews have produced inconclusive evidence about whether cannabis use causes some of the posited health outcomes.[3,4] Furthermore, existing research on cannabis may be only partially generalizable to modern levels of product potency, individual differences in usage frequency, and emerging trends in both product types (e.g., extract oils) and usage forms (e.g., vaping vs smoking).[5] Regardless of how cannabis is consumed, frequent use—such as daily or near-daily use—is likely of more concern than occasional use and has recently been identified as a risk.[6]

Studies on other commercialized controlled substances offer some insight on potential for preventing harms following legalization. Increased local access to off-premise-use alcohol outlets has been repeatedly associated with higher rates of problematic use and related adverse health outcomes.[7–9] Hence, the *Community Guide to Preventive Services* recommends limiting alcohol outlet density, days of sale, and hours of sale as effective strategies for reducing excessive alcohol consumption and associated motor vehicle crashes.[10] Similarly, greater local access to tobacco retail outlets has been associated with higher rates of tobacco use initiation[11] and lower success rates for quitting[12–14] among select adult population groups. And although medical cannabis is not available to the general public, local retail medical availability in California was found to be associated with increased adult cannabis use.[15]

To control retail density, the Washington State Liquor and Cannabis Board, the state agency that oversees regulation of the cannabis market, established maximum numbers of retail licenses allowed.[16] Initially following legalization, the state allowed a total of 334 retail licenses statewide, with specific allocations by city and county jurisdictions. The number was increased to 556 in 2016 to accommodate access to medical markets, which were concurrently integrated into the retail system.[16] In light of the uncertainty about health harms, or in response to other community concerns, numerous local

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jurisdictions acted to prohibit or otherwise further regulate retail sales.[17,18] As of June 2016, 2 years after the initial opening of retail markets, about one third of Washington State's population still lived in a city or county where retail cannabis sales were permanently or temporarily banned. Because of local bans, only 377 of the potentially allowed 556 retailers reported sales in mid-2017, and there has been great variation in access to cannabis retailers among different regions of the state as a result.[19]

The objective of this study was to examine the effects of local access to cannabis retailers on adult cannabis use in Washington, where the retail cannabis market opened in July 2014. To our knowledge, our study is the first to examine the complex associations between local access to a new retail market and use of cannabis among adults.

METHODS

We obtained survey data on individual cannabis use outcomes and then linked them by respondent zip code and month of survey to measures of state legalization and local retail access. Multilevel models predicted use based on access while accounting for legalization, secular trends, demographic factors, and nesting within communities.

Adult Cannabis Use

We used 2009 to 2016 data from the Washington State Behavioral Risk Factor Surveillance System (BRFSS) to describe local cannabis use.[20] The BRFSS is a nationally conducted, state-administered telephone survey of adults. The Washington BRFSS randomly contacts households from a statewide pool of telephone numbers including landlines and, since 2011, cellular telephones. A total of 121 632 people participated in the BRFSS from 2009 to 2016; 58% were female, 58% were 55 years or older, and 87% primarily identified as non-Hispanic White. In 2016, Washington's BRFSS had a response rate of 39.3%[21] (calculated according to the American Association for Public Opinion Research's response rate 4 formula[22]).

The Washington BRFSS asked questions about cannabis use for a random subset of 90 622 total respondents between 2009 and 2016. Respondents were asked on how many of the past 30 days they used any cannabis products. We created primary outcome variables for current use, indicating any cannabis use in the past 30 days, and frequent use, an indicator[23] of use on at least 20 of the past 30 days. BRFSS data on individual demographic characteristics including age, gender, race/ethnicity, education, marital status, and type of telephone (landline or cellular) were also used. A total of 85 135 respondents had complete data on all of these measures.

We used Rural-Urban Commuting Area codes from the Washington Department of Health to define urban and non-urban areas on the basis of participants' zip codes.[24] We used 5-year county-level estimates of the percentages of individuals living below the federal poverty level from the 2011 to 2016 versions of the American Community Survey.[25]

State Legalization Measure

Washington Initiative 502 passed in November 2012. Effective December 6, 2012, the measure legalized small-amount possession and private use of cannabis among adults 21 years or older.[26] For our analyses, we created a binary legalization effect term set to 0 for all months up through November 2012 and 1 for all months after. In addition, we created a term for month centered on legalization with values set to −1 for November 2012, 0 for December 2012, 1 for January 2013, and so on.

Retail Access Metrics

Washington's retail cannabis market opened on July 1, 2014. The number of cannabis retailers with active sales grew each month, from fewer than 20 in July 2014 to more than 300 by mid-2016. We obtained data from the Washington State Liquor and Cannabis Board BioTrackTHC "seed-to-sale" tracking system to determine the months and locations where retail cannabis sales activity had occurred. Using this data set, we computed 3 alternate measures of monthly local access to the retail market: proximity, geospatial density, and per capita density.

Proximity. Our first retail access metric measured the average distance to the nearest retail location among residents of each zip code for each month of the study. To compute proximity, we first applied a grid overlay of 5000 foot by 5000 foot cells (0.9 square miles each) to the state of Washington using ArcGIS 10.5 software (Esri, Redlands, CA) and the Washington State Plane South (ftUS) NAD83(HARN) (EPSG:2927) projection. Using PostgreSQL 10.1 with PostGIS extension 2.4.2 (PostgreSQL Global Development Group), we determined the direct (crow-fly) distance between the center of each grid cell and all retailers with active sales for each month. We selected the shortest distance for each cell per month.

Although we did not know the intra–zip code locations of individual BRFSS respondents, we estimated the cell-level population distribution for each zip code. This distribution was based on 2014 census block group population estimates from the Washington Office of Financial Management,[27] which we initially apportioned to individual blocks using ratios from the 2010 US census[28] and then apportioned to grid cells based on area. Using this distribution, we weighted cell-level proximity computations up to the zip code level, resulting in the average distance to the nearest retailer for residents of each zip code.

Geospatial density. Our second retail access metric was computed in a manner similar to that for proximity but based on the nearest 5 active retail locations. After determining the nearest 5 retailers to each grid cell, we summed the inverse of each cell-to-retailer distance (such that a higher sum indicated more density) and then aggregated these sums to the zip code level. Whereas proximity represented a measurement of the minimum distance a local resident would need to travel to purchase retail cannabis, geospatial density was intended to assess the local retail environment. We adapted this metric from the spatial accessibility index included in the Centers for Disease Control and Prevention's *Guide for Measuring Alcohol Outlet Density*.[29]

Per capita density. Our third access metric was defined at the "community" (contiguous city or unincorporated county) level to reflect the jurisdictional boundaries in which local cannabis-related policies are typically enacted. We computed per capita density for each community by dividing the number of active monthly retailers by the estimated 2014

population. We assigned each BRFSS respondent to his or her most likely community of residence. Using a crosswalk file based on 2010 census block-level population data,[28] we selected the most populous community subsection within each combination of zip code and county. Our resulting sample included 194 distinct communities, with 1 to 6935 participants in each community over the 8 years combined. We assigned a per capita density value to each BRFSS respondent on the basis of his or her community and month and year of survey participation.

Categorization of retail access metrics. We first divided proximity values for the entire study period into ventiles (twentieths) and visually examined both current use and frequent use prevalence across the ventile range. We found both relationships to be nonlinear, resembling 3-tier step functions, so we created a single set of cut points to capture the tier changes in the relationships. Specifically, we created a categorical variable with 5 levels of retail access: premarket, top 5% active market (within approximately 0.8 miles of a retailer), next 5% (0.8–1.1 miles), middle 80% (1.2–18.4 miles), and bottom 10% (beyond 18.4 miles). We followed the same categorization procedure for geospatial density and arrived at an identical set of percentile cut points for retail access categories. We categorized per capita density similarly but with a larger bottom access tier given the many communities and months with no retailers: premarket, top 5% active market (9.7 retailers or more per 100 000 population), next 5% (6.7–9.6 retailers), middle 53% (0.1–6.6 retailers), and bottom 37% (zero retailers active market).

Statistical Analyses

We used descriptive statistics to examine patterns of cannabis use prevalence (current use and frequent use) by participants' demographic characteristics and access to cannabis retailers for the most recent year of survey data (2016). Data for these prevalence estimates were weighted to represent the state population.

We fit generalized mixed models[30] with a random intercept by community effect as well as a random time by community effect. Hence, each community had its own intercept (given that baseline cannabis use might vary by community) and slope for time (given that change in use might vary by community). The key fixed effects in each model included a term for time to describe the average secular trend in statewide cannabis use, a term for state legalization to estimate the average change in cannabis use after legalization, and a term for retail cannabis access. To adjust for other factors, our models also included fixed effect terms for urban classification by zip code, county poverty rate, and individual demographics (i.e., age, gender, race/ethnicity, education, marital status, and landline or cellular phone). Separate models were fit for current use and frequent use as the dependent variable.

We conducted all statistical analyses with Stata version 14.1 (StataCorp LP, College Station, TX). We used the .05 level of significance.

RESULTS

Figure 1 displays Washington statewide adult cannabis use prevalence over time. Quarterly current use prevalence more than doubled over the course of our study, increasing from 5.8% in quarter 1 of 2009 to 13.2% in quarter 4 of 2016; frequent use increased over that period as well, from 2.0% to 5.5%.

As shown in Table 1, a majority of the members of our 2016 BRFSS sample were White (86.9%), were 35 years or older (85.7%), and had at least some college education (73.1%). The 2016 prevalence of current cannabis use was highest among participants who were 18 to 34 years of age (24.2%), those who identified as male (16.9%), those without a high school degree or equivalent (20.9%), and those who had a partner but were not married (27.9%).

Figure 2 shows the monthly distribution of Washington residents, based on zip code–level density values and small-area population estimates, living in various categories of geospatial density. Access to retailers increased over time. When the market first opened in 2014, only 3.8% of state residents lived in a zip code with a geospatial density value of 1.0 or greater; by December 2016, however, 73.2% of residents lived in such environments.

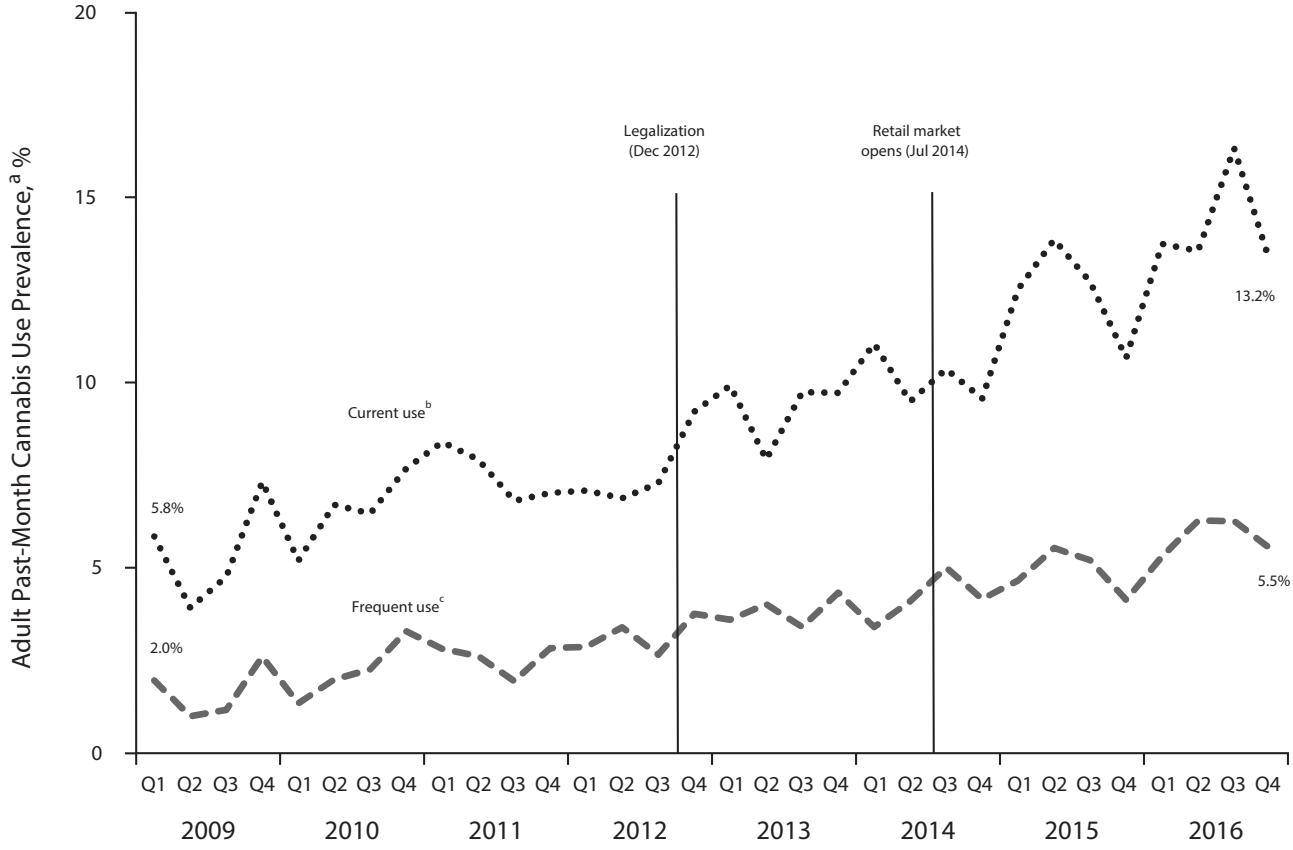
Regardless of the retail access measure used, our adjusted models suggested that current cannabis use and frequent use were significantly increasing between 2009 and 2016 but did not significantly change directly after possession was legalized in 2012 (Table 2). The relationship between retail access and cannabis use varied according to the measures used, as detailed subsequently.

In the proximity model, current use of cannabis significantly increased with closer proximity to retailers; specifically, it increased in zip codes where residents lived an average of less than 0.8 miles from a retailer (odds ratio [OR] = 1.45; 95% confidence interval [CI] = 1.24, 1.69), between 0.8 and 1.1 miles (OR = 1.27; 95% CI = 1.08, 1.49), and between 1.2 and 18.4 miles (OR = 1.18; 95% CI = 1.08, 1.29). Current use did not significantly change in association with the retail market in areas more than 18.4 miles from a retailer (OR = 1.06; 95% CI = 0.89, 1.26).

The proximity model results for frequent use of cannabis varied somewhat from those for any current use. Although the retail market was associated with a significant increase in frequent use among zip codes averaging less than 0.8 miles from a retailer (OR = 1.43; 95% CI = 1.15, 1.77), frequent use did not significantly change in areas located 0.8 to 1.1 miles (OR = 1.02; 95% CI = 0.80, 1.29) or 1.2 to 18.4 miles (OR = 1.04; 95% CI = 0.89, 1.21) from a retailer.

Results for geospatial density were similar to those for proximity; the same terms reached statistical significance in the respective current use and frequent use models. As continuous measures, geospatial density and proximity had a correlation coefficient of –0.45 (data not shown; the value was negative because density was based on inverse distances).

In the per capita density model, results for current use of cannabis were largely similar to those for proximity and geospatial density. Current use increased significantly among communities with at least 9.7 retailers (OR = 1.36; 95% CI = 1.13, 1.64), 6.7 to 9.6 retailers (OR = 1.52; 95% CI = 1.22, 1.89), and 0.1 to 6.6 retailers (OR = 1.17; 95% CI = 1.07, 1.27) per 100 000 population. In contrast with the geospatial models, current use also increased significantly among communities with no retailers (OR = 1.17; 95% CI = 1.03, 1.32), although this lowest-access tier was much larger (37% of the sample) than the bottom tiers for geospatial density and proximity (10%).



[a]Prevalence estimates were weighted to be representative of the state population. A different weighting methodology was used for data prior to 2011, and these data did not include cellular phones in the sample.

[b]Current use: self-reported use of cannabis on any of the past 30 days.

[c]Frequent use: self-reported use of cannabis on 20 or more of the past 30 days.

FIGURE 1—Adult Cannabis Current Use and Frequent Use Prevalence, by Quarter: Behavioral Risk Factor Surveillance System, Washington State, 2009 Quarter 1 to 2016 Quarter 4

Our per capita density model proved less predictive of frequent use than did the geospatial models. Whereas frequent cannabis use increased among areas in the top 5% tiers of proximity and geospatial density, it did not change significantly among communities with at least 9.7 retailers per 100 000 population (OR = 1.12; 95% CI = 0.82, 1.52).

DISCUSSION

This study was the first to our knowledge to explore the association between changing access to retail cannabis and adult cannabis use. We found that adult current use significantly increased in areas located within 18.4 miles of a cannabis retailer, with a larger increase occurring in areas located within 0.8 miles of a retailer. Frequent past-month use, likely the more serious public health concern, increased significantly in areas located within 0.8 miles of a retailer.

Washington already had among the highest US state rates of cannabis use prior to retail sales,[31] suggesting that individuals determined to obtain cannabis may have had little difficulty doing so. The lack of a broad market-related change in frequent cannabis use suggests that most adults prone to such behavior may not have been further compelled to engage in it by the mere existence of the retail market. In the market's highest-access areas, however, elevated levels of convenience or promotion may have had sufficient influence such that additional adults became frequent users. Notably, the number of high-access areas increased over the course our study: by December 2016, approximately 1 in 10 Washington residents (10.1% for proximity, 11.0% for geospatial density) lived in a location where the level of retail access was associated with increased frequent use.

We found local retail access, but not state legalization of possession itself, to be associated with increased cannabis use. Local jurisdictions in legalized states may therefore have some ability to limit increased use through enacting policies such as retail bans, moratoriums, caps on retail license numbers, or density or zoning restrictions. Despite challenges such as bordering communities with less stringent policies, community-level policies may help to prevent especially high levels of local retail access, such as the areas within 0.8 miles of a retailer for which frequent use increased.

TABLE 1—Sample Characteristics and Cannabis Use Prevalence by Demographic Characteristics: Behavioral Risk Factor Surveillance System, Washington State, 2016

Characteristic	Observations, No. (%)	Cannabis Use Prevalence (95% CI)	
		Current[a]	Frequent[b]
State total, 2016	11 765 (100.0)	14.2 (13.4, 15.2)	5.7 (5.2, 6.4)
Age group, y			
18–34	1 683 (14.3)	24.2 (21.9, 26.7)	9.4 (7.9, 11.1)
35–64	5 647 (48.0)	12.6 (11.6, 13.7)	5.5 (4.8, 6.3)
65–99	4 435 (37.7)	4.7 (4.0, 5.5)	1.3 (1.0, 1.8)
Gender			
Female	6 574 (55.9)	11.8 (10.7, 13.0)	4.0 (3.4, 4.8)
Male	5 191 (44.1)	16.9 (15.6, 18.3)	7.6 (6.6, 8.6)
Education			
< grade 12	562 (4.8)	20.9 (16.7, 25.7)	11.0 (8.1, 14.8)
High school degree or equivalent	2 599 (22.1)	17.3 (15.4, 19.3)	7.8 (6.5, 9.2)
Some college	3 525 (30.0)	14.1 (12.6, 15.6)	5.4 (4.5, 6.4)
College	5 079 (43.2)	9.9 (8.9, 11.0)	2.8 (2.3, 3.5)
Telephone type			
Landline only	982 (8.3)	11.8 (9.0, 15.5)	6.0 (4.2, 8.7)
Landline survey, own both	5 688 (48.3)	9.3 (8.2, 10.4)	3.1 (2.5, 3.8)
Cellular survey, own both	1 806 (15.4)	11.6 (9.9, 13.5)	4.3 (3.2, 5.7)
Cellular only	3 289 (28.0)	18.7 (17.2, 20.3)	7.9 (6.9, 9.1)
Race/ethnicity			
Non-Hispanic White	10 220 (86.9)	14.6 (13.6, 15.6)	5.8 (5.2, 6.5)
Non-Hispanic Black	234 (2.0)	25.5 (18.9, 33.5)	11.6 (7.1, 18.3)
Non-Hispanic American Indian/Alaska Native	144 (1.2)	26.0 (17.8, 36.4)	8.0 (4.1, 15.1)
Non-Hispanic Asian	377 (3.2)	6.7 (3.9, 11.0)	1.0 (0.4, 2.5)
Non-Hispanic Hawaiian/Pacific Islander	35 (0.3)	11.9 (3.1, 36.5)	2.7 (0.4, 16.7)
Other non-Hispanic	113 (1.0)	9.2 (4.5, 17.9)	4.2 (1.2, 13.3)
Non-Hispanic, no race preference	38 (0.3)	37.5 (20.9, 57.6)	20.2 (7.6, 43.6)
Hispanic	604 (5.1)	11.8 (9.1, 15.2)	6.5 (4.5, 9.3)
Marital status			
Married	6 488 (55.1)	9.4 (8.5, 10.4)	3.4 (2.9, 4.1)
Divorced	1 715 (14.6)	15.0 (12.7, 17.5)	6.6 (5.2, 8.3)
Widowed	1 339 (11.4)	5.4 (4.0, 7.2)	2.3 (1.4, 3.8)
Separated	178 (1.5)	21.7 (15.2, 30.0)	11.2 (6.6, 18.5)
Never married	1 608 (13.7)	25.0 (22.3, 27.8)	10.4 (8.7, 12.5)
Unmarried with partner	396 (3.4)	27.9 (22.5, 33.9)	11.0 (7.5, 15.9)
Refused	41 (0.3)	16.1 (6.2, 35.5)	9.7 (3.0, 27.2)
Urban status			
Nonurban	4 004 (34.0)	15.2 (13.6, 17.1)	6.8 (5.6, 8.1)
Urban	7 761 (66.0)	13.9 (12.9, 15.0)	5.4 (4.7, 6.1)
Community[c] retailer per capita density[d]			
Highest (≥ 9.7)	1 120 (9.5)	15.7 (12.8, 19.1)	7.0 (5.0, 9.6)
High (6.7–9.6)	983 (8.4)	16.4 (13.5, 19.7)	6.0 (4.2, 8.5)
Medium (0.1–6.6)	6 390 (54.3)	13.9 (12.8, 15.1)	5.2 (4.5, 6.0)
None (0.0)	3 272 (27.8)	13.9 (12.1, 16.0)	6.6 (5.3, 8.1)

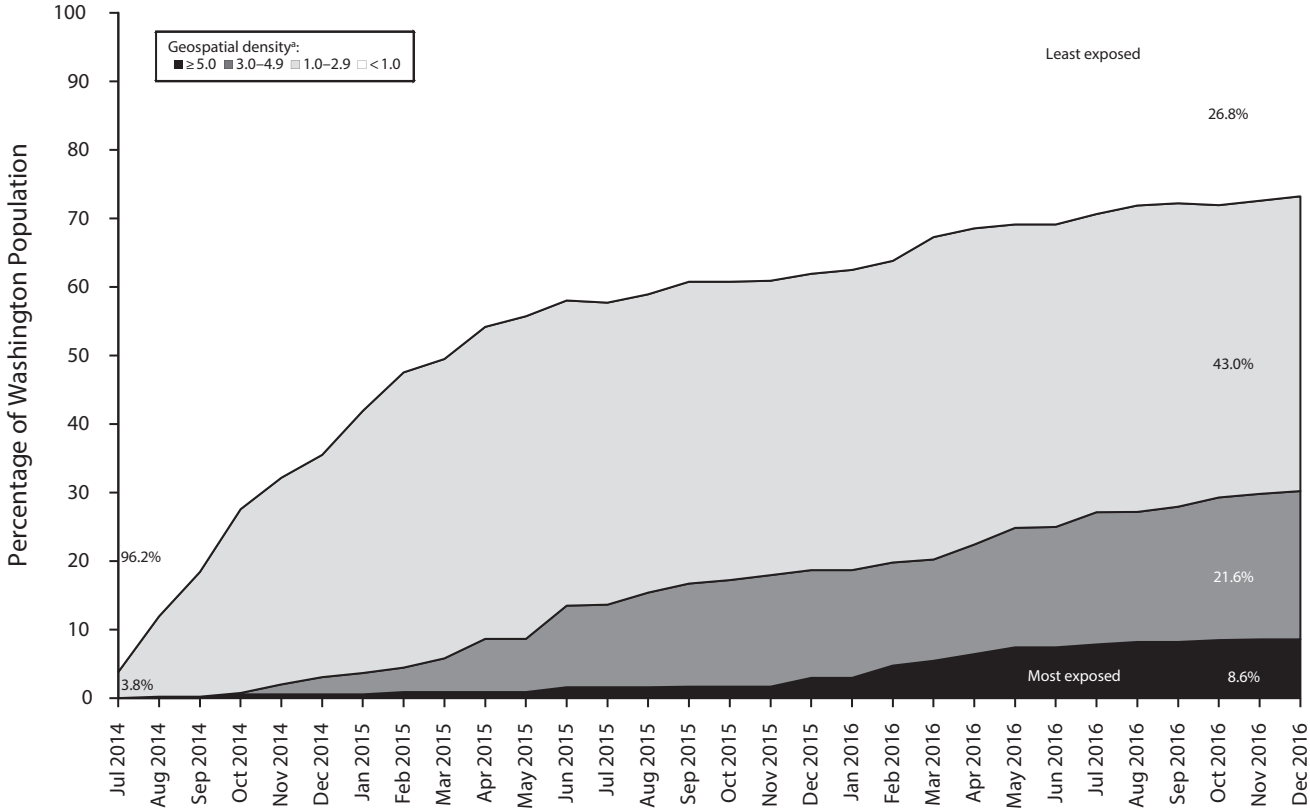
Note. CI = confidence interval. Prevalence estimates were weighted to be representative of the state population.

[a]Current use: self-reported use of cannabis on any of the past 30 days.

[b]Frequent use: self-reported use of cannabis on 20 or more of the past 30 days.

[c]Community: city or unincorporated county (n = 190 in 2016), assigned according to respondent zip code and county.

[d]Number of active cannabis retailers per 100 000 estimated population in each community.



Note. Data were derived from the Washington Office of Financial Management and the Washington State Liquor and Cannabis Board.
[a]Geospatial density: population-weighted sum of inverse distances from home zip code to the nearest 5 active retail locations. Higher values indicate more retail access.

FIGURE 2—Percentages of Residents Living in Areas of Various Categories of Geospatial Density of Recreational Cannabis Retailers: Washington State, July 2014 to December 2016

Also, although occasional adult cannabis use may not prove to be a substantial public health problem, our results suggest that restricting retailer density to fewer than 6.7 locations per 100 000 community population may help mitigate increases in use. Given the variation in cannabis use prevalence among demographic groups, however, the effectiveness of such policies may vary by neighborhood. For example, restricting retail density to a set limit would likely have a different mitigation effect on a college campus than in a suburban community.

Our per capita density model showed that even communities with no active retailers experienced a market-associated increase in current use of cannabis. This suggests that the efficacy of any jurisdictional policy restricting local retail access may be tempered by retail availability in nearby communities. Thus, in nonremote communities, a regional- or state-level policy approach may be necessary to effectively limit retail access. Washington limited retailer density at the city and county levels by establishing caps on the number of issuable retail licenses. It is also noteworthy that per capita density, although commonly used in regulations, did not characterize access as meaningfully as the geospatial-based metrics included in our study.

To regulate alcohol-related problems, Washington has already established community-requested "alcohol impact areas"[32] that include limitations on retail hours and the sale of specific products. This may be another model for limiting retail access to cannabis markets in a different way than restricting numbers of licenses, if communities are experiencing adverse consequences.

Other factors may affect the concept of access to retail cannabis, including price. Average retail prices fell considerably over our study period and will likely continue to decrease,[5] although lower prices may be more likely to affect individual usage volumes than prevalence of occasional or current use. Visibility, including that due to advertising, could also be important. One study showed that more than half of Oregon adults had recently seen cannabis advertising such as retail storefront and billboard promotions, with greater exposure among residents of neighborhoods containing cannabis retailers.[33] Regulatory approaches to address prices (e.g., taxes) and limit retail promotions may be another relevant consideration for policymakers to broadly influence accessibility.

Although our study included 30 months of market data, longer-term cannabis use trends may vary as the retail market stabilizes. Longer-term study is needed to determine whether increases in current use will be sustained.

TABLE 2—Odds Ratios for Past-Month Cannabis Use: Behavioral Risk Factor Surveillance System, Washington State, 2009–2016

	OR[a] (95% CI)		Adjusted OR[b] (95% CI)	
Retail Access Metric	Current Use[c]	Frequent Use[d]	Current Use[c]	Frequent Use[d]
Proximity[e]				
Time (12 mo)	1.14 (1.09, 1.18)	1.19 (1.12, 1.26)	1.11 (1.07, 1.16)	1.16 (1.10, 1.23)
Legalization	1.10 (0.96, 1.26)	1.07 (0.88, 1.30)	1.12 (0.98, 1.29)	1.09 (0.89, 1.33)
Retail access				
Top 5% (<0.8 mi)	1.46 (1.25, 1.72)	1.46 (1.15, 1.86)	1.45 (1.24, 1.69)	1.43 (1.15, 1.77)
Next 5% (0.8–1.1 mi)	1.24 (1.04, 1.47)	1.01 (0.81, 1.25)	1.27 (1.08, 1.49)	1.02 (0.80, 1.29)
Middle 80% (1.2–18.4 mi)	1.08 (0.99, 1.18)	0.96 (0.83, 1.11)	1.18 (1.08, 1.29)	1.04 (0.89, 1.21)
Bottom 10% (>18.4 mi)	0.93 (0.79, 1.11)	0.90 (0.69, 1.17)	1.06 (0.89, 1.26)	0.97 (0.75, 1.26)
Geospatial density[f]				
Time (12 mo)	1.13 (1.09, 1.18)	1.19 (1.12, 1.26)	1.11 (1.06, 1.15)	1.16 (1.10, 1.23)
Legalization	1.11 (0.96, 1.27)	1.06 (0.87, 1.29)	1.14 (0.99, 1.31)	1.09 (0.90, 1.33)
Retail access				
Top 5% (≥4.70)	1.28 (1.05, 1.56)	1.28 (0.96, 1.7)	1.39 (1.13, 1.71)	1.40 (1.07, 1.83)
Next 5% (3.36–4.69)	1.36 (1.16, 1.59)	0.97 (0.73, 1.28)	1.45 (1.25, 1.69)	1.01 (0.76, 1.35)
Middle 80% (0.18–3.35)	1.11 (1.02, 1.20)	0.98 (0.84, 1.13)	1.20 (1.10, 1.31)	1.05 (0.90, 1.22)
Bottom 10% (<0.18)	0.87 (0.73, 1.03)	0.85 (0.65, 1.12)	0.97 (0.81, 1.16)	0.93 (0.71, 1.22)
Per capita density[g]				
Time (12 mo)	1.14 (1.09, 1.19)	1.20 (1.14, 1.27)	1.11 (1.07, 1.16)	1.17 (1.10, 1.24)
Legalization	1.09 (0.95, 1.24)	1.03 (0.85, 1.25)	1.13 (0.98, 1.29)	1.07 (0.88, 1.30)
Retail access				
Top 5% (≥9.7 per 100 000)	1.13 (0.93, 1.36)	0.93 (0.67, 1.29)	1.36 (1.13, 1.64)	1.12 (0.82, 1.52)
Next 5% (6.7–9.6 per 100 000)	1.31 (1.08, 1.59)	1.01 (0.74, 1.38)	1.52 (1.22, 1.89)	1.17 (0.85, 1.62)
Middle 53% (0.1–6.6 per 100 000)	1.08 (1.01, 1.16)	0.94 (0.8, 1.11)	1.17 (1.07, 1.27)	1.00 (0.84, 1.20)
Bottom 37% (0.0)	1.07 (0.95, 1.19)	0.98 (0.83, 1.15)	1.17 (1.03, 1.32)	1.06 (0.90, 1.25)

Note. CI = confidence interval; OR = odds ratio. All models clustered by community (n = 194; city or unincorporated county assigned according to respondent zip code and county). Retail access terms describe the change in cannabis use between premarket and active-market periods for locations of the given access categorization. For example, in the proximity models, the top 5% (<0.8 mi) term describes the change in use prevalence associated with the retail market among locations within 0.8 mi of a retailer, for only the months those locations met the <0.8 mi access criterion.

[a]Odds ratio taken from generalized linear mixed model with time, legalization, and retail access measure as independent variables.

[b]Odds ratio taken from generalized linear mixed model adjusted for age, gender, education, race/ethnicity, marital status, urban status, county poverty rate, and survey telephone type.

[c]Current use: self-reported use of cannabis on any of the past 30 days.

[d]Frequent use: self-reported use of cannabis on 20 or more of the past 30 days.

[e]Proximity: population-weighted average distance from home zip code to nearest active retail location.

[f]Geospatial density: population-weighted sum of inverse distances from home zip code to the nearest 5 active retail locations.

[g]Per capita density: number of active cannabis retailers per 100 000 estimated population in each community.

Limitations

Our study has several limitations. First, we assumed Washington BRFSS respondents to be representative of the state population in estimating associations between access and cannabis use. Second, because cannabis has been illegal and has carried social stigma, it is possible that some survey respondents opted not to disclose their actual use. If this underreporting decreased over time in conjunction with state legalization, this may have led to an exaggerated increase in actual cannabis use. However, we do not have reason to believe that survey respondents were more or less likely to admit use according to their proximity to a retailer.

Third, our retail access measures involved limitations. We computed geospatial retail access on the basis of survey respondents' residential zip codes. Some of Washington's less populated zip codes span large areas, such that actual retail access may vary considerably according to intra–zip code location. We used small-area population estimates to accurately compute population-average access for each zip code, reducing attenuation of findings that would have resulted from this limitation. For the per capita model, we assigned survey respondents to the most likely community given their zip code and county, but an estimated 21.4% of respondents were incorrectly assigned to a community neighboring their actual residence. These misclassifications may have attenuated our findings and limited the per capita model's predictive ability, although defining retail access on the basis of jurisdictional boundaries is moderately imprecise by nature.

Fourth, our study did not account for average retail cannabis prices, which decreased substantially over time as the market grew.[5] To what extent decreasing prices magnified the effect of access on use is an area for further study.

Fifth, we analyzed access to retail cannabis but did not account for cannabis availability from other sources. In addition to the outright illicit market, Washington had a large number of minimally regulated medical cannabis "collective gardens" in operation between 2009 and June 2016.[34] Because we did not account for alternate sources, we overestimated the net proportional increase in cannabis access attributable to the retail market (although not for the law-abiding general public). Our findings may thus underestimate the potential effect of introducing retail access as compared with locations with smaller or less easily accessible medical and illicit markets.

Public Health Implications

We found the Washington retail cannabis market to be associated with increased past-month adult use throughout most of the state and increased frequent use among locations with especially high retail access. Although the public health implications of increasing cannabis use are not yet clear, our findings suggest that local jurisdictions can mitigate

increased usage through policies limiting retail access in residential locations. AJPH

CONTRIBUTORS

E. M. Everson, J. A. Dilley, and J. E. Maher designed the study, interpreted results, and wrote the article. E. M. Everson led the data analysis. C. E. Mack advised on geospatial analysis design and performed geospatial computations.

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Note. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

HUMAN PARTICIPANT PROTECTION

No protocol approval was needed for this study because no human participants were involved and secondary data were used.

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Cannabis in Medicine

An Evidence-Based Approach

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Equo ne credite, Teucri. Quidquid id est, timeo Danaos et dona ferentes
– Publius Vergilius Maro, 19 B.C.

Medicus necesse est dicere quod possit ex antecedentibus, quia praesens et futura dicamus - haec medium est, et in intuitu obiecti specialem duo de morbo, scilicet facere bonum non est non nocere
– Hippocrates, Of the Epidemics, 400 B.C.

Dedicated to those who have been affected or have lost loved ones to any substance of abuse and addiction, including marijuana, and to the memory of Peggy Mann, and other pioneers, not afraid to speak the truth.

Foreword

Losing Ground: The Rise of Cannabis Culture

Addressing the Wider Implications of Increasing Marijuana Use

Why Our Knowledge of the Risks in Cannabis Exposure Has Increased

As ongoing science enhances our understanding of the health risks of cannabis/marijuana exposure, two dimensions of the problem have been revealed. First, the range of health concerns has grown. Second, our confidence has grown that the risk lies in the impact of cannabis exposure itself, as an independent variable, rather than in a constellation of potential confounders.

To be sure, genetic propensity and co-morbidity issues affect the risk of cannabis exposure, placing some populations at higher risk than others, but the exposure to cannabis has a clear effect on the course of the propensity and/or the expression of the co-morbidity over and above the simple fact of a predisposition.

More broadly, of the known health concerns that were visible in research over the past 20 years (to pick an arbitrary period), it is reasonable to argue that few have been allayed or disconfirmed, while the majority of concerns have been not only confirmed but, in several instances, rendered even more worrisome, fraught, and widespread in terms of populations affected and the severity of the effects.

Results are surely still contested, but in general cautions are increasingly becoming questions more of the persistence and depth of the effects, rather than rejection of the validity of strong correlations between cannabis exposure and increased risk of negative effects.

Studies increasingly support some attributional role to the elements of cannabis themselves as producing risk and, in some instances, even strengthen suspicions of a more direct or even causal role from cannabis exposure, particularly when prolonged. This generalization seems to hold especially regarding susceptibility to psychotic episodes and other emotional or cognitive adverse outcomes.

A major reason for the growing confidence in findings of negative health effects has been a series of changes affecting both the cannabis drug itself as currently marketed, as well as the power and subtlety of the research methods brought to bear on our understanding of the effects.

Simply put, the science has changed, growing more robust, as the drug and exposure to it has changed, the result being a more urgent sense of individual as well as population damage.

Specifically, the science informing our portrait of cannabis consequences has become more refined and more grounded in neurophysiology, as better techniques utilizing brain scans or animal models increasingly show what appear to be profound changes in brain physiology and function under certain circumstances of exposure.

In addition, wider and more careful evaluation of the consequences of *in utero* and perinatal exposure (as well as the potential impact of exposure of infants through maternal use and lactation) are all informing our understanding of the basis for epidemiological and behaviorally based evidence long seen with regards to the consequences of cannabis exposure.

That is, widespread population findings are now being provided with enhanced biologically based cognitive and neurophysiological reinforcement that the impact of cannabis consumption produces elevated behavioral and mental performance risks.

The drug as consumed likewise has changed from as recently as 20 years ago, not only with respect to average potency on the market (rising from roughly 3% THC to a national average of no less than 15% THC for smoked marijuana plant material), but further with respect to the relative market share of high potency product. Potency is not only rising as an average, but the proportions available in the commercial market are also shifting upwards towards higher potency smoked cannabis, such as found with sinsemilla, averaging nearly 20% potency, becoming the market standard.

Today, with respect to the "industrialized" ultra-high potency product accelerated by commercialization (still reportedly replete with heavy metal and fungal contaminates), we find available potencies routinely ranging from 20% THC to upwards of 40% as found in smoked joints filled with plant product, now supplemented by new products presenting concentrates of nearly pure THC (reported at 60–90% potency) capturing high-end commercial market share.

One corollary of these changes in potency is that longitudinal studies of youth, begun several years in the past, are therefore based on THC exposure at relatively low potencies, and as such their findings may not be reliably projected onto the impact that today's initiates may experience over their lifetime, given the far stronger doses that constitute their initiation experience.

That is, the marijuana of the past has been supplanted by a drug with qualitatively different characteristics and potential impact, with changes even found in shifting ratios of the cannabinoids presented (smaller percentages of CBD, for instance, diminished in favor of concentrated THC). Moreover, while there is evidence of some positive or at least ameliorative effect from CBD exposure, there are concerns that greater doses of CBD may produce biphasic responses. This potential

is only now being explored. Nevertheless, much of the modern commercial product has been deliberately selected for THC concentration at the expense of other cannabinoids, such as CBD.

Moreover, early blandishments from cannabis activists that such changes in the product, showing increasing potency of THC, were not "real" but were a function of measurement artifacts, or second if the changes were "real" that they need not signal greater ingestion of THC because users might titrate their dosages, or even arguments that stronger doses at higher potencies would not necessarily present greater risks of intoxication and potential dependency profiles, have all been shown to be illusory reassurances.

Instead, we have learned that users, especially naïve users, do not show a profile of careful titration, but instead seem to be getting dramatically more intoxicated, for longer periods than heretofore, coupled with growing evidence [1] that higher potency exposure is indeed correlated with increased risk of dependency or the onset of Cannabis Use Disorder (CUD).

Further, the modes of consumption of cannabis (principally THC) have changed, largely as a function of commercialization, generating not only new products but also new forms of their being consumed, such as in the form of edibles or drinks, or concentrated forms of the drug consumed no longer as smoked leaves but rather as forms of "shatter" or purified THC extraction products, often "vaporized" rather than smoked, or orally ingested.

One potential effect of such novel products is that our surveys of self-reported usage, especially by youth, are rendered less reliable as a measure of cannabis prevalence, since survey questionnaires built around models of smoked leaf consumption struggle to capture the proportions of consumption represented by the new modes of ingestion.

Increasingly, for instance, we learn that "edibles" [2] may now represent as much as half of new youth consumption, according to sales data from state dispensaries [3], while questions concerning "vaporizing" over and beyond "smoking" are only now being incorporated into standard youth surveys.

That is, the overall reliability of our measures of use is declining, and changes in the relative trajectory of youth use, in particular, are becoming less certain because of survey discontinuities (in particular, changes to the NSDUH survey methodology leading to a discontinuity with years prior to 2001).

The changes to the drug itself, and our means of detecting its effects, are intersecting with yet additional changes in the patterns of consumption, particularly by youth at developmentally susceptible periods. The window of susceptibility for developmental impact ranges from early adolescent exposure (not uncommonly at ages 12–15) up through early adulthood, at ages 18–25, when brain development still presents a vulnerability.

It should trouble us, for instance, that the age group showing the greatest increase in cannabis prevalence rates is the young adult population ages 18–25, as found in national surveys. Though subjects are in early adulthood, in terms of brain development they are still at a vulnerable period for negative cannabis effects to become long-standing adult problems.

Further, many of this age group live in a college or university setting, where nearly half of the student population is still legally underage for legal commercial purchase, comingling there with the young adults who are not only the heaviest users but are "legal" commercial product consumers. Do colleges present a particular domain of underage access to high-potency commercial cannabis acquired from peers?

Not only are more youth now exposed to cannabis markets as a function of state legalization and the rise of commercial markets, but the patterns of use are increasingly intensifying, in the sense that the frequency of use in youth populations is moving towards daily or near-daily exposure.

For instance, data from the largest national survey of drug use (discussed in detail below) show that the percentage of users of marijuana within the past year who used "more than 300 days" during the past year has risen steeply, from 12.2% of the total in 2002 to 19.8% of Past Year users in 2017, the most recent data available.

Hence, not only are more people using cannabis today than before, but they are using the drug more frequently, and at considerably higher potencies than before.

That is, a larger share of youth and young adult users, in particular, is gravitating towards a profile of use that presents the greatest developmental threat: frequent, repeated exposure at a developmentally sensitive period, an exposure that moreover is sustained for multiple years. The risk of developing Cannabis Use Disorder (CUD), for instance, becomes more pronounced with every year of use; according to recent research, for each succeeding year of exposure after initiation, the percentage of users experiencing CUD increases [4] steadily, rising to more than 20% of users at the fourth year of use beyond initiation.

As we have noted, longitudinal studies of the impact of early exposure traced over time into adulthood are worrisome enough, without taking into account that the THC potency routinely encountered at first exposure was likely a fraction of what an early adolescent is presented with today. This fact leads to the realization that the true developmental impact of early exposure, traced into maturity, is likely to understate the current potential impact, as the career of users initiating with high-potency THC products and then progressing to daily use at an early age has not yet been seen in current longitudinal studies.

In 1992, only 9% of Past Month cannabis users reported being heavy users (25 or more days per month). By 2014, that figure had risen to 40%. Recent analyses of dispensary users show that those "daily/near-daily" users consume about three times as much per day of use as less-frequent smokers and are estimated [5] to account for more than 80% of cannabis sales. Under the impact of high-potency THC consumption, tolerance progresses rapidly, and in order to sustain sufficient intoxication, dosages offered at unprecedented levels are now a routine share of all cannabis sales, and are escalating.

Hence, the damage that we observe today is best understood as a retrospective grasp of the consequences of cannabis exposure from a period when, in relative terms, the drug was less dangerous, while the impact of adolescent exposure today has as yet to be manifested, and is likely far worse than we have yet to witness. The

future may yet reveal a greater risk for early, frequent, high-potency use than we have anticipated.

These changing factors taken together will likely produce an enhanced understanding of the "disease burden" of greater cannabis prevalence following from "legal" commercialization, and resultant normalized attitudes towards ingestion in the wider society, and the likely correlative impact of heavy cannabis use on the use of other substances of abuse.

That "burden" may considerably exceed our current estimates, and even require us to rethink our sense of the "ranking" of drug threats, with vastly greater cannabis prevalence elevating substantially whatever impact is found at the individual level.

That is, this current experiment with cannabis, underway nationwide, is leading us towards a future of unanticipated consequences, a future already established in the patterns of use "seeded" in the population but as yet unmanifested.

To be sure, studies of cannabis risk are largely "correlational" or show "associations" with relative risk, and are not clear demonstrations of cannabis "causality," a rarity in any epidemiological undertaking.

Nevertheless, the correlations are compelling, especially when there is found a robust relative risk signal, a demonstration of a dose-response relationship between the exposure and the impact, and plausible biological pathways or mechanisms for the exposure to be linked to the effect, such as found in studies of brain development and in animal models.

Moreover, critics of the notion that cannabis exposure is causally linked to negative effects often fail to recognize that the "correlation" arguments constitute not just single dimensions of damaging effects, limited to one domain of biological consequences, but rather present a striking and wide-ranging "constellation" of studies and effects across a wide horizon of biological domains. What we increasingly see in research reports is a convergence of findings regarding cannabis risk that are mutually reinforcing.

That is, the dangers of exposure are found not only in brain physiology and function, ranging across a variety of functions and performances including cognition, memory, emotion, motivation, and potential psychological pathologies, but are further compounded by multiple behavioral studies and outcomes, involving school performance, lifetime achievement, susceptibility to social pathologies and disorders, and troubling propensities, such as suicide [6] risk.

In general, the literature shows not only multiple negative effects on large proportions of regular cannabis users, but we learn that for some specialized populations, such as those with mental or genetic predispositions or histories of pathologies or co-morbidities, cannabis exposure can be elevated beyond the risky to the level of the catastrophic, involving psychotic breaks and dissociations.

An added perversity is that many advocates, as well as those promoting greater commercial access and use of the drug, encourage exposure for populations already known to be at risk, such as sufferers of Post Traumatic Stress Disorder (PTSD), pregnant or nursing women, those with compromised immune systems, or those already at risk from substance use disorders, such as dependent opioid users.

That is, populations at high risk of developing cannabis abuse disorders and suffering disproportionately the consequences are being, perversely, targeted with messages to use cannabis as a putative protection or relief from their condition, either through so-called "medical marijuana" programs found in multiple states or through commercial, "recreational" market advertising and promotion. There are even direct targeted inducements [7] for pregnant women to consume marijuana to ease their afflictions, or unproven efforts to provide cannabis as an alternative to medications available for opioid use disorder, or even as a pain management regime thought to be superior to opioids.

In summary, each of these factors, when taken together, renders what dangers we thought were likely risks, as seen in the current literature, as being in fact likely understatements of the real risk now presented to the generation now affected, those coming of age in the era of a normalized, widespread, and aggressive market promoting drug exposure.

Limitations to Our Knowledge: Inadequate Measures, No Real Baseline

Before turning to current data showing the extent of cannabis use, it is important to stress the dismaying limitations on our knowledge. In some measure because drug use has been an illicit activity, our grasp of the true scope of prevalence, as well as accurate trajectories of change, has been deficient, perhaps presenting more uncertainty than found for any other large-scale medical challenge.

There are three major surveys providing information on use at the national level. The National Survey on Drug Use and Health (NSDUH), run under the auspices of the federal Department of Health and Human Services, is performed annually on a sample population of roughly 70,000 persons, with summed state-level data being reported every 2 years. The scope of coverage is taken to represent all Americans aged 12 and older living in households.

In addition, there are two surveys directed specifically at the youth/young adult population. Monitoring the Future (MTF) is conducted, under a grant from the National Institute on Drug Abuse (NIDA) to the University of Michigan, in select high schools (with a separate college age population segment), reporting on 8th, 10th, and 12th grade drug use. MTF routinely samples, on an annual basis, approximately 44,000 youth. The 12th grade data extend back to 1975, while the addition of 8th and 10th grade data begins since 1991.

The third is the Youth Risk Behavioral Survey (YRBS), overseen at the state level by the Centers for Disease Control (CDC). This survey is biennial, and questions a wide array of health-risk behaviors, only some of which behaviors include a substance use component. Prevalence rates are affected by the setting of the survey instrument, with school-based responses commonly exceeding those reported from households. Limitations on the YRBS as a national-level survey, (such as low response rates, incomplete state coverage, and even under-coverage

within states – the Colorado YRBS version has not had participation from the largest school district since 1995) render it less useful for our purposes.

None of the three surveys is an ideal surveillance instrument for a variety of reasons, the most prominent deficiency being that they all rely on self-reports of behavior, with the reports not subject to any objective evidence of actual exposure.

Moreover, the coverage of the sample populations presents an inherent limitation, given that either residence in stable households or current school attendance are necessary preconditions in order to be captured in the survey response. Hence, we may be systematically missing the very population most at risk for heavy substance use, since they may have suffered attrition from the sample population, being found neither in stable households nor enrolled in school.

While it is possible to supplement the findings of these surveys by reference to data such as drug-related arrests, incarcerations, treatment admissions, and hospital emergency department episodes, efforts to capture these data at the national level are inadequate, and poorly funded.

In fact, several sources of supplemental federal data on populations most at risk, such as the nationwide data-collections known as the Drug Abuse Warning Network (DAWN), which was focused on emergency department admissions (and/or mortality data), or the Arrestee Drug Abuse Monitoring (ADAM) program, focused on law enforcement intake populations, are currently unfunded at the national level, their operation suspended under the Obama administration.

Finally, though we can review the most recent survey reports (restricted in this discussion to the most reliable instruments, the NSDUH and the MTF), it remains a surprising fact that analysts at the federal level face considerable uncertainty establishing either the volume of illicit substances produced domestically or globally (Supply), and have even less reliable information on the volume of such substances consumed, or the market value of the products (Demand).

It follows that authorities trying to implement national drug control strategies that integrate “supply reduction programs” with “demand reduction programs” are faced with the reality that measurements of both supply and demand are woefully uncertain.

The challenge is particularly acute when it comes to cannabis production and consumption, since the metrics may rely on metric tons of organic material, while the most consequential variable should be the quantity of intoxicant actually consumed. Obviously, a marijuana plant with average THC potency of 3% available for market consumption is simply not comparable to a concentrated chemical product sold at 70% THC. Hence, the true metrics of actual THC consumption are exceedingly uncertain.

Current Measurements of Marijuana Use Showing the Comparative Scope of the Problem

Deficiencies aside, we can nevertheless observe relative changes over time in the self-reported data, even acknowledging that important populations with heavy use are likely not being measured at all.

American society has been plagued by various forms of substances of abuse throughout its history. But until the later half of the twentieth Century they did not include widespread consumption of cannabis, particularly by youth.

Before chronicling the most recent findings regarding cannabis use in the USA, as reflected in the 2018 National Survey on Drug Use and Health (NSDUH), it is worth a momentary reflection on the contemporary status of alcohol consumption as reflected by the same measuring instrument.

Surely some of the disease burden of a substance like alcohol is a function of its legal status for adults, producing prevalence rates of routine use that are multiples greater than the rates of use of cannabis, prior to legalization. If the impact of commercial legalization produces for cannabis prevalence rates in emerging generations that approach those of alcohol use, not only will cannabis use itself register as a more grave public health problem than it has been, its use somewhat truncated by legal risk, but the resultant impact of the concomitant use of alcohol and cannabis as dual public health threats could well exceed the damage of either of the substances taken alone.

That is, the future may present us with an intensifying "additive" model of substance misuse, as emerging and increasing cannabis patterns of use intersect with already prevalent alcohol use, there being little support for the hopeful speculation that cannabis use might supplant, rather than complement, concurrent alcohol consumption. Needless to say, measures of their interactive effects are as yet poorly developed.

A second reason to view contemporary alcohol consumption is that it might prefigure the potential scale of future cannabis consumption, after legalization and normalization of cannabis use becomes the context in which future generations acquire their norms of substance misuse.

Alcohol is more widely used, to be sure. But at least some of the disparity in prevalence is a function of the heretofore inhibitory effect on cannabis use deriving from the fact of societal prohibition, backed by legal sanction. Once those legal sanctions are removed, at least for adults 21 and older, we might be seeing in alcohol use the potential scale to which cannabis use might well grow, once promoted, fully commercialized, and normalized for a generation or more.

Accordingly, for the use of alcohol, in 2017, according to the NSDUH survey, there were in the population 12 and older 140.6 million current (Past Month) alcohol users, 66.6 million of which were "binge drinkers," 16.7 million of which were "heavy drinkers" during the Past Month, while 7.4 million drinkers were "under-aged."

While by no means inevitable, we see at least a plausible model for the scale of nationwide cannabis use following full legalization, a figure approaching fully half of the American population 12 and older routinely consuming an additional addictive substance.

Moreover, it would be a substance, cannabis, that has its greatest negative impact relatively early in life, compared to the worst negative health effects of alcohol, most commonly manifested later in life after years of abuse. In this regard one may further note recent research arguing that cannabis exposure is even more damaging [8] to adolescent brain development than is alcohol exposure.

To grasp the scale of illicit drug use, and its steep recent rise, we should look to what NSDUH terms Past Month (or "Current") use for the set substances identified as constituting use of "Any Illicit" drug (which category is inclusive of marijuana use).

Retrospectively, for 2015, shortly after early state-level commercial legalization of marijuana, NSDUH reported that during the course of that year, Past Month use of "Any Illicit" drug in the population 12 and older stood at 27.1 million Americans.

Scarcely a year later, however, the 2016 figures show a rise to 28.6 million users, an increase of 1.5 million additional drug users. This increase of Past Month users was nearly 6% in a single year.

The main reason for the overall "Any Illicit" increase can be found in the increased use of marijuana, which rose between 2015 and 2016 from 22.2 million Past Month marijuana users to 24 million users, an increase of 1.8 million users. The increase was just over 8%.

Since those data came out, NSDUH has advanced one more year to 2017 data (the survey results are released in September of the succeeding year, so the 2018 NSDUH report contains the 2017 data).

First, the new figures for "Any Illicit" drug use: In 2017, 30.5 million Americans 12 and older (that's about 1 in 9 Americans) were Past Month users of "Any Illicit" drug. That rise once again represents a slightly greater than 6% increase in a single year over 2016's 28.6 million users. That is, in two short years we have witnessed an increase in regular illicit drug use of 12%.

More specifically, focused just on marijuana, the 24 million Past Month users from 2016 has now risen to 26 million users in 2017. Again, for marijuana use, for the second consecutive year, the rise is just over 8% in a single year – yielding slightly greater than a 16% rise in what could arguably be seen as the first 2 years of the period post commercialization.

Marijuana use far outstrips the self-reported use of any other "illicit" substance.

The second-ranked "illicit" drug used is found in the misuse of prescription analgesics, with 3.2 million Current or Past Month misusers.

From there, the numbers drop even further, with the third-ranked drug, cocaine, having no more than 2.2 million Past Month users, while both methamphetamine and heroin both report fewer than 1 million Past Month users.

The contrast with marijuana use, the first-ranked illicit drug by far, is striking. While still lower than current use of alcohol, currently, the estimated 26 million Americans 12 and older reporting regular marijuana use in 2017 far exceeds any other substance use problem (leaving aside the issue of tobacco). The 26 million persons corresponds to 9.6% of the population 12 and older, and as we have seen, the figure is increasing by 8% with each passing year.

Where, then, is the population limit? What happens to our calculation of the relative "disease burden" of marijuana compared to alcohol when the number of users moves towards parity? Bear in mind that we are just now discovering the impact of legalization, which is still recent and partial across the states.

Moreover, the NSDUH survey allows the breakdown [9] of the population 12 and older into age groups, those 12–17, those 18–25, and those 26 and older. In addition to Past Month use, they also inquire as to Past Year use and Lifetime use.

Past Year use shows an enormous segment of the American population engaged in regular drug use. For Americans 12 and older, for 2017, there were 51.7 million Past Year users of any illicit drug. Of these, there were 40.9 million Past Year users of marijuana, or 15% of the population 12 and older. (By way of contrast, for the second and third leading illicit drugs, 6.6% misused psychotherapeutic drugs and 2.2% used cocaine.)

The increase since 2008, when there were 25 million Past Year marijuana users, is a stunning 64%. The percentage of users for 2017 exceeds any year, based on data that track back to 2002, before which year the survey was rendered discontinuous because of changes in methodology. The increase is driven most by those aged 18–25 and by those 26 and older. In 2017, among those aged 18–25, Past Year use of marijuana stood at 11.9 million (34.9% of this age group).

Switching categories now to the more regular Past Month users, how are the drug usage patterns distributed? Of adolescents, 12–17 years old (those arguably most at risk for damage), 6.5% were Past Month (Current Users) of marijuana. That figure represents approximately 1.6 million adolescents.

For 18–25 year olds, 22.1% (more than 1 in 5) were Past Month marijuana users. The figure has risen in a statistically significant manner every year since 2012, when it stood at 18.7%. That figure represents about 7.6 million young adults.

For adults 26 and older, the percentage for Past Month marijuana use is 7.9%, nearly double of what it was in 2008 at 4.2%. The current percentage represents about 16.8 million adult Past Month marijuana users.

Summarized 2017 Findings in Brief Tabular Form for Past Month and Past Year Marijuana Use:

- NSDUH 2017 [10] (reported in 2018): among approximately 70,000 people 12 and older surveyed:

- Past Year Marijuana Use ages 12–17: 12.4%
- Past Month Marijuana Use ages 12–17: 6.5%

- Past Year Marijuana Use ages 18 and older: 15.3%
- Past Month Marijuana Use ages 18 and older: 9.9%

- Past Year Marijuana Use ages 18–25: 34.9% (the increase from 2007, which showed 27.5% using, is 27%)
- Past Month Marijuana Use ages 18–25: 22.1% (the increase from 2007, which showed 16.5% using, is 34%)

- Past Year Marijuana Use ages 26 and older: 12.2% (the increase from 2007, which showed 6.8%, is 79%)
- Past Month Marijuana Use ages 26 and older: 7.9% (the increase from 2007, which showed 3.9%, is 102%)

In addition to overall increases in prevalence, we also see the "intensification" of use patterns. For all ages 12 and older, among Past Year users, the percentage of "daily/near daily" marijuana use stands at 19.8%, and at 21.9% for those 18–25.

Among Past Month marijuana users 12 and older, the average number of days used during the past month is 14.5 days, while the percentage of Past Month users consuming marijuana "daily/near daily" is a remarkable 41.7%. (NSDUH [11] table 7.21 B).

For those Past Month users who are aged 12–17, 25.1% were "daily/near daily" users.

For the 22.1% of those aged 18–25 who are Past Month users, the "daily/near daily" percentage stood at 44.3%.

Use of marijuana on a "daily/near daily" basis is the pattern of exposure most likely to produce Marijuana Use Disorder (the term for Cannabis Use Disorder or CUD). For 2017, CUD in the Past Year was reported as 5.2% for the category of 18–25 year olds.

Cannabis Use Disorder (CUD) is rising, in general. Data [12] from the National Epidemiology Survey on Alcohol and Related Conditions (NESARC), comparing successive waves of data between the years 2001–2002 and the years 2012–2013, show that the prevalence of marijuana use more than doubled, which prevalence was accompanied by a large increase in CUD experienced within the past year, largely because of the increase in the number of users.

According to NESARC, nearly 3 in 10 marijuana users experienced CUD. (The rate of CUD among marijuana users, however, did not increase, potentially owing to the fact that the "pool" of new users may have dampened the overall rate of disorder; subsequent NESARC waves, especially given the steeply rising potencies now experienced, may disambiguate the factors behind changes in CUD rates.)

Moreover, based on the same survey data set, additional research [13] has shown that the increase in CUD prevalence was greater in states that had passed "medical marijuana" laws than in states that had not.

Marijuana Use in Sub-populations at High Risk

Even further insight [14] regarding our future threat can be seen in use of marijuana by specialized populations presenting particular risks.

For pregnant women, aged 15–44, 7.1% report using marijuana during the Past Month. This represents an increase since 2015, when it stood at 3.4%, of 108% in two years. On the whole 3.1% of pregnant women report "daily/near daily" marijuana use, up from 1.2% in 2015.

For youth aged 12–17 who are Past Year "daily/near daily" marijuana users, 15.5% report a co-morbidity of past month "heavy alcohol use" while 24.1% report a Major Depressive Episode (MDE).

On the whole 31.8% of Past Year "daily/near daily" marijuana users suffer a co-morbidity of past-year opioid misuse (reported by only 1.6% of non-marijuana users for this co-morbidity).

The corresponding figures for the age group 18–25, by Past Year "daily/near daily" marijuana use, are: 20.7% Heavy Alcohol Use, 17% past year Major Depressive Episode, and 24.1% past year Opioid Use Disorder, respectively, for the co-morbidities reported.

Monitoring the Future School-Based Data

Some additional insights on the scope of youth exposure can be gained from the Monitoring the Future Survey of high-school youth. MTF 2018 [15] is a school-based survey reporting on 44,482 students from 392 public and private schools, examining self-reported substance use amongst 8th, 10th, and 12th graders (as mentioned earlier, the trajectory for 8th and 10th grades begins since 1991, while reports from 12th graders have been gathered since 1975).

For 12th graders, 22% report Current, or Past Month, marijuana use (a rate that exceeds cigarette use, which has fallen to 7.6%; binge drinking, at 13.8%, has been in steady decline since 1998). Past Year marijuana use stands at 36.9%.

Of current enrolled students, 5.8% of 12th graders report daily marijuana use.

In a troubling recent development, 37% of 12th graders report vaping some substance, primarily nicotine, while the 13.1% report vaping marijuana or hash oil. The rise between 2017 (the first year that inquired about vaping) and 2018 for all grades reporting vaping marijuana is significant (for 8th and 10th graders, it is 63%).

For vaping marijuana (only), the rise for 12th graders is from 4.9% in 2017 to 7.5% in 2018, an increase of 53% in a single year.

It may well be that we are failing to capture the full extent of marijuana use prevalence because of the rise of vaping and consumption of comestible forms of the drug are only now being systematically included in the survey instruments.

Additionally, MTF [16] reports that marijuana use among college age students, seen among a cohort that they track beyond high school, has risen steeply. They report that 30-day use of marijuana has increased significantly by 5.1% across the past 5 years, ending in 2018 at 24.1%, an all-time high for the study. In fact, annual and 30-day marijuana use among young adults aged 19–28 are at the highest levels in the 33 years that MTF has been monitoring their use.

Finally, MTF has for years measured subjective norms regarding the acceptability of smoking marijuana, as well as asked concerning student perceptions [17] of risk in using. These two metrics are often seen as harbingers of future prevalence; for instance, when perceptions of risk rise, prevalence rates tend to fall shortly after. Disturbingly, therefore, we learn from the most recent MTF perceptions by high school seniors of harmfulness in regular use of marijuana have fallen from high of 78.6% in 1991 to only 26.7% in 2018, a fact which may well show the triumph of the misleading “medical marijuana” campaign.

Widening Societal Impact of Increased Marijuana Prevalence

It is disturbing to realize that no one knows the full societal impact of these kinds of drug use changes spreading into every sector of the nation. Surely we can expect some societal consequences, not least on educational attainment, on workforce performance, on economic attainment, and even military recruitment, over and above the consequences found in strictly public health or criminal justice dimensions.

A recent (and proprietary) publication from Baron Public Affairs, a risk-assessment firm that provides analysis and guidance to public policy and corporate

decision makers, evaluated the possible impact of commercial marijuana in a document entitled "The Unintended Consequences of Marijuana Legalization."

While by no means exhaustive, their research nevertheless identified several areas of societal concern over the emerging levels of marijuana use, which concerns extend beyond just the public health and criminal justice impact.

The Baron report anticipated widespread impact on individual initiative and motivation, affecting the economic prospects not only for the generation of heavy users but for the wider economy. They noted such effects as those who smoked marijuana regularly had lower social class as adults than their parents experienced. They also had greater levels of welfare dependency and higher levels of unemployment.

Given further effects, such as those on family formation and collapsing social capital, Baron anticipated even greater social stratification, income inequality, greater damage to those with fewer economic resources, and greater class conflict.

Baron further anticipated a link to the multi-billion dollar opioid crisis, to which the coming marijuana epidemic will add further addiction and greater need for government services, welfare relief, and public funding, particularly for treatment purposes, to address the consequences of widespread marijuana use.

To these effects they add alarms concerning the available pool of warfighters and the potential erosion of military standards through either drug use waivers or tolerance of on-going use, which could render users compromised as decision-makers and vulnerable as security risks.

Even after the acute effects of intoxication have faded, users may experience reduced [18] cognitive/executive function, long-term, with strongest effect on adolescents.[19]

Finally, with regards to economic impacts, Baron notes that in one rural area, half of all job applicants were reported to have failed their employment drug test, which in a tight labor market is an obstacle to growth. In fact, data [20] from the largest national drug testing business, Quest, show that those who fail an employment drug test stands at its highest level (4.4% in 2018) in 14 years.

We are only at the beginning of the consequences of commercialization. The recent political calculus of both California and Canada to enter commercial marijuana markets has during the last 2 years added a combined population of nearly 77 million persons now living under "legal" marijuana regimes.

No wonder, as Baron concludes, has cannabis investment nearly quadrupled during the year 2018, built on major investments from well-established tobacco, pharmaceutical, and alcohol companies.

The Societal Impact of Expanded Cannabis Extends to the Use of Other Substances Of Abuse

First, we should recognize that trafficking networks for all drugs penetrate expanding marijuana markets. These criminal networks operate with a business model that is polydrug and polyfinance, operating with violence, coercion, and corruption as standard modes of behavior, capitalizing on addiction.

There are multiple ways in which the spread of marijuana prevalence is tied to the continued strengthening [21] of the illicit criminal market not only for marijuana but also for the trafficking in all illicit drugs, including the opioids.

Criminal organizations are polydrug traffickers, and wherever they establish a presence by capitalizing on the expanding commercial prevalence of marijuana, they begin to exploit their access to traffic other substances, thereby feeding [22] not only the opioid crisis (responsible for 47,000 of the overall 70,000 overdose deaths from all drugs in 2017) but further fueling the overdose crisis in cocaine (deaths rising rapidly to over 13,000 in 2017) and methamphetamine (contributing to over 10,000 deaths nationwide in that same year).

To take but one example, in Colorado [23], between 2015 and 2016, after steady rise since 2002, pharmaceutical opioid overdose deaths declined by 6%. But in that same year, overdoses from heroin increased 23% (subsequent data have shown that even the pharmaceutical overdose deaths have rebounded upward). Numerous communities, such as Pueblo, note that rapid expansion of homeless populations following the proliferation of marijuana dispensaries has been accompanied by increased trafficking and use of methamphetamine, illicit opioids, and cocaine, the effects of which can be observed in local emergency rooms.

Moreover, the financial profits accruing to the criminal cartels from marijuana sales serve to fund the full scope of their trafficking activities, supporting their capacity to insulate themselves not only financially but also politically.

To understand the broader relationship between adolescent drug use, including the initiation of marijuana, and the persistence of our current opioid overdose epidemic, we can turn to the work of Dr. Robert DuPont, a psychiatrist who is President of the Institute on Behavior and Health.

DuPont recently authored [24] *"A New Narrative to Understand the Opioid Epidemic,"* noting that for many opioid-addicted individuals, drug use frequently began in early adolescence, particularly with the use of alcohol and marijuana. "Early poly-drug use often sets the stage for later transition from medical to addictive use of opioids that are prescribed for pain. These patients' brains have been primed for the addictive response to opioids."

As DuPont notes, opioid overdose deaths nearly always involve the use of other addictive drugs, such as marijuana, cocaine, methamphetamine, and alcohol. About 95% of current opioid overdose deaths, according to studies of particular populations, involve other drugs, with an average of 2–4 and a maximum of 11 in addition to the opioids.

The standard overdose narrative, DuPont argues, overstates the degree to which physician prescribing of opioid medications is the primary pathway for overdose risk and ignores the significant role of adolescent initiation to drug use in the opioid overdose epidemic, occurring at older ages. While for many opioid addicted people their first use of an opioid was a prescribed opioid from a physician, it is also true that the majority of these individuals first used other drugs before or with their first use of opioids.

Further, only about 4% of people who use prescription opioids non-medically initiate heroin within 5 years of first prescription opioid use. For example, among 4493 individuals treated for opioid addiction whose first exposure to opioids was through a

prescription from their physician, notably 94.6% reported prior or coincident use of other psychoactive drugs. Alcohol was used by 92.9%, and marijuana by 87.4%, and excluding these top substances, fully 70.1% reported other prior or coincident drug use.

The clear message is that in order to comprehensively address the current drug abuse crisis and accompanying fatalities, we must address early adolescent exposure to marijuana as a contributing factor.

Multiple accounts now found in the literature clearly show that cannabis use, especially persistent use of high-potency cannabis in adolescence, is a risk [25] factor for the development of subsequent opioid use disorder.

To take but one example, a 2017 study [26] using NESARC data found specifically that cannabis use is linked to prescription opioid disorder: "… cannabis use at wave 1 was associated with increased incident nonmedical prescription opioid use (odds ratio = 5.78) and opioid use disorder (odds ratio = 7.76) at wave 2."

As the Centers for Disease Control succinctly summarized [27] the matter, "People addicted to marijuana are three times more likely to be addicted to heroin." In addition, multiple studies, particularly using animal [28] models, show an effect of brain "priming" and "cross-sensitization" between cannabis exposure and opioid exposure. Overall, we are witnessing increasing validation of a marijuana "gateway" [29] effect on subsequent drug use. Indeed, there is increasing evidence [30] that "early marijuana use by itself, even after control for other covariates, increases [31] significantly the use of other illicit drugs."

Final Thoughts on the Wider Implications of Increased Use

The full scope of the potential negative effects of increased marijuana use, particularly as accelerated by commercial legalization, is now emerging, and the damage affects many domains of national life.

First, we should be concerned over the future impact of a marijuana "gateway" effect, whereby early adolescent exposure increases the risk of subsequent initiation of other addictive substances, and further heightens the risk of multiple drug use disorders in later life.

To the extent that the gateway thesis is validated, we can expect that the surging crisis in the use of drugs such as opioids, cocaine, methamphetamine, and other emerging synthetic drug threats will continue at an epidemic level, as widespread marijuana prevalence serves to feed vulnerable users into polydrug dependency and disorders.

Moreover, it is not just the users of such substances who are placed at risk, we recognize that major criminal enterprises, those that traffic lethal poisons, find in the "legal" marijuana market an open pathway for their operation, thereby enhancing their revenue, and reinforcing their violent and corrupting methods.

But the public health impact is not limited to the effect on users. We should acknowledge that the rise of "medical marijuana" treated as though it were a legitimate medicine approved through clinical trials, scientific rigor, and demonstrations

of safety and therapeutic efficacy, shows the consequence of allowing a political process to supplant strict medical trials as the basis for legal acceptance.

As such, the integrity of the drug approval process itself, and the authority of the criteria upon which it is based, has been compromised by resort to illegitimate mechanisms.

Further, there are lessons to be learnt in how both "medical" and commercial marijuana progressed at the state level, in settings such as Colorado. Promises were made by advocates, seeking a political appeal to sway voter approval. Promises were made of enhanced state revenue sufficient to compensate for possible public health or law enforcement costs. Promises were made of more effective means for protecting youth from access to the drug. Promises were made of forcing out criminal activity, with its attendant violence, coercion, and fear. Promises were made of reducing supposed injustices in legal enforcement of anti-drug laws.

In fact, so appealing were the promises that the Obama administration's Department of Justice (DOJ) agreed to reorder federal prosecutorial priorities to enable state legislation to operate. In repeated memos from the DOJ we were told that there would be established certain "Red Lines," which, if crossed, would trigger an intervention on behalf of federal law. The "Red Lines" pertained to such issues as drug access by youth, or evidence of smuggling activities, or other signs of criminal activity.

Yet we cannot forget that those "Red Lines" were repeatedly, even flagrantly, violated in succeeding years, as multiple reports from the Rocky Mountain High Intensity Drug Trafficking Area (HIDTA) [32] joint law enforcement command readily demonstrated. But no federal intervention was triggered. (Further, we now see evidence at the state level that the promised taxation revenue has not been sufficient to cover the greater costs to society of increased prevalence, nor have certain putative benefits manifested, and that black market marijuana, offered more cheaply, has captured major market share.)

Suffice it to say that the promises have not been kept. Yet we now see them repeated at the national level.

So as we pull back the lens for a wider picture, we see not only a public health crisis affecting users and medical institutions, but an emerging criminal justice crisis, as the black market thrives in states that have approved commercial marijuana, and as violence, smuggling, and corruption have all persisted in support of strengthened criminal activity, which now seeks to insulate itself by gaining political [33] power.

As noted, there are now efforts in Congress to alter at the federal level not only the Schedule I status of marijuana but further enable banking and financial legislation that could threaten the integrity of the US financial system, were transnational criminal organizations could exploit the proposed changes to mask or launder illicit proceeds from their entire international operations.

If we pull the lens back even further, we now see the international impact of our failure to uphold federal drug law at the state level. Simply put, the position of the USA as the moral leader in drug control, and the primary protector of the global drug control enterprise, has been compromised.

Our international commitments, such as found in treaty obligations in partnership with the United Nations, have been countermanded. Our allies, themselves fighting transnational criminal organization, feel abandoned, and many are yielding the fight. Even US development objectives, seeking to strengthen not only international economies but human rights and democratic institutions, have been eroded by the threatened emergence of corrupt narco-states among international partner nations who once depended on us for protection.

That is, we can now count the costs of the spreading acceptance of legalized drug use as serving to damage not only public health and criminal justice, but national security as well.

None of these developments make our own borders more secure, nor our own citizens safer nor healthier. In fact, US interests and well-being may be facing a coming debacle of major dimensions through unprecedented drug use and the attending criminal attack on our institutions, financial as well as political.

It should finally trouble us greatly that all of these developments represent self-inflicted wounds, against which many have warned us. We may well find that we done no other than to enable a virtual Trojan Horse in our midst, a development likely to occasion great regret.

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September 8, 2021

Mayor, Council, and Staff,

Thank you for allowing public comment and input into the writing of new cannabis regulations in the City of Billings. This is a monumental task and one that was forced upon our community by actions of the state legislature. I relish the opportunity to help educate on the subject matter, as CM Ronning said last night, and help provide meaningful feedback to this critical and time sensitive process.

As the Mayor alluded to last night, very few good decisions are made quickly. Access to quality information is one of the factors that can alleviate poor decision making. My goal is to provide you factual data, as well as my insights, into these issues from experience in the industry. I approach this process with a unique perspective of being a licensed landscape architect with a strong understanding of zoning regulation and land use economics. I am also an entrepreneur who owns and manages three totally unrelated businesses, one of which is a vertically integrated cannabis farm.

This letter reflects the five bulleted points (zoning restrictions, comprehensive licensing and screening of marijuana businesses, product testing, cultivation regulations and caps, and dispensary regulation and caps) that were discussed at length in the working session on Tuesday September 7, 2021.

<u>Zoning Restrictions</u>

There is a lot of value in seeing all the buffers presented in one map, as the remaining area of allowable properties will likely be quite small and specific. The few properties that will fall into these zoning islands are likely currently occupied being used by existing businesses. The likelihood of them being available for rent/lease/purchase is low.

This limited zoning approach is not the best path forward for our community. Our city currently contains a plethora of vacant properties that seem to grow every month. Vacant properties are not only detrimental to the aesthetic of our community, but they also affect the business climate, employment, and the all-important tax base. Supporting cannabis businesses and their ancillary businesses can be one of the tools in your toolbox to begin to provide anchor tenants and create jobs throughout our city.

The same rules should not apply for a retail dispensary as for a manufacturing or grow production facility. We should not exclude retail from properties that are designed to provide retail service. Conversely, we do not want to have a manufacturing or grow facility located in a retail area. Testing laboratories are a white coat professional type business – do we really want to discourage those businesses from locating here because the zoning requires them to locate

in a heavy commercial or industrial area where employees have no access to walkable distance services?

I strongly encourage staff and council to consider a much more refined approach, with independent and sensible zoning restrictions for each type of cannabis business. There should be a provision allowing for a special review process for properties located outside the determined zoning boundary that wish to be a cannabis business. The zoning regulations need to reflect the seven types of businesses that have previously been identified: cultivation, manufacturer, adult use dispensary, medical use dispensary, combined use dispensary, testing laboratories, and transportation. One additional field should be recognized for this effort – medical research and development – which is potentially the largest and most lucrative type of cannabis businesses. Medical research and development is a growing field that attracts high paying jobs. Billings would be wise to provide an attractive home for these new and burgeoning businesses, as they complement our existing high quality medical services. A recent Wall Street Journal article that explains a little bit about the cutting-edge research and development that is beginning to occur is attached.

<u>Comprehensive Licensing and Screening of Marijuana Businesses</u>

The state of Montana completes a thorough background investigation into all owners of every licensed cannabis business. Before any license is issue or renewed, every shareholder of the business is required to undergo a full FBI background check that includes fingerprinting of all parties. This application process also includes state checks into the following for each shareholder: custody or supervision of the department of corrections or a youth court; no felony convictions; no convictions for a drug offense; no convictions for fraudulent representation; failure to pay taxes, interest, penalties or judgments due to any government agency; stay out of default on a government student loan; pay child support; remedy an outside delinquency for child support or for taxes judgments owed to any government agency. Verification from applicants include that no portion of the property in use by the applicant shall be shared with, rented, or leased to another provider or registered cardholder. Financial disclosures are also included the application process. I have my most recent application to the state that I would be happy to share with you if you feel it would be helpful.

The DPHHS and now Department of Revenue Cannabis Control Division highly regulate all aspects of the business. Seed to sale tracking allows the department to track all aspects of every process involved from planting a seed or clone, through the growing process, harvest, drying, curing, and eventual sale of flower or manufacturing. This system is complicated and comprehensive. Regional inspectors are assigned to perform announced and unannounced audits of the product inventory, plant counts, worker certification, and overall compliance with state law.

If the city deems this process inadequate, I'd be interested to know what additional measures would allay the fears or misgivings of cannabis business owners. Duplicate regulations and unnecessary expansion of our local government is generally not a value supported in our community.

Product Testing

All testing labs are required to be independent of cannabis businesses, and provide unbiased, science-based, results that can be repeated with accuracy. I have provided you with a login and password for accessing the Green Bee testing records with the laboratory that we utilize.

Website: Client Portal / swlims.io Login: admin@greenbeedispensary.com

P/W: OurData123!@#

I encourage you to look at the testing information provided to us. Look at the types of agents that all products are tested for – eighteen different pesticides, a variety of molds and microbials, foreign matter, heavy metals, mycotoxins, residual solvents. I think you'll find the list comprehensive. If you'd like more information about what types of tests can be performed, I encourage you to look at the website of Stillwater Laboratories, the company we use for testing. Fast, Reliable Cannabis Testing Results In Montana | Stillwater Labs (stwlabs.com)

Testing is already a substantial cost to cannabis businesses. In fact, at the Green Bee, testing accounts for approximately 10% of all our expenses. The state has established extremely stringent guidelines for how frequent, when, and what types of tests are required. I have concerns that if the city ventures into this arena, the staffing and city's expense of requiring additional testing will be more than anticipated. I again encourage diving into the existing state regulations to understand what is already required. If additional areas of testing are identified, let's discuss what those are and how those measures can be included in the required round of state testing.

The state of Montana has very clear and concise requirements for labeling of all products. In fact, the testing lab provides the label to the retail facility, so that there is no confusion on what data should be included. This system also ensures that the label affixed to a product is consistent with the test that was performed on that product. The information that Ms. Tracy presented indicated that product mislabeling was rampant in other areas, outside of Montana. This may be true, but this is not a failure of testing, but rather incorrect or untruthful labeling. To my knowledge, this is not an issue here.

Cultivation & Dispensary Regulations and Caps

I have combined the last two categories, as my thoughts on them are similar. As previously discussed in this letter, I feel that a more in-depth approach for zoning is the best policy. Limiting the number of businesses that may operate within those allowable zones is not in the best interest of property owners or residents. Retail services, no matter what you sell, are best when distributed throughout commercial districts. Industrial operations, like commercial indoor farming, is best suited for heavy commercial and industrial zones.

Free enterprise values run strong in our community. Allow the market to dictate what the number of, and types of businesses, call Billings home. I think you'll find that the vast majority of cannabis businesses are well run, organized, and clean. They are an asset to a community.

Thank you for your consideration in these matters. I look forward to further discussion on these regulations. If anyone would like to have a personal tour of the Green Bee, including an in-depth look at the state's existing regulatory structure, I welcome the opportunity to provide you access to my business. Knowledge is power.

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| HEALTH

CANNABIS RESEARCHERS SEEK TO UNLOCK THE HEALING POWER OF POT

Cannabis contains dozens of rare and intriguing compounds, but they haven't been easy or cheap to produce. That is changing.

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The Future of Everything covers the innovation and technology transforming the way we live, work and play, with monthly issues on education, money, cities and more. This month is Health, online starting Sept. 3 and in the paper on Sept. 10.

Cannabis, the leafy group of plants including marijuana and hemp, is best known for the THC that gets people high. But cannabis can contain many other chemicals. Products with the nonintoxicating compound CBD, for example, have proliferated over the past five years. Now, pharmaceutical makers, product researchers and investors are wondering, what else do the plants have to offer?

Scientists say there are at least a hundred cannabinoids, a class of organic compounds found primarily in cannabis and often abbreviated to three or four letters. THC and CBD are abundant, and the Food and Drug Administration has already approved them in some forms. But many other compounds may have therapeutic effects, and not every plant produces every cannabinoid. Rare and intriguing compounds like CBM and CBD-V would require years of strategic breeding of plants to create a stable and inexpensive supply chain.



At Lygos, microbial fermentation generates the desired cannabinoid molecules in a broth.

PHOTO: HELYNN OSPINA FOR THE WALL STREET JOURNAL

Researchers say a technique known as biological synthesis, a method that involves engineering yeast, algae or bacteria to produce compounds in a fermentation tank, will allow them to quickly generate molecules without the expense and complexity of growing hemp or marijuana plants.

This technology could fundamentally alter the way cannabis products are sourced and consumed—and possibly help unlock the plant's potential as a source of medical therapies, say scientists. Early studies show that cannabigerol, or CBG, for example, holds promise as a treatment for neurological disorders such as Huntington's disease.

SHARE YOUR THOUGHTS

What potential do you see in cannabis as a source of medical therapies? Join the conversation below.

Though questions remain about the efficacy of compounds isolated from the rest of the cannabis plant, the rise of biosynthesis will allow for a purified, consistent study drug, hastening scientific understanding of each compound's potential toxicities and benefits, cannabis researchers say. Analysts at the investment bank Raymond James predict the nascent biosynthetic cannabinoid industry will be worth $10 billion globally by 2025. This is despite potential legal complications arising from selling cannabis-related products, even if the compounds were grown in a lab.

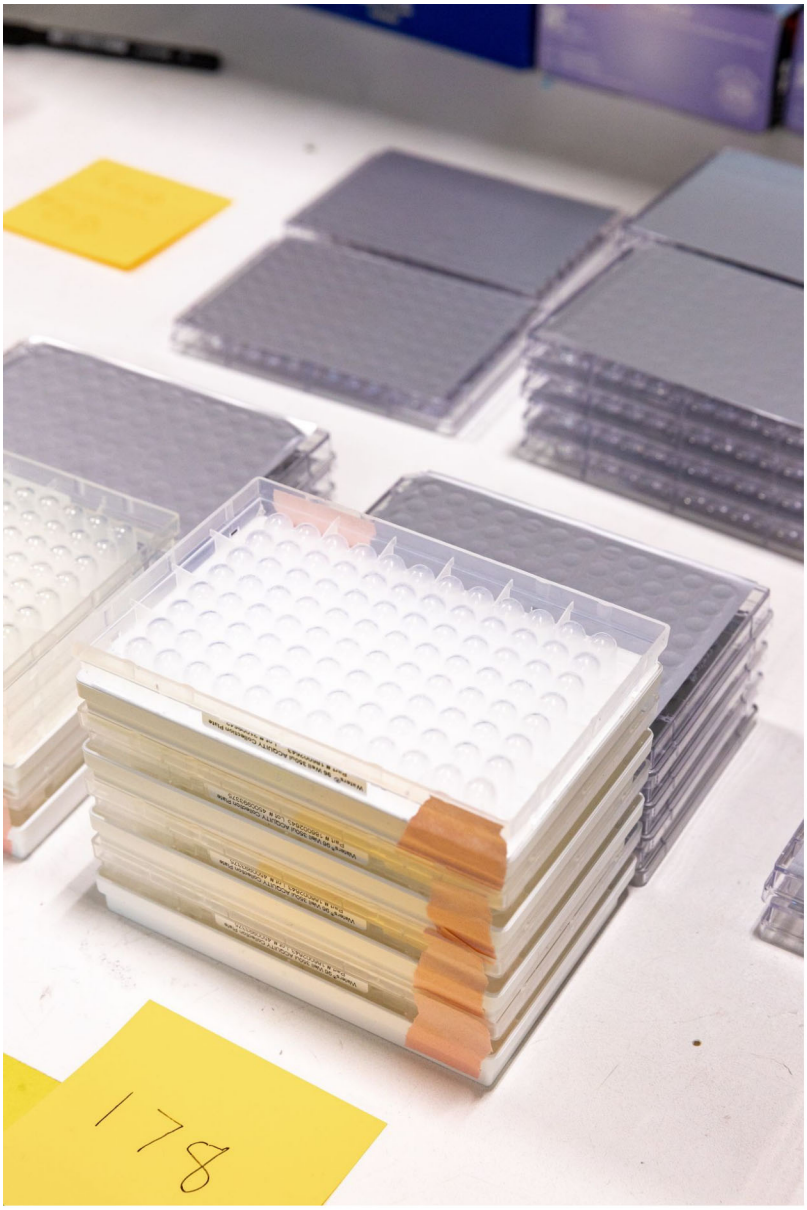
"The marijuana plant has tremendous potential, so the more access we have to the constituents of marijuana, the more we can continue to move the science forward," says Dr. David Shurtleff, the deputy director of the National Center for Complementary and Integrative Health at the National Institutes of Health.

The recent surge of research and development at biotech companies around molecular biosynthesis has implications beyond cannabis. A McKinsey analysis from 2020 predicted that this kind of "biomolecule" will soon have an annual global direct economic impact in the trillions of dollars, for industries ranging from agriculture to health to energy production. Some vitamins are already produced biosynthetically.

In the cannabis industry, the technology has been particularly alluring, researchers and entrepreneurs say, due to the breadth of potentially therapeutic compounds, the dearth of existing research on those compounds, and the difficulty and expense of producing the compounds through either chemical synthesis or conventional plant breeding.

Here's how it works: First, scientists identify the enzymes in a cannabis plant that contain the chemical blueprint to produce the desired compound. Next, they sequence those enzymes to find their DNA, and then insert the genes into a microorganism like yeast, using gene-editing technology such as Crispr or a more traditional technique called homologous recombination. From here, the yeast is fed oxygen, sugar and nutrients, and mixed with water in a fermentation tank, in a process similar to brewing beer. Within a few days, the yeast begins to secrete the cannabinoid. Finally, scientists add an organic solvent like oil to the fermentation tank,

attracting the newly produced compounds and leaving a cannabinoid solution that can be further manipulated.



Thousands of strains are generated and tested for Lygos's desired production characteristics.

PHOTO: HELYNN OSPINA FOR THE WALL STREET JOURNAL

The whole process takes about a week, compared with up to six months to grow and harvest a single plant. It is cheaper, more accessible and, without the need for entire fields of cannabis and energy-intensive extraction processes, more sustainable, says UCLA Cannabis Research Initiative founder Dr. Jeff Chen.

"This platform is a game-changer for research," he says. "It enables the study of what the individual cannabinoids are doing, which is very difficult if not impossible to tease apart when you're working with the plant material itself, or plant extracts."

Cannabinoid biosynthesis companies are generally not interested in THC because state marijuana markets are so tightly regulated.

Instead, they are looking at mysterious compounds that few humans have tried, with names like CBE and CBC. Each cannabinoid seems to have a unique effect. Where THC has a propensity to induce hunger, also known as "the munchies," THC-V seems to take away appetite, according to early research. Other cannabinoids seem to influence everything from blood pressure to bone density, according to research done mostly in mice.

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At Lygos, petri dishes containing genetically modified yeast are selected and then screened for the production of cannabinoids.

PHOTO: HELYNN OSPINA FOR THE WALL STREET JOURNAL

Cannabinoids "may have therapeutic potential in almost all diseases affecting humans," wrote NIH researchers Pál Pacher and George Kunos in 2013, citing early evidence of the comprehensive nature of how various compounds from the cannabis plant affect the body.

If that is true, biosynthesis may be the technology that allows researchers to puzzle out which compounds help, which hurt, and how they can be combined to treat various ailments.

Clinical research involving cannabis in the U.S. remains stymied by federal restrictions. It is very difficult to gain permission to do trials in human beings, and it has been even more difficult to access a variety of cannabinoids from the University of Mississippi, home to the country's sole legal source of pot for research. More thorough research on cannabis and cannabinoids tends to come from other countries, such as Israel and the Netherlands. While it isn't yet clear how regulatory agencies would handle the legal status of biosynthetic cannabinoids, researchers are optimistic.









Lygos hopes to mass produce cannabinoids for some of the biggest corporations and research institutions in the world. PHOTOS: HELYNN OSPINA FOR THE WALL STREET JOURNAL(2)

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So far, products containing biosynthetic cannabinoids are few and far between. The skin care brand High Beauty sells an acne treatment that contains biosynthetic CBG, which early research suggests has anti-inflammatory properties, at Macy's. The CBG is made by the Berkeley, Calif.-based biotechnology company Lygos.

Other companies working on biosynthetic cannabinoids include the Vancouver, Canada-based Willow Biosciences, which is partnered with Curia Inc., and the Boston-based Ginkgo Bioworks, a synthetic biology company which is partnered with the Canadian cannabis producer Cronos Group.

Back in 2014, when Lygos bioengineer Jason Poulos started working with biosynthetic cannabinoids, friends joked that he was a stoner; now, he is hoping to mass produce cannabinoids for some of the biggest corporations and research institutions in the world.

"We want to be the supplier of these ingredients to everybody," Dr. Poulos says.



Lygos produces CBG for an acne treatment from skin care brand High Beauty.

PHOTO: HELYNN OSPINA FOR THE WALL STREET JOURNAL

To be sure, some of these compounds may have negative effects at certain doses. “It’s a drug that is metabolized, and if it is overdone it will tax on your liver,” Dr. Poulos says. “We should expect all the cannabinoids to have a similar toxicity window to CBD.”

And for many cannabis researchers, activists and businesspeople, the quest to manufacture, understand and sell single-cannabinoid products is a waste of time. No isolated cannabinoid, they say, will ever be able to replicate the benefit of the entire plant, with its mix of major and minor compounds—a theory known as “the entourage effect.”

“I’m still a believer that the whole plant is more therapeutically beneficial than any one cannabinoid by itself,” says Dr. Malik Burnett, an addiction medicine physician at the University of Maryland Medical Center, who has experience in cannabis business and policy. “The concept of using biosynthesis to increase production of lesser cannabinoids is not a scientific breakthrough, but there is a significant amount of potential to create products that can be marketed, and can convince people that they need to use them.”

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Corrections & Amplifications

Cannabinoid biosynthesis companies are looking into compounds with names like CBE and CBC. An earlier version of this article incorrectly said that one of the names was CDD, but there is no cannabinoid by that name. (Corrected on Sept. 3)

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Original Scholarship

County-Level Recreational Marijuana Policies and Local Policy Changes in Colorado and Washington State (2012-2019)

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University of California, Merced

Policy Points:

- In 2012, Colorado and Washington were the first states to legalize recreational marijuana through voter-initiated ballots. In these states, counties could restrict or ban local marijuana facilities through a variety of regulatory methods such as ordinances and zoning.
- County-level recreational marijuana policies in Washington and Colorado vary substantially, with 69.2% of Washington counties and 23.4% of Colorado counties allowing all types of recreational marijuana facilities as of April 1, 2019.
- After Colorado and Washington legalized recreational marijuana, many counties modified their marijuana policies over time, with shifts in county policy often preceded by advocacy and information-seeking activities.

Context: In 2012, Colorado and Washington were the first states to legalize recreational marijuana. Both allowed local governments to further regulate the availability of marijuana facilities in their jurisdictions. As early adopters, these states are important quasi-natural experiments to examine local marijuana policy and policy change processes, including key stakeholders and arguments.

Methods: We conducted a policy scan of county-level recreational marijuana ordinances and regulations in Colorado and Washington. Data collected included policy documents from counties in both states and newspaper articles. We used

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a mixed-methods approach to describe the types of county-level recreational marijuana policies enacted by April 1, 2019; identify key policy stakeholders involved in local policy debates; and explore arguments used in support or opposition of county policies. We also selected four counties that represent three county policy environments (all marijuana facility types allowed, some marijuana facility types allowed, all marijuana facility types prohibited) and described the policy changes within these counties since recreational marijuana was legalized.

Findings: By April 1, 2019, Colorado counties were less likely than Washington counties to allow marijuana facilities—48.4% of Colorado counties prohibited recreational marijuana facilities in their jurisdiction compared to 23.1% of Washington counties. Since state legalization, several counties in both states have made substantial marijuana facility policy modifications, often preceded by information-seeking activities. Primary stakeholders involved in policy debates included elected officials, law enforcement, individual growers/farmers, marijuana business license applicants, parents, and residents. Proponents referenced local economic gain, reduced crime, and potential health benefits of marijuana as arguments in favor of permitting local facilities, whereas opponents pointed to economic loss, negative health and public health issues, public safety concerns, and existing federal law. Both sides referenced local public opinion data to support their position.

Conclusions: By early 2019, a patchwork of local marijuana policies was in place in Colorado and Washington. We identify key areas of policy and public health research needed to inform future local marijuana policy decisions, including the impact of legalization on public health outcomes (particularly for youth) and public safety.

Keywords: marijuana, cannabis, local policy, county, ordinance, regulation.

In the 1990s, states across the United States began to legalize marijuana for medical use, which helped usher in the transition to the legalization of nonmedical (recreational) marijuana use.[1] In 2012, Colorado and Washington were the first states to legalize recreational marijuana for adult use and sales through voter-initiated ballots, with legal sales beginning in 2014.[2] As early adopters of recreational marijuana legalization, these states set precedents for other states to follow suit, even though marijuana remained an illegal substance under federal law. In both Colorado and Washington, local governments (i.e., counties and cities) could enact ordinances or regulations to limit the availability of local marijuana facilities, including prohibiting them altogether.

Colorado and Washington serve as quasi-natural experiments to examine how local jurisdictions have responded to state marijuana legalization. By investigating local marijuana policy decisions, such as ordinances to prohibit marijuana facilities, we can identify key factors and themes that drove those policy choices. Understanding these can provide critical insight about local policy change processes that may be generalizable to localities elsewhere. Further, longitudinal monitoring and examination of local policy decisions around marijuana, including the policy stakeholders and arguments, can help identify patterns in how local jurisdictions are regulating emergent recreational marijuana markets and allow us to analyze whether and how local policy has shifted over time.

Currently, there is a dearth of local marijuana policy surveillance research[3] and a lack of investigation of how these policies have changed since legalization.[4] Examining county-level policies can be of use because counties are administrative arms of state government—they assume key governance and service provision roles for businesses and residents in unincorporated areas, and they have expanded their policymaking responsibilities over time in the area of health care.[5] County governments are also subject to local perspectives and needs, providing an interesting political and policy context for health policy decision making.

Prior research focusing on Washington (through 2016)[3] and California[6] suggests there is large variation in the types of county-level marijuana policies adopted in states that have legalized recreational marijuana. As of July 2014, 10 of 39 Washington counties either adopted a permanent ban of retail recreational cannabis outlets or did not modify a moratorium (i.e., temporary ban) that they had previously enacted.[7] By mid-2016, 10 Washington counties still had a permanent or temporary ban on cannabis retail sales (another 9 did not have a specific policy identified), and approximately 30% of the state population lived in locations with permanent bans or moratoriums on retail sales—indicating considerable variation across cities and counties.[3] In California, a study of marijuana laws in local jurisdictions (534 of the state's 539 cities and counties) enacted by January 31, 2019, reported that 62% of the state's 58 counties allowed any retail sale of marijuana for either medical or adult recreational use.[6]

For several reasons, research is needed on current local recreational marijuana policy environments, stakeholders, and related communication to inform public health research, practice, and policy. First,

although some work examining local policies in Washington and California has been undertaken, to our knowledge, similar policy surveillance research has not been conducted in Colorado. Analysis of both Washington and Colorado provides an opportunity to capture local policy evolution in states that were early adopters of marijuana legalization. This is important because relative to other jurisdictions that only recently legalized marijuana, Washington and Colorado afford several years of data to capture current local policies as well as the dynamics of policy change over time.

Second, analysis of local policy allows greater granularity to identify important arguments about policy change, as well as tensions. The calculus underlying local legalization of marijuana may vary, with possible public concerns about permitting marijuana facilities ranging from public health and safety issues[2,8] (including a blurring of medical and recreational use)[9] to ideological arguments and local public opinion.[3]

Third, previous local marijuana policy surveillance studies did not investigate changes in policy over time or the policy stakeholders and actors involved in local policymaking processes. Examining these components in a policy debate can reveal important dynamics about the policymaking process and involvement of advocacy coalitions.[10] Local stakeholders and audiences in Washington and Colorado have had more time than those in other states to weigh and debate the merits and concerns associated with various marijuana policies[11]; therefore, the stakeholders and arguments at the local level in Washington and Colorado may anticipate policy trends and processes developing elsewhere.

This study uses a mixed-methods research design to describe the types of county-level policies (ordinances and regulations) enacted in Colorado and Washington by 2019 to allow or restrict recreational marijuana facilities; identify key policy stakeholders/actors involved in county-level marijuana policy debates; and explore arguments used to support or oppose these policy positions.

State Policy Context

In both Washington and Colorado, legalization of marijuana was initiated by voters. In Washington, voters approved the Legalization and Regulation Initiative 502 (Initiative 502) legalizing the production, processing, and sale of marijuana for recreational purposes in November 2012. The initiative included certain restrictions, such as restricting

possession and use by minors (under the age of 21), setting quantity limits, and restricting public use. The Washington State Liquor Control Board (renamed the Washington State Liquor and Cannabis Board) became the primary regulatory body for licensing and oversight of the cannabis market. It was tasked with regulating and issuing licenses for marijuana production, processing, and retail facilities. These licenses could be forfeited if a city, town, or county adopted a ban or moratorium prohibiting retail marijuana businesses or adopted an ordinance or regulation related to zoning, licensing, or land use, or a regulation to prevent receipt of an occupancy permit for the facility.[12] New marijuana retail outlets could only sell marijuana products, and vertical integration with other types of retailers was not allowed.[13,14] The board also limited the number of retail stores to a maximum of 334 statewide and used a formula to issue a maximum number of licenses per county based on population size. No limits were set for producer or processor licenses.[15]

In Colorado, voters approved a ballot referendum in November 2012 to enact a state constitutional amendment (Amendment 64) that legalized possession and consumption of marijuana among adults (21 years or older); created an excise tax on wholesale marijuana with earmarked conditions; provided for licensing of marijuana establishments (including marijuana cultivation facilities, product manufacturing facilities, testing facilities, and retail stores); and required localities (county, municipality, or city and county) to enact an ordinance or regulation by October 1, 2013, to define the entity responsible for processing license applications. Localities could also prohibit any or all marijuana facilities within their boundaries with an ordinance or voter measure.[16] Counties opting for a voter measure would have to do so after the licensing of facilities in 2014.[17]

At the state level, Colorado's Marijuana Enforcement Division was tasked with creating rules, regulations, and licenses for the recreational marijuana marketplace. The state sought a variety of stakeholder perspectives to develop principles for the policy framework. The resulting principles included a focus on the health, safety, and well-being of youth; consumer needs; efficient and effective regulation; funding mechanisms; balanced and nonduplicative regulation between state and local authorities; interactions and transactional relationships; and community safety.[11]

Washington and Colorado shared several marijuana policy and market environment characteristics in addition to their voter-initiated legalization approaches. First, these state policies were enacted while

marijuana was illegal under federal law as a Schedule 1 drug under the US Controlled Substances Act—a source of tension in state legalization.[4,13] Second, both states had already legalized medical marijuana use more than 10 years prior to legalizing recreational marijuana (medical use was legalized in 1998 in Washington and in 2000 in Colorado).[13] Third, both states prohibited public use of marijuana in nearly all smoke-free spaces.[14] Fourth, legalizing recreational marijuana ushered in a new potential source of revenue for state and local governments.[18,19]

However, the revenue models in Colorado and Washington are not the same. Unlike Colorado, local jurisdictions in Washington were not allowed to tax marijuana[3]; instead, the state distributes revenue to local jurisdictions from the state's marijuana tax.

In addition to the taxation policies, there are other policy and implementation differences between Washington and Colorado.[20,21] For example, Washington merged its retail and medical marijuana markets in 2015 (with some exceptions) and subjected most of the medical marijuana market to retail marijuana regulations and taxes to reduce illegal marijuana cultivation and sales.[3,13,14] This merger led to other changes as well. The Washington State Liquor and Cannabis Board increased the statewide maximum number of marijuana retail licenses from 334 to 556 and increased the cap on county licenses (particularly for those with high medical sales levels) to expand access to medical marijuana.[22]

Unlike Washington, Colorado allowed home cultivation of marijuana (up to six plants per adult Colorado resident). This maximum was increased to 12 plants in 2018. Colorado counties and municipalities could set stricter home cultivation limits.[23]

Most notably for the purpose of this study, both states similarly gave local governments the decision-making authority to enact ordinances or regulations to allow or prohibit any or all types of marijuana facilities as businesses within their jurisdictions.[3,13] In Washington, the local authority to ban or pass a moratorium against marijuana sales was confirmed by the passage of House Bill 2136 in July 2015.[4] Local governments in both states could also restrict aspects of retail operations in their jurisdictions through land use regulations (e.g., zoning restrictions) or by setting business regulations, such as limiting hours of sale.[3,19] In Washington, counties and cities could also limit the number of licenses in their jurisdiction beyond the State Liquor and Cannabis Board's adopted maximum.[15]

Methods

We conducted a policy scan of county-level recreational marijuana policies in Colorado and Washington. Of note, this study focuses on marijuana and not hemp. While hemp and marijuana belong to the same plant species, *Cannabis sativa* L., they are distinguished in the United States by the legal threshold for the delta-9 tetrahydrocannabinol (THC) concentration on a dry-weight basis. The threshold for THC concentration in hemp ($\leq 0.3\%$) is low compared to the threshold in marijuana ($>0.3\%$). Unlike marijuana, hemp has been regulated by the US Department of Agriculture (USDA) since the Agriculture Improvement Act of 2018[24] authorized the production of industrial hemp in the United States and removed hemp and hemp seeds from the federal schedule of controlled substances.

Data Collection

The data we collected include county-level marijuana ordinances or regulations and newspaper articles about county-level marijuana policy. Over a six-month period in 2019, two trained research assistants independently conducted policy scans to identify county-level policies regulating recreational marijuana facilities in Colorado and Washington that were enacted by April 1, 2019.

For Washington, data were collected from policy documents from the Municipal Research and Services Center[25] (using a search approach similar to that used by Dilley and colleagues[3]), and from county ordinances and codes from the Washington State Association of Counties.[26] Colorado county ordinance data were pulled from the Colorado Counties, Inc., website.[27] To supplement these searches, research assistants reviewed all of the available Washington and Colorado county websites to identify county ordinance documents with missing data, verify data, and collect available zoning maps or planning documents. If the research assistants were unsure about the content or eligibility of a policy document, they checked with the lead author, who made final decisions about the database.

Research assistants first completed a policy scan training conducted by the lead author using an existing ten-step guide.[28] Next, they

independently reviewed and abstracted pertinent policy data from these documents and systematically input the information into a policy database template. Column titles included the county name, date enacted, source, policy summary, recreational marijuana policy status (all types allowed, some types allowed, all types prohibited, none identified), and named stakeholders/advocates. We classified recreational marijuana policies using three categories we developed:

- All types of marijuana facilities were allowed in the jurisdiction, even with zoning restrictions (all types allowed). In Colorado, facilities included those for cultivation, manufacturing, testing, and/or retail. In Washington, facilities included those for production, processing, and/or retail.
- At least one type of marijuana facility was allowed in the jurisdiction (some types allowed).
- All types of marijuana facilities were prohibited in the jurisdiction (all types prohibited).

We could not identify or find marijuana policy data for 11 of 64 counties in Colorado and 1 of 39 counties in Washington, and are unsure about these counties' policies. We excluded ordinances that only focused on regulating marijuana intended for medical use, based on the premise that there are different types of marijuana policy categories (decriminalization, legalization of medical marijuana, and legalization of nonmedical marijuana),[4] and we were most interested in examining county-level policies and the availability of nonmedical (recreational) marijuana.

The lead author conducted a quality assurance review, randomly selected 30% of policies in each state for comparison, and provided the research assistants with a finalized codebook. All policies identified were double-coded, and the lead author addressed coding discrepancies in discussion with the coders. During the development of the database, the research assistants took notes about policy changes mentioned in ordinances or regulations (e.g., a prior ordinance was referenced in the content) and saved copies of earlier ordinance and regulation documents identified, if available. The original policy database included all county-level recreational marijuana policies identified for Washington and Colorado (i.e., longitudinal data), including multiple columns for counties with evolving policy environments. Because several counties only

provided their most recent policy document online, we could not ensure the comprehensiveness of the longitudinal policy data set. As a result, the final database used for quantitative analyses included cross-sectional data with only the most up-to-date policy information as of April 1, 2019.

Research assistants also conducted a search of English-language US newspaper articles published from January 1, 2012, through May 1, 2019, on county-level marijuana policies in Colorado and Washington, using "marijuana or cannabis" and "policy, law, ordinance, or regulation" as key search terms. We used three newspaper databases (Newsbank: Major Metro Newspapers; EBSCO: Newspaper source; and Nexis Uni) and targeted newspapers with articles available during the study period.

Data Analysis

The Mann-Whitney *U* test was conducted to compare differences in local county marijuana legalization between Colorado and Washington. The *P* value was derived from a two-tailed test, and results were considered significant at $P < .05$. Descriptive statistics and data analysis were performed using Stata 14.2 (Stata Corp).[29]

Research assistants used a grounded theory approach[30] to identify policy change processes, key stakeholders, and arguments in newspaper articles and policy documents to supplement ordinance data findings. They wrote thematic summaries, which were iteratively discussed and reviewed with the lead author to identify content for inclusion in this article. Using the original policy database (with longitudinal data), we selected four counties to serve as illustrative examples of different policy environments and policy changes, and found all related newspaper articles for these counties during the study period. In each state, we purposefully identified two geographically distinct counties representing different marijuana policy environments.

Findings

We identified county-level marijuana regulatory policies for 53 of 64 counties in Colorado (83%) and 38 of 39 counties in Washington (97%) (Table). Overall, 38.8% of counties (n = 40) prohibited all marijuana facility types, and 40.8% of counties (n = 42) allowed all types of

Table 1. County-Level Policies on Recreational Marijuana Facilities[a] in Colorado and Washington Enacted by April 1, 2019

County-Level Adult Use Marijuana Policy	Colorado Counties, n (%)	Washington Counties, n (%)	Total, n (%)
All marijuana facility types allowed (zoning restrictions may apply)	15 (23.4%)	27 (69.2%)	**42 (40.8%)**
Some marijuana facility types allowed (i.e., allows ≥1 type of marijuana facility)	7 (10.9%)[b]	2 (5.1%)	**9 (8.7%)**
All marijuana facility types prohibited (category includes moratoriums or permanent bans permitting existing use, i.e., "grandfathered facilities")	31 (48.4%)	9 (23.1%)	**40 (38.8%)**
Missing data (no policy identified)	11 (17.2%)	1 (2.6%)	**12 (11.7%)**
Total	**64 (100%)**	**39 (100%)**	**103 (100%)**

[a] Does not include policies that focused only on regulating retail marijuana for medical use. Policies included may have had language to regulate the medical marijuana market (which we did not examine).
[b] In Colorado, facilities include those for cultivation, manufacturing, testing, and/or retail. In Washington, facilities include those for production, processing, and/or retail.

marijuana facilities in their jurisdictions. Nine counties (8.7%) permitted at least one type of marijuana facility but restricted others and were categorized as allowing some facilities.

Although both states were early adopters, the two states demonstrated considerable variation in county-level recreational marijuana policies (Table 1). Counties in Colorado were significantly less likely than those in Washington to allow marijuana facilities ($z = -3.831$; $P < 0.01$). About 69% of Washington counties enacted policies allowing all types of facilities in their jurisdiction, compared to 23.4% of Colorado counties. Less than a quarter of Washington counties prohibited all marijuana facilities, compared to nearly half of Colorado counties. Only two Washington counties and seven Colorado counties were in the

intermediate category—allowing at least one type of marijuana facility in their jurisdiction by 2019.

Among counties categorized as allowing all types of marijuana facilities, the restrictiveness of zoning conditions varied. For example, some counties mandated a conditional-use permit in limited zone classifications with additional approvals or standards that needed to be met before approval, whereas others limited the overall number of facilities.

Prohibitions took the form of moratoriums (temporary bans) still in effect, permanent bans, and zoning restrictions. In some counties, bans permitted existing use or "grandfathered" existing recreational facilities, allowing them to continue operations within the county's jurisdiction. Moreover, cities located within counties with prohibitions had the authority to enact their own policies, which could be different from the county's policy. In Washington, marijuana facilities could be licensed by the state, but not able to operate in counties with moratoriums or bans in place.[31]

Local Policy Changes and Information-Seeking Activities

Based on our policy change tracking of county-level marijuana ordinances and review of newspaper articles, we found that some counties were early adopters of permanent ordinances or regulations, but many more counties modified their policies several times during the study period. Policy change was often preceded by information-seeking activities (e.g., public comments or planning advisory committee meetings). Key information desired by local policymakers included the effects of marijuana on health, safety, and well-being outcomes; and local public opinion/perspectives on marijuana legalization.

Counties also used moratoriums to pause the expansion of the local marijuana market and allow time to engage in policy learning processes or to address residential concerns. For example, in August 2014, Jefferson County, Washington, enacted a moratorium on marijuana production and processing after two public hearings where citizens expressed concern about marijuana production and processing as an "'attractive nuisance' for criminals, vandals and minors—said 'attractive nuisance' status being contrary to the quiet and pastoral rural nature of much of unincorporated Jefferson County."[32] After further review, involving

the Planning Commission and additional public hearings, the county voted to permit marijuana production and processing establishments if they complied with notice provisions (e.g., informing neighbors of the proposal) and strict zoning restrictions. On the eastern side of Washington state, the Spokane County Commission imposed a moratorium on outdoor marijuana farms in November 2016, because of residential complaints about odors from marijuana agriculture and processing; at the time of the moratorium, over 160 marijuana growers and processors were operating in the county.[33] By the end date of our data collection (April 1, 2019), some counties still had moratoriums (temporary bans) in place and stated in policy documents they were awaiting additional information to make a permanent decision.

A few counties permitted marijuana facilities but integrated policy mechanisms to address residential concerns about matters such as odors, bright lighting, and increased traffic and perceived risk of crime associated with these establishments. For example, Chelan County, Washington, required marijuana producers and processors to register and pay a fee for an enforcement fund to ensure regulatory compliance.[34]

Policy Stakeholders and Arguments

Although policy communication and advocacy strategies varied by county and state, we found patterns during our qualitative review of ordinance and newspaper article data related to (a) primary county-level policy stakeholders, and (b) arguments in support of or opposition to local marijuana policy.

Primary stakeholders and advocates involved in county-level marijuana policy debates were similar in both states and included elected county officials tasked with decision making (e.g., county commissioners or supervisors), law enforcement (usually the county sheriff), individual marijuana growers/farmers, marijuana business license applicants, parents, and other residents. Several ordinances also named county voters as stakeholders who would be impacted by policy decisions. Some ordinances named specific county government departments (e.g., planning, building, and public health), zoning authorities/commissions, or public entities (e.g., schools) as local stakeholders. We did not identify any specific advocacy groups or advocates external to the county involved in county-level policy debates.

Our analysis of arguments in support of or opposition to specific policies revealed that many counties pointed to local public opinion as a basis for decision making, as well as local election results from the statewide 2012 marijuana legalization referendum, as evidence of either support of or opposition to legalizing marijuana facilities. For example, in 2012, *The Wall Street Journal* quoted the chair of the Douglas County, Colorado, Board of Commissioners as saying the local election results (less than half [46%] of county voters favored the referendum) supported a prohibition: "Our county has never passed or supported anything regarding the legalization of marijuana…we tend to be very conservative," he said.[35]

Alternatively, in Jefferson County, Washington, the ordinance included the quote, "Whereas, some 65% of voters in Jefferson County voted yes on Initiative 502,"[32] to support allowing marijuana facilities. Similarly, a local newspaper article about a 2015 proposal to extend a moratorium in Huerfano County, Colorado, quoted a resident as saying, "Legalization of marijuana passed by 60 percent of the vote here in Huerfano, and we need to respect the will of the people."[36]

Table 2 presents the main policy arguments, including public opinion, to support or oppose county-level marijuana policy positions in Colorado and Washington.

Frequent arguments in Colorado and Washington in favor of allowing some or all commercial marijuana facilities focused on economic gain, reduced criminality, and potential health benefits. Economic arguments from proponents of legalized marijuana varied and included mention of local revenue increases for the municipality, increased employment opportunities (i.e., economic development), expanded tourism, and personal financial gain for local residents involved in marijuana cultivation, processing, or retail.

In Whitman County, Colorado, opponents of a moratorium said it "would prohibit people from getting jobs and cause the county to lose out on revenue from the industry."[37] During a community forum in Wahkiakum County, Washington, a resident pointed to local revenue for a nearby county in support of allowing marijuana retail facilities, "I am merely speaking from a financial perspective…The county is in financial difficulty, and this is a legal revenue source available to the county."[38]

Criminality arguments—less commonly mentioned by marijuana legalization proponents than economic arguments—pointed to the potential reduction of illegal marijuana markets and activity as a benefit.

Table 2. County-Level Marijuana Policy Arguments in Colorado and Washington

Position	Definition	Types of Arguments
Proponents	Arguments used either in favor of allowing any or all marijuana facilities or against prohibiting these facilities	• Local public opinion • Economic gain • Reduced crime • Health benefits
Opponents	Arguments used either in favor of prohibiting any or all marijuana facilities or against allowing these facilities	• Local public opinion • Economic loss • Negative physical/mental health outcomes (particularly for children and youth) • Public health impact (e.g., environmental hazards) • Increased crime and public safety concerns • Existing federal law

We identified a wider variety of arguments used in support of prohibitions, including economic loss arguments to counter economic gain arguments from proponents of legalized marijuana. Economic loss arguments pointed to the possible loss of tax revenues (including reduced tourism), increased lawsuits, and increased cost of law enforcement to enforce regulations. Concerns about public health, safety, and welfare were among the most frequently mentioned arguments against permitting local marijuana establishments. Residents noted concerns about environmental hazards (e.g., noxious odors, light pollution, and water pollution), increased addiction, increased traffic issues around retailers, and the risk of accidental poisoning or overdose among minors. Additionally, elected local officials and residents pointed to federal law, namely the illegality of the cultivation, possession, sale, and use of marijuana under federal criminal statutes, as a deterrent for allowing marijuana facilities.

Crime issues raised by opponents demonstrated concern for public safety as well as law enforcement's capacity to address perceived crimes associated with marijuana facilities. A 2017 article described the tension between local economic development and legal production in Saguache County, Colorado:

> While many see marijuana as the ultimate "cash crop" and believe it is the solution to the county's financial woes, others paint a darker picture of what the county may become if growers wishing to establish large grows continue to receive approval from the county for their operations.[39]

The article noted residents' concerns about illegal growing of marijuana in Colorado, which was described as a substantial challenge for local and federal law enforcement. Three minor arguments included land use concerns, proximity to states where marijuana was illegal, and possible harm to the county's reputation or local identity. For the latter, proponents of bans/moratoriums pointed to potential harm or loss of neighborhood character/identity, suggesting that allowing a marijuana facility would be detrimental to the status quo.

In the following sections, we provide illustrative examples of four counties to describe in more detail the various county policy environments (all marijuana facility types allowed, some marijuana facility types allowed, and all marijuana facility types prohibited) and highlight policy changes within the counties. These counties are classified using a brief version of the rural-urban categories from the USDA Economic Research Service's Rural-Urban Continuum Codes: metropolitan; nonmetropolitan, urban; and rural.[40]

Mason County, Washington: All Marijuana Facility Types Allowed

On November 12, 2013, Mason County, a nonmetropolitan, urban county located in western Washington (population 60,699 in 2010), initially adopted an ordinance allowing licensed marijuana producers, processors, and retailers.[41] Meeting minutes from a county commissioner meeting on June 24, 2014, highlighted resident concerns about marijuana producers and processors during a public comment period when a majority of marijuana opponents, self-identified as county residents who lived near a licensed marijuana production or manufacturing facility,

expressed NIMBY (not in my backyard) sentiments about these facilities. Noted concerns included possible criminal activity, safety issues, odor problems, environmental risks (e.g., the potential environmental impact of water runoff on shellfish was stated multiple times), decreased property value, and law enforcement implementation issues.[42]

On July 1, 2014, the board of commissioners enacted a six-month moratorium prohibiting building or land use related to the production and processing of marijuana, allowing these activities solely in agricultural and industrial zones (2-1 vote).[42] Public hearings were subsequently held to elicit further public perspectives. On July 22, 2014, opponents of the moratorium said they felt specifically targeted and residents should "be concerned about meth, heroin and other drugs, not legal marijuana," in addition to expressing concerns about financial losses. Proponents reiterated arguments about the potential crime impact, loss of property value, and marijuana being "against federal law." Some residents asked for more time for public input and recommended revising the ordinance to address residential concerns but allow legal cultivation, processing, and sales.[42] On October 21, 2014, the board of commissioners voted to repeal the moratorium and simultaneously issued code amendments to address certain residential concerns (e.g., a 100-foot buffer between production or processing operations and the nearest property line in rural residential districts).[43]

Costilla County, Colorado: Some Marijuana Facilities Allowed

Costilla County is a rural county (population 3,524 in 2010) located along the southern Colorado border with New Mexico. It presents a unique local jurisdiction that enacted policies to allow cultivation and retail facilities.[44] Permitting these facilities contrasted with other rural counties that opted to prohibit all marijuana facilities.

Costilla County spans 1,227 square miles with a large swath of high desert land lacking in building or residential infrastructure. The low cost of land, coupled with state legalization of recreational marijuana, led to an influx of outsiders interested in purchasing property for commercial marijuana cultivation and production.[45] Marijuana facility licensing and license renewal fees were sources of revenue in addition to the distribution of the retail marijuana state sales tax. Local governments could also

implement their own local sales or excise taxes. Concerns included the increased use of educational and social service resources for new families from out of state and lack of local licensing and enforcement personnel. The *Denver Post* quoted a county commissioner as saying there was a shift in the jail population from local residents to a majority "from outside," but also said there was not a spike in crime in these early years.[46]

A local disagreement between a proposed marijuana cultivation facility and a museum in early 2015 highlighted the conflict between marijuana business license owners and other establishments in the county. Supporters of the museum opposed issuing a license for the proposed facility, mentioning the facility's potential impact on minors and other museum visitors.[47] Ultimately, the business owner decided to change the location of the marijuana cultivation facility to "be a good neighbor" and ameliorate possible odor and lighting concerns. The owner, however, continued to pursue a license for a retail facility and medical marijuana dispensary next to the museum.[48]

Chaffee County, Colorado: All Marijuana Facility Types Prohibited

Chaffee County, located in the central part of Colorado, is an example of a nonmetropolitan, urban county (population 17,809 in 2010) with a restrictive marijuana policy environment. In September 2013, the county unanimously approved ordinance 2013-02, which temporarily banned new recreational marijuana establishments in the county through December 31, 2014.[49] However, the county permitted recreational marijuana cultivation licenses in industrial zones, and some facilities that cultivated medical marijuana or manufactured medical marijuana–infused products were exempt from the ban—if such facilities were in good standing in the county and met the state and county licensing standards, they were allowed to convert to recreational facilities.[49] Grandfathered facilities could apply for recreational facility licenses (in the same category).[50] Ordinance 2014-02,[51] unanimously adopted in 2014, amended the prior ban through December 31, 2015, to include all marijuana facilities and limit the number of facilities in the county to six. An exception was again made for cultivation or manufacturing facilities in good standing with the county and state; these facilities were grandfathered and could renew their licenses or expand their operations and

the number of plants within their existing parcel(s) allotted. The moratorium banning any type of recreational marijuana establishment, with the exception of certain grandfathered facilities, was reissued multiple times (2015-01, 2016-01, 2018-01, and 2019-01).[52]

Noted arguments in favor of the moratoriums included health, safety, and welfare concerns as well as federal marijuana policy:

> Marijuana remains an illegal substance under federal law, specifically as a Schedule I drug under the Controlled Substances Act found in Title II of the Comprehensive Drug Abuse and Control Act of 1970 (P.L. 91–513, 84 Stat. 1236) which creates uncertainties regarding certain aspects of allowing marijuana establishments.[50]

County moratoriums also cited environmental concerns (namely, odor issues from existing establishments), and enforcement and monitoring issues related to marijuana cultivation and processing, and said additional time was needed to examine these uncertainties to inform a permanent decision.[50]

Benton County, Washington: All Marijuana Facility Types Prohibited

Benton County, Washington, is a metropolitan county (population 175,177 in 2010) bordering Oregon. This county was a unique case: it transitioned from permitting marijuana businesses to enacting moratoriums, ordinances, and zoning limitations, and eventually banning new recreational marijuana facilities while grandfathering in existing operations in response to local concerns and complaints.

Benton County did not start out with a ban. In 2015, recreational marijuana retail facilities opened in the county.[53] Later that year, multiple residents expressed concern over a marijuana grow site, which led to an emergency moratorium and public hearing process.[54] The controversy continued, and, in late 2017, a local newspaper article featured alternate perspectives from two longtime county residents expressed during the county's public hearing: one had concerns about the odor associated with marijuana facilities and the effect on children, whereas the other, a landowner who rented property to a marijuana producer, opposed a ban.[55] Opponents of a ban mentioned economic empowerment and access to medicinal marijuana, whereas supporters mentioned odor and enforcement issues. The county opted to ban new marijuana retail

facilities and enact a moratorium on new producers and processors. In April 2018, the board of county commissioners voted two to one to permanently ban all new marijuana production and processing operations in all unincorporated zoning districts, although over 50 licensed operators in these areas were allowed to continue operating.[56] The commission also expanded the sheriff's authority to enforce nuisance and odor rules in response to residential complaints.[57]

Discussion

Our county-level recreational marijuana policy surveillance study reveals a patchwork of local policies in place by 2019 in the two earliest states to legalize recreational marijuana. Our findings add to existing literature that suggests state marijuana legalization policies are nuanced and complex, varying at the local level.[3] Our policy change results highlight the importance of ongoing policy surveillance research to examine changes to local marijuana policy over time. We found 40 counties (38.8%) across both states prohibited all marijuana facilities by early 2019, either through temporary or permanent bans. Prior research in Washington similarly found 10 counties (25.6%) had moratoriums or permanent bans in effect on retail recreational cannabis outlets as of mid-2014[7] and mid-2016,[3] compared to 9 counties (23.1%) at the end of our study period (April 1, 2019).

To our knowledge, this is the first study to report county-level recreational marijuana policies in Colorado. We found that nearly half (48.4%) of Colorado counties had prohibited all types of marijuana facilities by the end of our study period. This is a high percentage compared to Washington. Of note, the lower percentage in Washington may be partially explained by Washington's merger of recreational and medical marijuana markets in 2015.[13] The proportion of counties in Colorado with prohibitions was also greater than that found in a policy surveillance study from California.[6] Our results add to existing reports that numerous counties are opting to prohibit recreational marijuana facilities in states where recreational marijuana can be legally purchased and consumed (range: 23.1%-48.4% of counties in a state).

We found local stakeholders (county representatives and departments, business owners, and residents) were publicly engaged in county policy decisions. We did not identify stakeholders who represented industry

groups or external entities, which appear to play a limited public role in local debates. It is feasible that industry groups or other external advocates were involved in private lobbying efforts as opposed to public-facing advocacy strategies. Our findings about the predominance of local stakeholders in policy debates are similar to research examining a local medical marijuana policy debate in California involving internal actors, and the arguments namely reflected a struggle between identity and social order within the region.[58]

The involvement of local stakeholders also suggests marijuana commercialization is currently a cottage industry. In the absence of targeted regulatory policy to retain small-scale growers and retailers, a large marijuana industry could emerge, prioritizing lobbying and aggressive advertising strategies.[14] Tobacco companies may potentially enter marijuana policy debates given their long-standing interest in entering into legalized marijuana markets based on the sales potential.[59]

Based on our qualitative data, whereas some stakeholders were likely to support allowing marijuana facilities as a way of attracting outside tourism, other stakeholders used concerns about legal liability or additional crime from outsiders as rationale to prohibit these facilities. Future work should further explore how county policymakers balance local-level politics and perspectives (e.g., residential complaints, economic issues, public opinion) with state policy directives and policies over time. Additional research could examine factors influencing enactment of local recreational marijuana policies and closely examine the effect of population density (rural-urban characteristics) and county-state borders on local marijuana policy decisions.

Arguments in favor of permissive marijuana county ordinances included economic benefits (e.g., additional tax revenue for local governments)[60] and increased access to medicinal and therapeutic treatment. Early evidence on cannabis markets in Washington suggests increased cannabis retail access is associated with more frequent use among adults in the state.[61] Sales data from Washington indicate a large and growing marijuana market, yielding a substantial source of state revenue allocated to the general fund, basic health, local municipalities, prevention and education, research, and other issues. In fiscal year 2019, Washington collected $395.5 million in legal marijuana taxes and license fees.[62] During the COVID-19 pandemic, monthly recreational marijuana sales in Colorado were $183 million in July 2020 alone.[63] As state and local governments continue to be impacted by the economic

losses associated with COVID-19, economic gain arguments might become increasingly attractive to offset diminishing revenues from other sources.

A limitation of the study is the categorization of county-level marijuana policy into three groups. The gradient of local marijuana policy is more nuanced than these three categories because some counties allowing all types of marijuana facilities also have restrictive zoning conditions, limit the maximum number of facilities, or limit acreage for cultivation or processing facilities.

Additionally, our study did not closely examine other local marijuana policy elements such as minimum buffer distances, business hour limits, public health messaging, or advertising restrictions.[3,6]

Another study limitation is the exclusion of cities and towns from the sample. It is important to note that counties are limited in their regional authority and can include cities with marijuana policies that differ from the county policy. Prior studies on similar topics and geographies have examined marijuana policy in Washington cities with more than 3,000 residents[3] and all cities in California.[6] Given our additional focus on policy stakeholders, arguments, and advocacy efforts, we elected to solely concentrate on county-level policies.

A key strength of our study is that it is the first to consider local policy variation across two states that legalized recreational marijuana use at the same time. The typology we created and employed can serve as the basis for future legal epidemiology work to examine the effects of policy on public health, health, and social outcomes. Other strengths are the inclusion of qualitative research and newspaper article data for the purpose of providing rich descriptions of the county policy environments and change. Prior cross-sectional policy surveillance studies lacked these elements. Further, our findings convey the value of ongoing local policy surveillance data because four counties identified as having moratoriums/bans in place as of July 2014 allowed recreational marijuana facilities by mid-2019, indicating considerable local policy change processes occurred within these jurisdictions in the span of a few years.

Policy and Research Implications

Since 2012, several other states have legalized recreational marijuana for adults and have permitted local-level jurisdictions to regulate local

markets. States may benefit from the results of our findings as they create their own frameworks to regulate marijuana and take into consideration similar fundamental local government concerns, such as public safety, health, and environmental impact issues.

Opponents of permissive marijuana policies point to perceived public health, safety, and welfare issues related to marijuana facilities and use, including addiction, increased crime, and detrimental health effects for minors. Early results from Colorado suggest legalization has led to increased marijuana-related hospitalizations, an initial surge in poison control center calls mentioning marijuana, and increased DUIs for which marijuana was identified as the primary impairing substance.[2,64,65] In Colorado and Washington, commercial marijuana legalization is significantly associated with increased rates of fatal motor vehicle accidents.[66] There is also evidence on the harms of marijuana secondhand smoke on cardiovascular health.[67,68] Use of high-potency cannabis concentrate products has also been associated with negative consequences like psychosis and emergency department visits.[69] These public health outcomes should be considered and used to inform policy decisions. Research about associations between crime and legal recreational marijuana facilities and local markets can also help address perceived concerns about increased crime. Findings from existing studies are mixed, likely due in part to challenges in interpreting law enforcement data.[8]

We found that advocates of allowing local marijuana facilities claimed legalization could reduce local marijuana black market activities; however, opponents were concerned about additional enforcement or implementation costs, as well as crime. Cost-effectiveness studies comparing the cost of additional enforcement or implementation mechanisms to local revenues are needed.

Potential associations between local marijuana policy and health effects and crime have gone largely unexplored due to restrictions and limitations on federal funding for marijuana research. Studies on the implementation and management of marijuana prevention and control programs have also been constrained by a lack of federal funding. However, interest in the public health and safety impact of local marijuana businesses expressed by local stakeholders in our study indicates a critical demand for policy effectiveness research to inform local decisions. Youth access to and use of marijuana, driving under the influence of marijuana, marijuana dependence and addiction, unwanted contaminants in marijuana products, uncertain potency of marijuana products, and

concurrent use of marijuana and alcohol have previously been identified as important topics for public health research and evaluation to inform policy.[9,20,21,70,71]

Public concern about noxious odors was a frequent argument against permitting marijuana cultivation and processing facilities in local jurisdictions, as well as a reason to overturn permissive marijuana ordinances. This is an issue that policymakers and marijuana producers need to address and mitigate with regulatory policy and practice. As the legal market continues to grow, more research is needed on the impact of operating marijuana cultivation and processing facilities on the environment,[13,72] including studies of the use of pesticides and cannabis cultivation and regulation standards.[73] Concerns have been raised regarding the concentration of cultivation licenses in agricultural areas and environmental health concerns for vulnerable populations,[74] who often disproportionately face environmental injustices.

Research is also needed to explore the role of state and local public health departments in regulating marijuana in states where recreational marijuana is legal, since a public health framework would designate them as the lead regulatory agency.[14] Studying the impact of marijuana legalization on public health departments' scope of work and health education and promotion efforts in marijuana prevention and control programs is also important. States such as Washington that have earmarked revenue for prevention, control, and research may have made further progress than counterparts in this area for developing educational campaigns (assuming funding has been released for these efforts).

Conclusion

As early adopters, Colorado and Washington serve as quasi-natural experiments for marijuana policy and regulations in the United States. Local-level policy surveillance research on marijuana policies reveals similarities and differences in the trajectory of local marijuana policy evolution and change processes, highlighting how counties are balancing state policy directives and local residential perspectives. The findings from this study provide a foundation for future policy and public health research on marijuana policy and outcomes in states that have legalized marijuana.

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Crash Fatality Rates After Recreational Marijuana Legalization in Washington and Colorado

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Objectives. To evaluate motor vehicle crash fatality rates in the first 2 states with recreational marijuana legalization and compare them with motor vehicle crash fatality rates in similar states without recreational marijuana legalization.

Methods. We used the US Fatality Analysis Reporting System to determine the annual numbers of motor vehicle crash fatalities between 2009 and 2015 in Washington, Colorado, and 8 control states. We compared year-over-year changes in motor vehicle crash fatality rates (per billion vehicle miles traveled) before and after recreational marijuana legalization with a difference-in-differences approach that controlled for underlying time trends and state-specific population, economic, and traffic characteristics.

Results. Pre–recreational marijuana legalization annual changes in motor vehicle crash fatality rates for Washington and Colorado were similar to those for the control states. Post–recreational marijuana legalization changes in motor vehicle crash fatality rates for Washington and Colorado also did not significantly differ from those for the control states (adjusted difference-in-differences coefficient = +0.2 fatalities/billion vehicle miles traveled; 95% confidence interval = –0.4, +0.9).

Conclusions. Three years after recreational marijuana legalization, changes in motor vehicle crash fatality rates for Washington and Colorado were not statistically different from those in similar states without recreational marijuana legalization. Future studies over a longer time remain warranted. (*Am J Public Health*. Published online ahead of print June 22, 2017: e1–e3. doi:10.2105/AJPH.2017.303848)

A recent analysis found that medical marijuana legalization has been associated with overall reductions in motor vehicle crash fatalities, although the state-specific effects vary widely.[1] Other studies of marijuana-related motor vehicle crashes before and after medical marijuana legalization have produced conflicting results.[2–5] What remains unknown is whether recreational marijuana legalization affects motor vehicle crash fatality rates. The purpose of this study was to evaluate pre– and post–recreational marijuana legalization changes in motor vehicle crash fatality rates in the first 2 US states to pass recreational marijuana legalization—Washington (November 2012) and Colorado (December 2012)—and to compare them with motor vehicle crash fatality rates in 8 similar states without medical marijuana legalization or recreational marijuana legalization.

METHODS

We selected control states a priori based on their similarity to Washington or Colorado, primarily in terms of traffic and roadway characteristics but also in terms of population, drivers, vehicle ownership, and traffic laws (Appendix A, available as a supplement to the online version of this article at http://www.ajph.org). We then used the National Highway Traffic Safety Administration's Fatality Analysis Reporting System (FARS) to determine the annual number of motor vehicle crash fatalities in Washington, Colorado, and each control state for 2009 through 2015. We obtained annual vehicle miles traveled data for each state from Federal Highway Administration reports and calculated annual motor vehicle crash fatalities per billion vehicle miles traveled.

We used a difference-in-differences approach[6] to compare year-over-year changes in motor vehicle crash fatality rates in Washington and Colorado following recreational marijuana legalization with the contemporaneous crash data for the control states. Common for analyzing policy-level interventions, this difference-in-differences approach allowed us to control for underlying time trends and state-specific population and traffic characteristics.[7] Our analysis included (for each state) year-specific population data; male-to-female population ratio; total annual Federal Highway Administration appropriations as a measure of road construction and maintenance activity; annual gross domestic product, per-capita real income, and unemployment rate as measures of economic conditions; per-capita alcohol consumption; and transportation system characteristics such as primary versus secondary seatbelt laws, road density, traffic density, and rurality.

We first used random-effects multivariate regression for panel data, incorporating the small-sample Swamy–Arora estimator individual-level variance component and clustered (by state) robust SEs, to confirm

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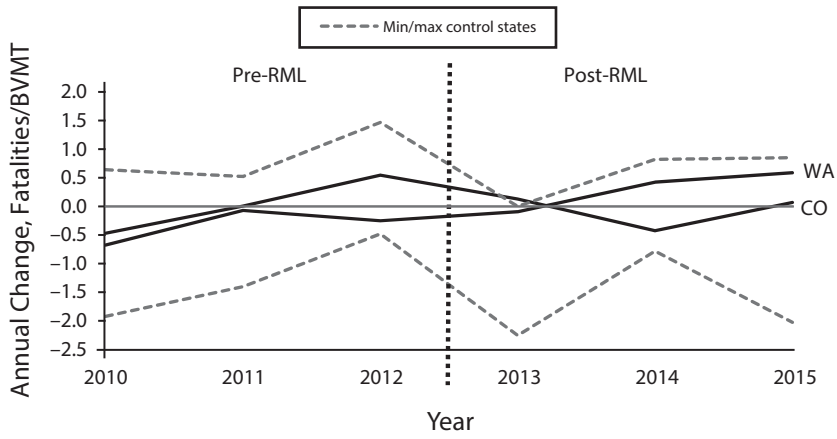
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parallel trends for the pre–recreational marijuana legalization (2009–2012) changes in motor vehicle crash fatality rates for Washington and Colorado and for the control states. We then modeled the interaction effect between recreational marijuana legalization (yes/no) and period (pre–/post–recreational marijuana legalization) on changes in motor vehicle crash fatality rates for the full study period (2009–2015), which produced the difference-in-differences coefficient. Positive difference-in-differences coefficients indicate higher motor vehicle crash fatality rates (smaller decreases or larger increases); negative coefficients indicate lower rates (larger decreases or smaller increases). We used the Hausman test to confirm appropriateness of the model specification. All tests were 2-sided with an α value of .05 used to establish statistical significance.



Note. min = minimum; max = maximum.

FIGURE 1—Annual Year-Over-Year Changes in Motor Vehicle Crash Fatality Rates per Billion Vehicle Miles Traveled (BVMT) Before and After Recreational Marijuana Legalization (RML): Washington (WA), Colorado (CO), and 8 Control States, 2010–2015

RESULTS

Alabama, Indiana, Kentucky, Missouri, South Carolina, Tennessee, Texas, and Wisconsin were the 8 states without either medical marijuana legalization or recreational marijuana legalization that most closely matched Washington and Colorado in terms of traffic, roadway, and population characteristics. Between 2009 and 2015, 60 737 motor vehicle crash fatalities occurred in Washington, Colorado, and the 8 control states. Overall, annual motor vehicle crash fatality rates decreased from 12.8 fatalities per billion vehicle miles traveled in 2009 to 11.4 fatalities per billion vehicle miles traveled in 2015.

Figure 1 shows the year-over-year changes in motor vehicle crash fatality rates for Washington and Colorado versus the control states in both the pre– and the post–recreational marijuana legalization periods. In the pre–recreational marijuana legalization period, the mean (±SD) year-over-year changes observed in Washington and Colorado did not differ from those observed in the control states (–0.2 [±0.4] vs –0.1 [±0.9] fatalities/billion vehicle miles traveled; $P = .38$). After legalization, motor vehicle crash fatality rates increased by a mean of +0.1 (±0.4) fatalities per billion vehicle miles traveled in Washington and Colorado and decreased by a mean of –0.5 (±0.9) fatalities per billion vehicle miles traveled in the control states each year. In the adjusted difference-in-differences analysis, however, the postlegalization changes in motor vehicle crash fatality rates observed in Washington and Colorado were not significantly different from those observed in the control states (difference-in-differences: +0.2; 95% confidence interval = –0.4, +0.9). (A summary of the results and the full regression model are shown in Appendix B, available as a supplement to the online version of this article at http://www.ajph.org.) Post hoc analyses that used nonclustered robust SEs, traditional random-effects regression, fixed-effects regression, or population rather than billion vehicle miles traveled as the denominator or that grouped Washington with its most similar control states and Colorado with its most similar control states all produced similar results (data not shown).

DISCUSSION

We found no significant association between recreational marijuana legalization in Washington and Colorado and subsequent changes in motor vehicle crash fatality rates in the first 3 years after recreational marijuana legalization. The difference-in-differences coefficient we observed, 0.2 fatalities per billion vehicle miles traveled, would equate to approximately 77 excess crash fatalities (of 2890 total) over nearly 38 million person-years of exposure in the 3 years since legalization. We do not view that as a clinically significant effect, but others might disagree. Although our findings seem at odds with the known effects of marijuana impairment[8,9] and with previous studies finding associations between motor vehicle crashes and marijuana use,[2–5] they are consistent with the most recent analysis of medical marijuana legalization and motor vehicle crash fatalities.[1]

This study was limited to the first few years after recreational marijuana legalization in only 2 states. Currently, however, Washington and Colorado are the only US states with multiyear postlegalization FARS data, and 2015 is the last year for which data are available. We used nonadjacent control states matched to Washington and Colorado based on traffic, roadway, and population characteristics, allowing a stronger analysis than if we had used adjacent, randomly selected, or a convenience sample of states as controls. All of the states had graduated drivers' licensing laws and used 0.08 grams per deciliter as their blood alcohol concentration threshold for impaired driving; all but 1 state (Tennessee) allowed administrative license revocation for impaired driving. Still, states are inherently unique and dynamic, and other unmeasured factors (e.g., enforcement activities; other laws and policy initiatives) could affect crash fatality rates. Selecting fewer control states could have provided for greater similarity

between Washington and Colorado and the control states but would have increased the risk of selection bias. We selected control states without medical marijuana legalization to provide the greatest opportunity to detect an effect of recreational marijuana legalization, presuming the difference between marijuana illegality and recreational marijuana legalization is likely greater than the difference between medical marijuana legalization and recreational marijuana legalization. We did not evaluate the effects of recreational marijuana legalization in Washington and Colorado separately, although their recreational marijuana legalization laws differ somewhat. Finally, we were unable to differentiate between the effects of recreational marijuana legalization (2012) and the effects of legalization of commercial marijuana sales (2014)—an issue deserving of future study.

Importantly, the absence of a statistically significant effect on motor vehicle crash fatality rates does not mean that recreational marijuana legalization is harmless. We did not assess other public health or policy implications of recreational marijuana legalization such as increased drug dependency, emergency department or rehabilitation center admission rates, suicides, or decreased economic productivity. A recent study reported increased marijuana-related emergency department visits among out-of-state visitors to Colorado following recreational marijuana legalization.[10]

This analysis was based on annual statewide motor vehicle crash fatality and billion vehicle miles traveled data; we were not able to evaluate possible differential effects in subpopulations such as younger versus older drivers or rural versus urban drivers. We studied total crashes rather than marijuana-impaired crashes because testing for marijuana use is not uniform in FARS-reported crashes, and the limitations of laboratory testing make studies of marijuana-impaired crashes difficult.[11] Also, FARS does not report nonfatal crashes, and no nationwide clearinghouse for nonfatal crash data is available. However, we also found no association between recreational marijuana legalization and total crash rates when analyzing available state-reported nonfatal crash statistics (Appenix C, available as a supplement to the online version of this article at http://www.ajph.org).

PUBLIC HEALTH IMPLICATIONS

We conclude that 3 years after recreational marijuana legalization in Washington and Colorado, the changes in motor vehicle crash fatality rates observed in those 2 states do not significantly differ from rate changes in similar states without recreational marijuana legalization. However, future studies over a longer time, including data from additional states with recent recreational marijuana legalization, remain warranted. AJPH

CONTRIBUTORS

J. D. Aydelotte and K. M. Luftman conceptualized the study. J. D. Aydelotte, L. H. Brown, K. M. Luftman, B. Coopwood, and C. V. R. Brown designed the study. L. H. Brown, K. M. Luftman, and A. L. Mardock acquired the data. J. D. Aydelotte, L. H. Brown, K. M. Luftman, P. G. R. Teixeira, and C. V. R. Brown analyzed and interpreted the data. J. D. Aydelotte, L. H. Brown, and K. M. Luftman drafted the article, and A. L. Mardock, P. G. R. Teixeira, B. Coopwood, and C. V. R. Brown provided additional critical revisions and intellectual content. All authors reviewed and approved the final version of the article.

HUMAN PARTICIPANT PROTECTION

The institutional review board affirmed that this study was not human participant research.

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Impact of recreational marijuana legalization on crime: Evidence from Oregon

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ABSTRACT

The legalization of recreational marijuana is a pivotal policy change, and its social consequences remain largely unknown. Central to the public concern is its impact on crime, about which competing views exist and empirical studies have yielded mixed results. Based on Uniform (UCR) data from 2007 to 2017, this study used Difference in Differences (DID) analysis to examine the impact of recreational marijuana legalization on the rates of a variety of serious crimes in Oregon, which passed its recreational marijuana law (RML) in late 2014. Results provide some evidence demonstrating a crime-exacerbating effect of recreational marijuana legalization, as reflected by substantial increases in the rates of multiple types of serious crimes as measured by the UCR in Oregon relative to non-legalized states following legalization, including property and violent crime overall, as well as other crimes such as burglary, motor vehicle theft, larceny, and aggravated assault.

1. Introduction

The last two decades saw dramatic changes in policies associated with marijuana use: over 30 states in the United States (U.S.) have legalized medical marijuana, and, more remarkably, there is a trend of legalizing recreational marijuana. Colorado and Washington State first legalized marijuana for recreational use in late 2012, and, to date, 11 states and the District of Columbia have also legalized marijuana for recreational purposes, which may include production, possession, and retail sale, although marijuana remains an illegal drug under the federal Controlled Substances Act. Notably, this pivotal policy change appears not to be restricted within the borders of the United States, but has global dimensions, shown by the recent recreational marijuana legalization in Canada and Uruguay.

As a social experiment, marijuana legalization, especially for recreational purposes, has generated concerns about its impact on public safety. Central to this is an ongoing debate on whether legalization increases or decreases crime rates (Lu et al., 2019). Opponents argue that marijuana legalization would increase crime not only because marijuana may be a gateway to more serious drugs such as cocaine and heroin that are closely associated with crime, but also because of the potential criminogenic effects of the increasing presence of marijuana dispensaries (Cleveland & Wiebe, 2008; Kepple & Freisthler, 2012). Proponents assert that legalization would lead to lower crime rates given the decriminalization of this drug and the reduction in the underground marijuana market that tends to generate criminal activities (Trilling, 2016, September 23). Proponents also argue that legalization would have a crime-reducing effect because the police would be able to reallocate resources and efforts to more serious crimes rather than focusing on marijuana possession arrests, which would in turn lead to increased crime clearance rates and deterrence effects (Makin et al., 2019). Despite these competing views about the impact of recreational marijuana legalization on crime and public safety, empirical studies using rigorous methodologies to examine this issue are few, yielding mixed results. While there is some evidence suggesting recreational marijuana dispensaries are associated with substantial increases in crime rates and disorder at the neighborhood level (Hughes, Schaible, & Jimmerson, 2019), other studies have either demonstrated a crime-reducing effect from marijuana legalization or the operation of marijuana dispensaries (Brinkman & Mok-Lamme, 2019; Dragone, Prarolo, Vanin, & Zanella, 2019; Wu, Boateng, & Lang, 2020) or found little to no impact of legalization on crime (Lu et al., 2019). Given the public concern about legalization's impact on crime, more studies based on rigorous research designs are needed to further examine the implications of recreational marijuana legalization for public safety.

The available limited prior studies on this issue have predominantly

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focused on Colorado and/or Washington State—the two states that first legalized recreational marijuana in the U.S. This is reasonable considering that an examination of a relatively longer post-legalization period would be helpful for revealing the prospective effects of legalization on such outcome variables related to public safety as crime rates and crime clearance rates. However, given that more states have legalized following Colorado and Washington State, and some of them have also implemented their recreational marijuana laws for a few years, it is now necessary to expand the examination to other states. For instance, although six years have passed since the passage of the recreational marijuana law (RML) in late 2014 in Oregon, it is difficult to find studies examining how legalization has affected crime in this state.

In effect, the impact of marijuana legalization on crime may vary across legalized states based on differential marijuana-related laws and regulations. For instance, although Colorado (CO), Washington State (WA), and Oregon (OR) have overall legalized marijuana for recreational purposes including production, possession, and sale, these three states differ in certain important aspects associated with the regulation of recreational marijuana. Specifically, for example, while CO and OR allow their residents over 21 to grow several marijuana plants for personal recreational use, it remains illegal in WA to grow recreational marijuana on private property for personal use. Also, these states differ in terms of the amount of marijuana concentrates that people can purchase – the maximum limits for CO, OR, and WA are 8 g, 7 g, and 5 g, respectively. Given these variations in marijuana-related policies across the legalized states, it is worthwhile to extend this line of research and examine how recreational marijuana legalization affects crime in states that have recently legalized marijuana such as Oregon. Moreover, prior relevant research has usually focused on a certain city or specific areas, which may limit generalizability of their findings (Brinkman & Mok-Lamme, 2019; Hao & Cowan, 2020; Hughes et al., 2019). It would be more informative to policy makers and the public to examine large geographical areas within a legalized state, thus examining the impact of recreational marijuana legalization on public safety for an entire state.

This study intends to address these important knowledge gaps. Specifically, it is a large-scale study using county-level Uniform Crime Report data that examines changes in rates of a wide range of serious crimes, including violent crime, property crime, robbery, aggravated assault, larceny, motor-vehicle theft, and burglary, in Oregon, relative to the 19 states[1] that have not legalized marijuana for recreational or medical purposes (until 2017). In addition, as a robustness check of the results, we have also conducted analyses using a control group consisting of five states[2] in which only medical marijuana are legal during the study period. This study not only offers an extended period of observation spanning from 2007 to 2017, but also involves analyses of crime data for all counties in the 25 states examined.

2. Perspectives on the relevance of marijuana legalization to crime

Although there seems to be a trend toward marijuana legalization, as manifested by the majority of U.S. states that have legalized medical marijuana and the increasing number of states legalizing recreational marijuana, the issue still generates controversy (Freisthler, Gaidus, Tam, Ponicki, & Gruenewald, 2017). As mentioned above, opposing perspectives exist regarding legalization's implications for public safety, and, central to this discussion, is its impact on crime. This is not surprising given the longstanding perceptions about the connection between drugs, especially illicit drugs, and crime (Allen, 2005). Those against marijuana legalization emphasize its potential adverse repercussions on crime, and make several arguments: First, marijuana is a "gateway" drug, and its increased availability and accessibility as a result of legalization would lead to an increase in not only the use of marijuana, but also the use of more serious drugs such as heroin and cocaine (Secades-Villa, Garcia-Rodríguez, Jin, Wang, & Blanco, 2015; Williams, 2020), although evidence on the gateway sequence is mixed and dynamics underlying the sequence are not well understood.[3] This means there would be more illicit drug users who may need to commit crimes to finance their substance use (Morris, TenEyck, Barnes, & Kovandzic, 2014). Second, marijuana use impairs individuals' cognitive functions. Specifically, marijuana use may increase violent behavior, not only because cannabis intoxication may negatively affect individuals' cognitive abilities and reduce their self-control (Howard & Menkes, 2007), but also because marijuana users tend to have a lifestyle involving more tolerance for deviance and greater willingness to take risks compared to non-users (Goode, 2008). In a similar vein, legalization would increase rates of driving under the influence of marijuana (Bedard, 2019, June 25). Third, there is also a concern about the criminogenic effects of marijuana retail outlets. As marijuana use is still illegal at the federal level, marijuana retailers largely cannot use financial institutions and, thus, primarily rely on cash sales. Given that the business is cash-based, marijuana dispensaries and customers (who need to carry large amounts of cash to buy marijuana) are likely to be the targets of property and violent crimes such as burglary and robbery (Freisthler et al., 2017; Hughes et al., 2019). Community members and police officials have additional concerns that marijuana dispensaries may have deleterious social and cultural effects on neighborhoods where these dispensaries operate and, as a result, may increase crime (Freisthler et al., 2017).

However, from the perspectives of legalization supporters, marijuana legalization would reduce crime rather than the opposite. Specifically, the proponents of marijuana legalization argue that legalization would decrease crime in several ways. First, the legalization of marijuana for recreational purposes itself would decriminalize the activities associated with possession, production, and retail sale of marijuana, which, as a result, would reduce crime (Mccall, 2019, October 8). Second, marijuana legalization would influence police allocation of resources and efforts in a way that may increase police effectiveness in dealing with more serious crimes (Makin et al., 2019). That is, without the need to focus on marijuana possession arrests after legalization, the police could reallocate their resources, both human and material, to more serious violent and property crimes, and this resource reallocation would arguably improve crime clearance rates and strengthen crime deterrent effects. Third, a diminished underground marijuana market likely parallels marijuana legalization (Gettman & Kennedy, 2014). Given the well-established connection between the black drug market and crime, a shrinking black marijuana market as a

[1] These 19 states are: Alabama, Georgia, Idaho, Indianan, Iowa, Kansas, Kentucky, Mississippi, Nebraska, North Carolina, Oklahoma, South Carolina, South Dakota, Tennessee, Texas, Utah, Virginia, Wisconsin, and Wyoming.

[2] These five states are: Hawaii, Montana, New Mexico, Rhode Island, and Vermont.

[3] It needs to be noted that the gateway hypothesis has been subjected to criticism. For instance, as Van Gundy and Rebellon (2010) noted, although there existed substantial evidence suggesting a temporal order and an association between the use of so-called "gateway" drugs such as marijuana and the use of "hard" substances such as heroin or cocaine, the causal link between marijuana use and other illicit drug use has not been well-established – research has typically failed to eliminate rival explanations. According to Van Gundy and Rebellon (2010), the observed association between early marijuana use and the subsequent use of other illicit drugs may be "due to common sources such as genetic predisposition, family environment, or social contextual factors" (p. 244). In a more recent marijuana research report by the National Institute on Drug Abuse (NIDA, 2020, it was reported that most people who used marijuana did not go on to use other harder illicit drugs. In addition, scholars have also pointed out that the gateway hypothesis may need to be abandoned because of its oversimplification of the dynamics associated with drug progression (Arnold & Sade, 2020). As Secades-Villa et al. (2015) noted, the dynamics of progression from marijuana to other illicit substances was still largely unknown.

result of legalization means a reduction in crime, especially violent crime.

3. Empirical evidence on the impact of marijuana legalization on crime

In the last two decades, there has been growing scholarly attention paid to the impact of marijuana legalization on crime (Brinkman & Mok-Lamme, 2019; Chu & Townsend, 2019; Contreras, 2016; Dragone et al., 2019; Freisthler et al., 2017; Freisthler, Ponicki, Gaidus, & Gruenewald, 2016; Kepple & Freisthler, 2012; Hao & Cowan, 2020; Hughes et al., 2019; Lu et al., 2019; Makin et al., 2019; Morris et al., 2014; Shepard & Blackley, 2016; Wu et al., 2020). Given that the legalization of marijuana for recreational purposes is still a relatively recent phenomenon, previous scholarly efforts have predominantly focused on medical marijuana legalization (Chu & Townsend, 2019; Contreras, 2016; Freisthler et al., 2017; Freisthler et al., 2016; Kepple & Freisthler, 2012; Morris et al., 2014; Shepard & Blackley, 2016). Studies examining the impact of recreational marijuana legalization, although increasing, remain few (Brinkman & Mok-Lamme, 2019; Hao & Cowan, 2020; Hughes et al., 2019; Lu et al., 2019; Stohr et al., 2020). A review of the extant literature suggests that research findings related to the effects of medical marijuana legalization on crime are mixed and inconclusive (Chu & Townsend, 2019; Hughes et al., 2019). This is also true for the results of the limited number of studies examining the effects of recreational marijuana legalization. In other words, the available evidence does not show clear and consistent patterns in changes of different forms of crimes within the context of marijuana legalization.

3.1. Effects of medical marijuana legalization on crime

Scholars have examined the impact of medical marijuana legalization on crime at the national (Chu & Townsend, 2019), state (Morris et al., 2014; Shepard & Blackley, 2016), and neighborhood (Contreras, 2017; Freisthler et al., 2016; Freisthler et al., 2017; Kepple & Freisthler, 2012) levels. Some studies found that the legalization of medical marijuana either had no effect on crime rates or reduced rates of certain types of crimes (Chu & Townsend, 2019; Gavrilova, Kamada, & Zoutman, 2017; Morris et al., 2014; Shepard & Blackley, 2016), while other studies, especially those conducted at the neighborhood level, have demonstrated a crime-exacerbating effect of medical marijuana legalization or the placement of medical marijuana dispensaries (Contreras, 2017; Freisthler et al., 2017; Freisthler et al., 2016; Holmes, 2014). For instance, using U.S. state panel data, Morris et al. (2014) found no evidence that medical marijuana laws (MML) increased rates of homicide, rape, robbery, assault, burglary, larceny, and auto theft—the most serious offenses as classified by the FBI. Interestingly, this study showed a possible crime-reducing effect of MML for homicide and assault. A recent study by Gavrilova et al. (2017) focusing on U.S.-Mexico border areas also found that MML decreased violent crime in states that border Mexico. Similarly, using data from 11 states in the Western United States, Shepard and Blackley (2016) found no exacerbating effect of medical marijuana laws on property and violent crimes. Rather, their results suggest a substantial reduction in rates of violent crime in states that have legalized medical marijuana.

Notwithstanding these studies suggesting a null effect or a crime-reducing effect of medical marijuana legalization, there is some evidence showing crime rates do increase following legalization at the state level, or with the increasing density of medical marijuana dispensaries at the neighborhood level. For example, based on the FBI's Uniform Crime Report (UCR) data, Holmes (2014) found that legalizing medical marijuana from 2000 to 2010 led to an increase in rates of both violent and property crime, though no such increase in crime rates was detected for the period of 1995–2010. In examining the relationship between the density of marijuana dispensaries and crime, Freisthler et al. (2016) observed a differential effect of the density of medical marijuana dispensaries on crime between local and adjacent areas. Specifically, they found that, although density of medical marijuana dispensaries did not influence violent and property crime in local areas, it was indeed positively correlated with the rate of violent crime in spatially adjacent areas. In line with the research focusing on the effects of medical marijuana dispensaries, Contreras (2017) found that medical marijuana dispensaries might be criminogenic in that the placement of these dispensaries was associated with an increase in multiple types of crimes, including violent crime, homicide, robbery, aggravated assault, larceny, and motor vehicle theft.

Scholars have also examined the impact of medical marijuana laws on adolescent marijuana use, other drug use, and traffic crashes (Anderson, Hansen, & Rees, 2013; Anderson, Hansen, Rees, & Sabia, 2019; Chu, 2015; Cook, Leung, & Smith, 2020). While it was proposed that MMLs may increase adolescent use due to increased social acceptance, availability and accessibility (Hopfer, 2014), evidence on this issue is mixed. For example, using National Survey on Drug Use and Health data from 2003 to 2011, Schuermeyer et al. (2014) found that medical marijuana legalization in Colorado was associated with a decrease in adolescent perceptions of marijuana risk in the state. By contrast, Chu (2015) found that although MML was associated with an increase in marijuana consumption it did not lead to an increase in cocaine and heroin usage. In addition, Anderson et al. (2019) detected no increases in marijuana use among youth after medical marijuana legalization. In terms of the impact of MML on traffic fatalities, Anderson et al. (2013) observed that legalization reduced traffic fatalities by 8–11%. Similarly, in a more recent study, Cook et al. (2020) found that MML had a negative effect on fatal traffic crashes for both males and females.

3.2. Effects of recreational marijuana legalization on crime

Studies examining the impact of recreational marijuana legalization on crime are few, despite a growing scholarly interest in this issue. However, several relevant studies deserve noting (Brinkman & Mok-Lamme, 2019; Dragone et al., 2019; Freisthler et al., 2017; Hao & Cowan, 2020; Hughes et al., 2019; Lu et al., 2019; Makin et al., 2019). Some scholars observed that legalization of marijuana for recreational purposes increased crime rates, especially when considered at the neighborhood level (Freisthler et al., 2017; Hughes et al., 2019). For instance, in examining the impact of the density of marijuana outlets in Denver, Colorado on crime, Freisthler et al. (2017), based on observations of over 16,000 space-time units, found that the density of recreational marijuana dispensaries was positively associated with the rate of property crime in spatially adjacent areas over time, though the effect was not detected for local areas where the dispensaries operated. Similarly, in another study also focusing on cannabis effects at the neighborhood level in Denver, Hughes et al. (2019) found that the placement of recreational marijuana dispensaries was linked to significant increases in rates of crime and disorder at the neighborhood level, and this was also true for the presence of medical marijuana dispensaries. A more recent study by Hao and Cowan (2020) specifically examined the spillover effect of recreational marijuana legalization in Colorado and Washington State on neighboring states, and found that border counties of neighboring states had experienced a substantial increase in marijuana possession arrests relative to non-border counties in these states.

In contrast to these studies showing a positive relationship between recreational marijuana legalization or the density/presence of marijuana outlets and crime, there exists research suggesting a crime-reducing effect of recreational marijuana legalization. For example, emphasizing the impact of marijuana legalization on neighborhood crime, Brinkman and Mok-Lamme (2019) found that the placement of an additional dispensary in a neighborhood was associated with a significant reduction in crime rate in the local area, while such a reduction was not observed for spatially adjacent neighborhoods. Another study

by Dragone et al. (2019) found that the legalization of marijuana for recreational use led to a significant decrease in property crimes and rapes on the Washington side of the border relative to the Oregon side, when comparing the crime rates between pre-legalization (2010−2012) and post-legalization (2013–2014) periods (Washington State legalized in 2012). A more recent study by Wu and his colleagues (2020) with a focus on the spillover effect of legalization has revealed that recreational marijuana legalization in Colorado resulted in significant reduction in property crime and larceny in the border counties of neighboring states (Wu et al., 2020). In addition, scholars also examined the effect of legalization on crime clearance rates and found that marijuana legalization in Colorado and Washington State increased the clearance rates of certain types of crime, and the positive effects were more pronounced for Colorado (Makin et al., 2019).

It is worth noting that recreational marijuana legalization has significant economic implications within communities and legalizing states. For example, a growing cannabis industry post-legalization resulted in job growth and opportunities for businesses throughout the supply chain from grower to retailer (Cheng, Mayer, & Mayer, 2018). Available data suggest that marijuana sales and associated tax revenues continue to increase in Washington State. In 2019, aggregate marijuana tax revenues in Washington were approximately $395.5 million (including about $390.4 million from cannabis sales taxes and $5.2 million from licensing fees). Moreover, these tax revenues were $172 million more than that of from liquor sales (Washington State Liquor and Cannabis Board, 2019). Since 2014 when retail sales of recreational marijuana began in the State of Colorado, total state revenue from the legal marijuana industry surpassed $1 billion by mid-2019 (Rosenbaum, 2019, June 13). As Cheng et al. (2018, p. 1588) has noted, municipal and county governments also significantly benefited from the increased tax revenues from marijuana legalization. Additionally, as discussed earlier, legalization may result in more cost-effective law enforcement if resources are re-allocated to more serious crimes rather than marijuana possession arrests (Makin et al., 2019). However, it has also been argued that the economic costs to society as a result of legalization may far outweigh the potential tax revenues generated (Rocky Mountain HIDTA, 2017), because of legalization's adverse effects on public health and public safety (e.g., potential increases in marijuana-related hospitalizations, emergency room visits, and marijuana-related impaired driving) and possibly overall human development. As mentioned previously, marijuana businesses in local communities may have an exacerbating effect on crimes in these communities as they provide attractive targets (e.g., cash-based businesses) for potential criminals.

Taken together, theoretical perspectives on the impact of recreational marijuana legalization on crime are ambiguous and empirical research has yielded mixed and inconclusive results. Given the very limited scholarly efforts made toward this issue, more research is needed to further examine the extent to which recreational marijuana legalization has affected crime and the nature of the relationship.

4. Methods

4.1. Data

As the purpose of this study is to explore the potential effects of recreational marijuana legalization on crime in Oregon counties, and this examination involves the comparison of crime trends between Oregon and the 19 states that have not legalized marijuana for recreational or medical purposes, we used county-level crime data for Oregon and these non-legalized states. In addition, as a robustness check of the results, we also used county-level crime data for the five medical marijuana-only states (Hawaii, Montana, New Mexico, Rhode Island, and Vermont) and compared crime trends between Oregon and these five states. Specifically, crime data for this study was based on the FBI's Uniform Crime Report for the period of 2007–2017, which we obtained from the Institute for Social Research at the University of Michigan (ICPSR) website. The UCR data contain crime information on most serious violent and property crimes, classified by FBI as Part I crimes including robbery, aggravated assault, burglary, larceny, and motor vehicle theft, for all counties in the states of interest. In cases where police agencies in certain counties did not report complete crime data, crime numbers for these agencies were imputed based on crime reported in other months by that agency and crimes in comparable jurisdictions in the month(s) of missing data. Accordingly, a coverage indicator (CI, ranging from 0 to 100) was provided for each county showing the extent of the coverage gap, with a high CI meaning a high coverage for that county.[4] For the data, the mean CI is 84.1. Counties with CIs greater than 80 account for 78.7% of all the counties included in the dataset, and counties with CIs greater than 90 account for 73.6%, suggesting a high overall level of completeness in the crime data. The presence of crime information for all counties in the states being examined allows examination of the legalization effect on a larger scale. To ensure the results were based on high-quality data, we used a high value of coverage indicator ($\geq$ 80) for analysis.[5]

County-level characteristics were also considered in this study as covariates, including county population size, percent below federal poverty level, median annual household income in dollars, and annual unemployment rate. Although synthetic control method, as that was used in the current study, was regarded as a useful analysis tool that "helps control for unobserved factors and for the heterogeneity of the effect of the observed and unobserved factors on the outcome of interest (Abadie, Diamond, & Hainmueller, 2015, p. 498)", the inclusion of these covariates was able to address their potential effects more directly. In effect, county poverty level, median household income, and unemployment rates reflect county economic conditions, which have been found to have a significant influence on crime (Hooghe, Vanhoutte, Hardyns, & Bircan, 2010; Patterson, 1991; Sampson & Groves, 1989). According to social disorganization theory, poor economic conditions, as reflected by high income inequality, unemployment rates, and poverty levels, were indicators of social ills that would weaken informal social control and, as a result, increase crime (Shaw & McKay, 1942). Data for these three variables pertaining to county economic conditions come from two sources. Specifically, data on county poverty level and median household income were obtained from the U.S. Census Bureau's Small Area Income and Poverty Estimates from 2007 to 2017. Data on county annual unemployment rates come from the Local Area Unemployment Statistics provided by the U.S. Department of Labor's Bureau of Labor Statistics. Data about county population levels for each year from 2007 to 2017 were available in the main data set containing crime information that we acquired from the ICPSR website.

Table 1 presents the descriptive statistics for the full sample, counties in Oregon, and counties in the 19 non-legalized states, respectively. Given that Oregon passed the recreational marijuana law in November 2014, the entire observation period (2007–2017) was divided into a pre-legalization period of 2007–2014 and a post-legalization period of 2015–2017. As Table 1 shows, the full sample overall displays a downward trend in the rates of property-related crimes, as manifested by the lower averages in the rates of property crime, burglary, larceny, and auto theft in the post-legalization period than those in the pre-legalization period. This downward trend in property-related crimes as observed in the sample is in line with the national trend in that property

[4] A detailed description of the imputation method can be found in the Uniform Crime Reporting Program Resource Guide, National Archive of Criminal Justice Data (NACJD) (https://www.icpsr.umich.edu/web/pages/NACJD/guides/ucr.html).

[5] In order to check the robustness of the results, we have also run separate models using CI greater than 50, and with no restrictions to CI values. Results based on these additional CI values overall align with the primary results associated with CI greater than 80, which were presented in the Appendix Tables A1 and A2.

Table 1
Summary Statistics for Full Sample, Counties in Oregon (OR), and Counties in the Non-legalized States.

	Full Sample			Counties in Oregon			Counties in Non-leg. States		
	N	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*
2007–2017									
Violent Crime Rate	16,416	260.25	214.35	316	199.79	22.44	16,100	261.43	215.69
Property Crime Rate	16,416	2174.74	1307.99	316	2636.52	126.67	16,100	2165.67	1313.07
Robbery Rate	16,416	35.40	52.75	316	29.17	3.32	16,100	35.53	53.08
Aggravated Assault Rate	16,416	193.22	171.76	316	139.63	19.01	16,100	194.27	172.83
Burglary Rate	16,416	553.72	378.50	316	500.11	50.25	16,100	554.77	381.28
Larceny Rate	16,416	1491.40	945.40	316	1951.16	82.97	16,100	1482.38	947.51
Auto Theft Rate	16,416	129.60	107.99	316	184.71	33.19	16,100	128.52	107.12
2007–2014									
Violent Crime Rate	12,015	260.99	218.62	239	193.23	118.31	11,776	262.36	219.97
Property Crime Rate	12,015	2281.03	1369.90	239	2676.54	909.67	11,776	2273.00	1376.50
Robbery Rate	12,015	37.06	55.45	239	30.02	32.28	11,776	37.20	55.81
Aggravated Assault Rate	12,015	194.01	174.34	239	134.66	92.84	11,776	195.22	175.40
Burglary Rate	12,015	592.86	400.30	239	523.27	182.88	11,776	594.27	403.38
Larceny Rate	12,015	1557.41	986.42	239	1978.74	691.13	11,776	1548.86	989.66
Auto Theft Rate	12,015	130.68	111.29	239	174.03	124.54	11,776	129.80	110.84
2015–2017									
Violent Crime Rate	4401	258.23	202.21	77	220.17	93.66	4324	258.91	203.56
Property Crime Rate	4401	1884.56	1069.34	77	2512.29	881.80	4324	1873.38	1069.13
Robbery Rate	4401	30.88	44.23	77	26.51	24.85	4324	30.96	44.49
Aggravated Assault Rate	4401	191.06	164.52	77	155.06	75.23	4324	191.70	165.61
Burglary Rate	4401	446.88	285.21	77	428.20	157.21	4324	447.21	286.97
Larceny Rate	4401	1311.21	795.78	77	1865.55	684.71	4324	1301.34	794.19
Auto Theft Rate	4401	126.64	98.39	77	217.87	159.37	4324	125.02	96.21

M, Mean annual number of crimes per 100,000 population; *SD*, Standard Deviation.

crime offenses in the U.S. have continued to decrease in the last decade (FBI, 2019). Specific to the sample, the average number of property crimes (per 100,000 population) for the entire period for the full sample is 2175, with an average of 2281 before legalization (2007–2014), and 1884 after legalization (2015–2017). This overall downward trend in property-related crimes for the full sample was also reflected by declining rates in property crime, burglary, and larceny in counties in OR and those in non-legalized states. However, it is noteworthy that the rates of these crime types seem to decrease faster in counties of the 19 states that have not legalized than those in OR. For example, the average number of property crime for counties in OR in the pre-legalization period was 2677 (per 100,000 population), and 2512 (per 100,000 population) in the post-legalization period, suggesting a decline of 165 cases on average. In contrast, for counties in the non-legalized states, the cases of property crime on average have decreased by 400 (before legalization: 2273; after legalization: 1873), which was a much bigger decline than that of counties in OR. Similar patterns were also shown for burglary (a decrease of 95 for counties in OR vs. a decrease of 147 for counties in the non-legalized states) and larceny (a decrease of 113 for counties in OR vs. a decrease of 248 for counties in the non-legalized states). Regarding auto theft rates, the differential changes in OR and the non-legalized states were similarly large – although counties in OR experienced an increase of 44 cases of auto theft (per 100,000 population) on average after legalization, those in the non-legalized states have seen a decrease of 5 cases (per 100,000 population) on average after legalization.

For violent crimes, we can also see some differences in changes in the rates of aggravated assault and violent crime in general associated with legalization between counties in OR and those in the non-legalized states. For example, while the average number of overall violent crimes has increased by 27 (per 100,000 population) after legalization (before legalization: 193; after legalization: 220) in counties in OR, it has decreased by 3 (per 100,000 population) in those in the non-legalized states (before legalization: 262; after legalization: 259). For aggravated assault, in contrast to the situation in counties in OR that has seen an average increase of 20 cases (per 100,000 population) after legalization (pre-legalization period: 135; post-legalization period: 155), those in the non-legalized states has experienced a decrease of 4 cases on average after legalization (pre-legalization period: 195; post legalization period: 191).

4.2. Estimation strategy

We used Difference in Differences (DID) linear probability regression to examine the impact of recreational marijuana legalization on rates of different types of crime. Essentially, this method relies upon observations collected from two groups (treatment group and control group) differentiated by the exposure factor (i.e., legalization) within two time periods (pre-treatment period and post-treatment period). The treatment group is the one that is subjected to the treatment in the second period (post-treatment period), while the control group is the one that is not exposed to the treatment during both periods. As Li et al. (2012) further explained, "in the case where the same units within a group are observed in each time period, the average gain over time in the non-exposed (control) group is extracted from the gain over time in the exposed (treatment) group. This double differencing, the so-called 'difference in difference' method, removes biases in the second period comparison between the treatment and control groups that could be the result from permanent differences between those groups, as well as biases from comparison over time in the treatment group that could be the result of time trends unrelated to the treatment" (p. 368).

In the last few decades, the DID method has served as an effective tool for researchers to assess policy impacts. As a quasi-experimental research design that considers pre- and post-treatment periods with the addition of a control group, the DID model accounts for changes due to factors other than treatment, and therefore allows researchers to estimate causal relationships (Meyer, 1995). For the current study, DID is an appropriate modelling strategy given the longitudinal nature of the data that can be divided into a pre-treatment period (2007–2014) and a post-treatment period (2015–2017) for the treatment group (counties in OR that legalized recreational marijuana) and the control group (counties in the states that have not legalized either recreational or medical marijuana), and our intention to examine if legalization has led to substantial changes in the rates of a variety of crimes in the legalized state – OR relative to the non-legalized states.

Using the DID approach, the outcome Y_{ist} is modeled by the following

equation:

$$Y_{ist} = \alpha + \beta DT_{it} + \gamma DP_{it} + \delta\,(DT_{it} \times DP_{it}) + X_{ist} + \varepsilon_{ist} \quad (1)$$

where Y_{ist} (the dependent variable) represents the rates of different types of crimes including violent crime, property crime, robbery, aggravated assault, simple assault, burglary, larceny, and motor vehicle theft) in county i of state s in year t, α is the constant, β is the specific group effect, γ is the time trend, and δ is the difference-in-differences estimator which estimates the policy impact on crime rates. DT_{it} is an indicator variable for the group-specific component, coded as 1 if Y_{ist} is an observation from the treatment group (counties in OR) or 0 otherwise. DP_{it} is the dummy variable for the time-specific component, which is 1 if the observation is from the post-treatment (legalization) period and 0 otherwise. X_{ist} is a vector of observed county-level characteristics including county population, poverty level, median household income, and unemployment rate. ε_{ist} is an error term.

4.3. Measures

The *outcome variables* are rates of a variety of crimes including violent crime, property crime, robbery, aggravated assault, burglary, larceny, and motor vehicle theft. The rate for each crime type is measured per 100,000 people. The *treatment indicator* is defined on an annual basis, and measures exposure to recreational marijuana legalization. It was dichotomously coded as 0 = not exposed and 1 = exposed for that year. As previously mentioned, four county-level characteristics were included in the study as control variables: county population, poverty level, median household income, and unemployment rate. Poverty level is a continuous variable measured by the percentage of the county population of all ages living below the federal poverty line. Unemployment rate only considers county residents who are in the labor force, and is a continuous variable measured by the percentage of the county population in the labor force who were unemployed.

5. Findings

Table 2 presents the effects of marijuana legalization on specific crime rates in Oregon using the control group of 19 non-legalized states. As it shows, recreational marijuana legalization in OR has led to significant increases in the rates of not only property crime overall (p = .021), but also subtypes of crimes such as burglary (p = .020) and motor vehicle theft (p = .000) in the state, relative to the non-legalized states following legalization in OR. In addition, an increase, having marginally statistical significance, has been observed for violent crime in general (p = .057) and two subtypes of crimes including aggravated assault (p = .066) and larceny (p = .079).

Specifically, on average, following legalization, Oregon experienced an increase of 365.4 cases of property crime (per 100,000 population) relative to the non-legalized states, and an increase of 103.6 cases of burglary, 56.2 cases of motor vehicle theft, 49.4 cases of violent crime, 39.4 cases of aggravated assault, and 205.3 cases of larceny per 100,000 population relative to the non-legalized states. As Table 2 shows, for the seven crime types considered, we found significant or marginally significant increases for six of them in Oregon following legalization, relative to the non-legalized states. Therefore, the results overall suggest a crime-exacerbating effect of recreational marijuana legalization. These results also find their support from the analyses based on other levels of coverage indicator (see Appendix Tables A1 and A2). In fact, as Appendix Table A2 shows, when all counties in the states of interest were included in the analysis, Oregon has experienced significant or marginally significant (only for robbery rate) increases in the rates for all these seven types of crimes examined.

In addition, we also examined the short-term retail sales effect using the control group consisting of 19 non-legalized states. The retail sales of recreational marijuana in Oregon began on October 1, 2015. The operation of recreational marijuana dispensaries increases availability and accessibility of recreational marijuana, and may have a more direct impact on the underground marijuana market, all of which may affect crime in the legalized state. In the examination of the potential retail sales effect, we used the pre-sales period of 2007–2014 and post-sales period of 2016–2017. We omitted the year of 2015 to isolate the potential legalization effect. The results about the retail sales effect were overall consistent with the legalization effects (see Appendix Table A3), although the effects on the rates of aggravated assault and larceny have reduced to be non-significant (they were "marginally significant" in the primary results associated with legalization effects).

5.1. Robustness check

We used a synthetic control design as a robustness check on whether counties in the 19 non-legalized states serve as an appropriate control group for counties in OR in our DID analyses. This check is necessary given that the DID framework relies upon the parallel trend assumption requiring that, in the absence of treatment, the "treatment" group would have experienced similar changes in the outcome of interest as the average of the "control" group. That is, specific to the current study, if counties in OR and those in the non-legalized states had different trends in the crime rates considered in the pre-legalization period, it would call into question whether recreational marijuana legalization is, in fact, responsible for our results. The synthetic control method, developed by Abadie and his colleagues (Abadie, Diamond, & Hainmueller, 2010; Abadie & Gardeazabal, 2003), addresses this concern by constructing a control group as a weighted average of non-treatment units where weights are chosen to best approximate the treated unit in the pre-treatment period. As Powell (2018, p.2.) noted, "while an unweighted average of other units may not be an appropriate control, a subset of units with non-uniform weights may provide a proper counterfactual. A major benefit of this approach is that it allows for estimation of a specification with interactive fixed effects which nests more traditional additive fixed effects models." We applied synthetic control design to the six crime types that were found to be significantly or marginally significantly affected by the legalization of recreational marijuana in OR, namely: property crime, burglary, auto theft, violent crime, aggravated assault, and larceny. The "donor pool" consists of counties in the 19 non-legalized states.

Using the approach provided by Abadie et al. (2010), we created the synthetic control region that best produces the values of predictors for each outcome variable of interest (crime rates for the six crime types) in the pre-treatment/pre-legalization period. Specifically, the predictors for each outcome variable include the corresponding crime rates for the years in the pre-treatment period.[6] We estimated the effects of recreational marijuana legalization on the outcome variables as the difference in each outcome variable between the treated region (counties in OR) and its synthetic versions in the years after recreational marijuana was legalized in OR. Fig. 1 displays the trends in the rates of property crime (Fig. 1A), burglary (Fig. 1B), auto theft (Fig. 1C), violent crime (Fig. 1D), aggravated assault (Fig. 1E), and larceny (Fig. 1F) for counties in OR and the synthetic control region. As these graphs show, the synthetic control region very closely tracks the pre-treatment trajectory of each outcome variable in treated counties (counties in OR). For these six outcomes, the two lines begin to diverge noticeably immediately after treatment/legalization. Specifically, the post-treatment trend lines for counties in OR are higher than those for the synthetic control counterparts,

[6] Given that the outcome variables may also be influenced by other factors related to county characteristics, we have also estimated models with the addition of such predictors as county population, poverty level, medium household income, and unemployment rate. The inclusion of these additional predictors yielded synthetic control groups that were very similar to those used in the paper.

Table 2
The Effects of Recreational Marijuana Legalization on Crime in Oregon (control group: 19 non-legalized states; 2007–2017).

	Violent Crime	Property Crime	Robbery	Aggravated Assault	Burglary	Larceny	Auto Theft
Legalization	49.435†	365.404*	6.961	39.426†	103.572*	205.324†	56.182***
	(25.994)	(158.141)	(5.795)	(21.423)	(44.583)	(116.856)	(12.728)
N	16,416	16,416	16,416	16,416	16,416	16,416	16,416
R^2	0.161	0.166	0.311	0.113	0.209	0.129	0.208
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Legalization effect was examined based on the pre-legalization period of 2007–2014, and post-legalization period of 2015–2017. Oregon's ballot Measure 91 (Legalizing recreational marijuana) was approved in November 2014 and took effect on July 1, 2015.
The covariates included in the models are county population, county poverty level, county employment rate, and county median household income.
† $p \leq .1$.
* $p \leq .05$.
*** $p \leq .001$.

suggesting substantially higher rates of property crime, burglary, auto theft, violent crime, aggravated assault, and larceny in counties in OR following legalization relative to the synthetic controls. The results obtained through the synthetic control method provide further support for those based on the DID analyses.

As an additional effort to check the robustness of the results based on the comparison between Oregon counties and counties in the 19 states that have not legalized either form of marijuana (medical or recreational), we also conducted DID analyses based on a control group consisting of five states in which only medical marijuana was legal during the period of 2007–2017. As mentioned previously, these five states are: Hawaii, Montana, New Mexico, Rhode Island, and Vermont. As Table 3 shows, the results based on this control group comprising medical marijuana-only states were substantively similar to the those that we obtained using the control group of 19 non-legalized states (that have not legalized marijuana for recreational or medical marijuana). Specifically, consistent with the primary results based on the 19 non-legalized states, counties in Oregon were also found to have experienced significant increases in rates for the six crime categories – violent crime ($p = .020$), property crime ($p = .009$), aggravated assault ($p = .111$), burglary ($p = .027$), larceny ($p = .056$), and auto theft ($p = .020$) – following recreational marijuana legalization, relative to the five medical marijuana-only states. In addition, we examined the retail sales effect using the control group of the five medical marijuana-only states, and the results were largely similar to those obtained using the control group of the 19 non-legalized states as well (see Appendix Table A4).

6. Discussion

We used a rigorous quasi-experimental research design and county-level crime data to examine the impact of marijuana legalization on serious crimes as measured by the UCR in Oregon. We examined violent and property crime in general, and a set of specific crimes such as burglary, larceny, motor vehicle theft, robbery, and aggravated assault. Overall, the results reveal that legalization in Oregon has likely led to substantial increases in most crime types examined relative to states that have not legalized. Furthermore, our analysis suggests that legalization of retail sales of marijuana similarly resulted in an increase in property crimes. Our study provides evidence suggesting an exacerbating effect of recreational marijuana legalization on crime.

This finding challenges the notion that legalization would reduce crime due to factors such as the increased availability of more affordable recreational marijuana compared to pre-legalization (it has been argued that legalization would decrease the price of marijuana, see Hall & Lynskey, 2016a), demotivating marijuana users to resort to predatory crime to support their drug use, as well as increased crime deterrence as a result of police reallocation of resources away from possession arrests to the control of more serious crimes including property crime (Shepard & Blackley, 2007). In effect, it remains unclear how legalization affects police resource allocation and the related potential deterrent effect, and the impact of marijuana price decreases, if any, may be complex and requires further scrutiny. It is likely that increased availability and affordability of marijuana in the context of legalization may lead to an increase in drug use, which may in turn motivate rather than demotivate drug users to commit predatory crime to support their habits (Cleveland & Wiebe, 2008). It is noteworthy that the findings of our study also contrasts with those from prior research that reported either a crime reducing effect or minimal to no effect of marijuana legalization on major crimes in Colorado and Washington State (for example, see Dragone et al., 2019; Lu et al., 2019). Given that some of these prior studies were also based on rigorous research designs, the inconsistent results concerning the impact of legalization seem to suggest that the impact of recreational marijuana legalization on crime may vary across states, perhaps due to differential state policy and law enforcement environments. As mentioned previously, although states such as CO, WA, and OR, have legalized marijuana for recreational purposes, there remain substantial differences across these states regarding specific policies regulating marijuana retail businesses and individuals' behaviors related to recreational marijuana. These inconsistencies in research findings further demonstrate the need to examine the implications of marijuana legalization to public safety for specific states in order to understand the relevance of differential policy contexts to the impact of marijuana legalization.

Despite competing views regarding the potential impact of marijuana legalization on crime, the results of our study reveal that recreational marijuana legalization increased serious crimes in Oregon relative to non-legalized states. This is not surprising given that scholars have commonly observed a positive link between the placement of marijuana dispensaries and neighborhood crime (Freisthler et al., 2017; Hughes et al., 2019). The findings of our study suggest that the criminogenic effect of marijuana legalization may also be reflected at the county or state level if the data used have a sufficient coverage of the geographical areas within the state of interest. In effect, one important reason that the proponents of legalization have offered about the expected crime-reducing effect of legalization was that a regulated marijuana market would diminish the underground marijuana market, which is associated with crime (Cohen & McGowan, 2012; Gettman & Kennedy, 2014). However, prior research suggests that legal marijuana may increase or maintain the size of illegal markets rather than the opposite – the illegal market for marijuana has persisted in the states that have legalized the drug (Fertig, 2019; Song, 2019; Stohr et al., 2020). Such developments associated with underground marijuana markets provide a context that helps explain why we did not observe a crime-reducing effect of legalization.

This study sheds light on the effects of recreational marijuana legalization on crime. However, it is not without limitations. First, although the most recent available data were used with the intent to have extended coverage of the post-legalization period, the post-

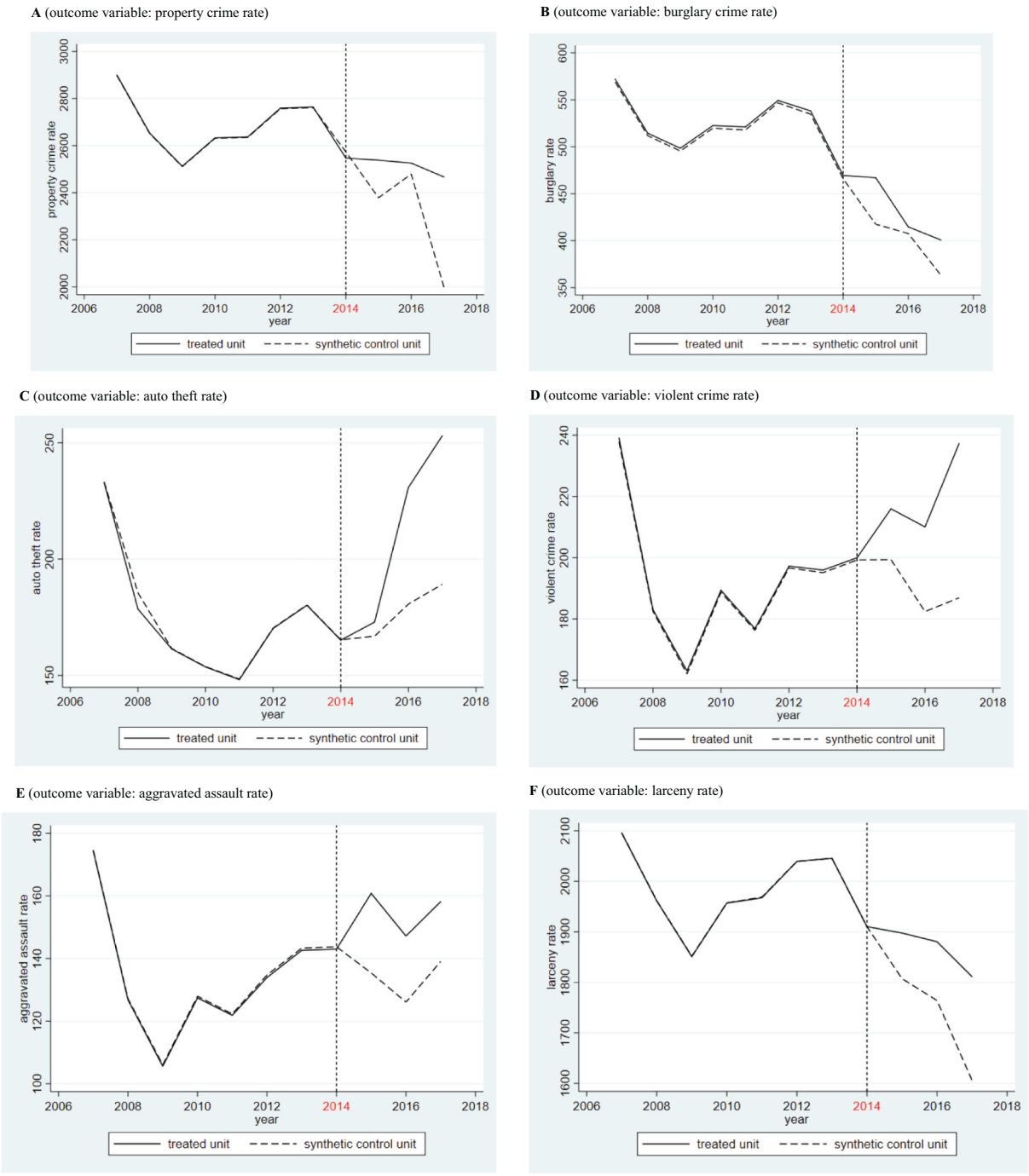


Fig. 1. The Effects of Recreational Marijuana Legalization on Crime in OR (Synthetic Control Method).

legalization periods for Oregon (2015–2017) is still relatively short. This issue is caused by the recency of the legalization year—late 2014. We acknowledge that observations based on a 3-year post-legalization period may be insufficient to identify the lagged effect of legalization on crime rates. Given this, the effects of legalization revealed in this study for Oregon are essentially short-term effects. Future research is suggested to continue the examination of the impact of legalization on crime when additional years of data are available. It is possible the magnitude of legalization effects varies across time. Second, notwithstanding the use of a quasi-experimental research design that helps identify the causal effect, this is just one study exploring the implications of legalization on crime. Therefore, we caution against over-interpretation of the results. Given the limited extant literature, more research is needed to study the aggregate and contextual impact of recreational marijuana legalization on crime.

7. Conclusion

The results of this study provide evidence suggesting a crime-exacerbating effect of recreational marijuana legalization, manifested by substantial increases in a variety of major crimes as measured by the UCR in Oregon counties relative to non-legalized states following legalization. Given that the findings of this study are inconsistent with those obtained in some prior studies focusing on Colorado and Washington State, this suggests a need to examine legalization impact with consideration of the specific social and policy contexts within legalizing

Table 3
The Effects of Recreational Marijuana Legalization on Crime in Oregon (control group: five medical marijuana-only states; 2007–2017).

	Violent Crime	Property Crime	Robbery	Aggravated Assault	Burglary	Larceny	Auto Theft
Legalization	131.536*	562.559**	−0.493	112.114†	171.531*	354.708†	81.075*
	(56.445)	(214.294)	(4.414)	(70.236)	(77.373)	(185.320)	(34.727)
N	1628	1628	1628	1628	1628	1628	1628
R^2	0.121	0.087	0.286	0.089	0.074	0.060	0.079
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Legalization effect was examined based on the pre-legalization period of 2007–2014, and post-legalization period of 2015–2017. The control group consists of 5 states in which only medical marijuana were legal during the period of 2007–2017, namely, Hawaii, Montana, New Mexico, Rhode Island, and Vermont.
Oregon's ballot Measure 91 (Legalizing recreational marijuana) was approved in November 2014 and took effect on July 1, 2015.
The covariates included in the models are county population, county poverty level, and county median household income.
† $p \leq .1$.
* $p \leq .05$.
** $p \leq .01$.

states. Recognizing that the full effect of legalization on public safety may take years to manifest (Hall & Lynskey, 2016b), and that the effect may change over time as a function of the changing societal environment (i.e., the development of regulations related to marijuana), further state-specific research is vitally needed on this issue in order to adequately examine how marijuana legalization affects public safety in the long term.

Appendix A. Appendix

Table A1
The Effect of Recreational Marijuana Legalization on Crime in OR (coverage indicator ≥50: control group: 19 non-legalized states)

	Violent Crime	Property Crime	Robbery	Aggravated Assault	Burglary	Larceny	Auto Theft
Legalization	47.148†	341.749*	7.473	37.959†	105.032**	179.897†	56.903***
	(25.729)	(146.002)	(5.280)	(21.667)	(41.454)	(107.720)	(11.707)
N	17,981	17,981	17,981	17,981	17,981	17,981	17,981
R^2	0.139	0.172	0.319	0.092	0.215	0.133	0.206
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Legalization effect was examined based on the pre-legalization period of 2007–2014, and post-legalization period of 2015–2017. The covariates included in the models are county population, county poverty level, county employment rate, and county median household income.
† $p \leq .1$.
* $p \leq .05$.
** $p \leq .01$.
*** $p \leq .001$.

Table A2
The Effect of Recreational Marijuana Legalization on Crime in OR (coverage indicator: no restrictions; control group: 19 non-legalized states)

	Violent Crime	Property Crime	Robbery	Aggravated Assault	Burglary	Larceny	Auto Theft
Legalization	81.079**	534.827***	8.926†	64.280**	157.090***	286.499**	91.617***
	(27.062)	(146.919)	(4.811)	(23.224)	(46.781)	(102.946)	(11.390)
N	19,712	19,712	19,712	19,712	19,712	19,712	19,712
R^2	0.134	0.165	0.318	0.093	0.198	0.130	0.191
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Legalization effect was examined based on the pre-legalization period of 2007–2014, and post-legalization period of 2015–2017. The covariates included in the models are county population, county poverty level, county employment rate, and county median household income.
† $p \leq .1$.
** $p \leq .01$.
*** $p \leq .001$.

Table A3
The Effects of Retail Sales on Specific Crime Rates in Oregon (control group: 19 non-legalized states; 2007–2017)

	Violent Crime	Property Crime	Robbery	Aggravated Assault	Burglary	Larceny	Auto Theft
Legalization	49.748†	380.982*	8.113	36.664	108.322*	199.862	72.557***
	(30.961)	(188.454)	(6.901)	(25.545)	(53.283)	(139.041)	(15.174)
N	14,922	14,922	14,922	14,922	14,922	14,922	14,922

(*continued on next page*)

Table A3 (*continued*)

	Violent Crime	Property Crime	Robbery	Aggravated Assault	Burglary	Larceny	Auto Theft
R^2	0.162	0.167	0.312	0.114	0.210	0.129	0.209
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The retail sales effect was examined based on the pre-sales period of 2007–2014, and post-sales period of 2016–2017. Retail sales in Oregon began on October 1, 2015. The year of 2015 was omitted to isolate the potential legalization effect.
† $p \leq .1$.
* $p \leq .05$.
*** $p \leq .001$.

Table A4
The Effects of Retail Sales on Specific Crime Rates in Oregon (control group: five medical marijuana-only states; 2007–2017)

	Violent Crime	Property Crime	Robbery	Aggravated Assault	Burglary	Larceny	Auto Theft
Legalization	142.104*	648.753**	−0.540	112.341	168.646†	382.555†	100.553**
	(67.571)	(253.154)	(5.175)	(83.568)	(92.701)	(221.016)	(40.763)
N	1480	1480	1480	1480	1480	1480	1480
R^2	0.122	0.084	0.284	0.091	0.072	0.057	0.082
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The retail sales effect was examined based on the pre-sales period of 2007–2014, and post-sales period of 2016–2017. Retail sales in Oregon began on October 1, 2015. The year of 2015 was omitted to isolate the potential legalization effect.
† $p \leq .1$.
* $p \leq .05$.
** $p \leq .01$.

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ORIGINAL RESEARCH

One Minute of Marijuana Secondhand Smoke Exposure Substantially Impairs Vascular Endothelial Function

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***Background*—**Despite public awareness that tobacco secondhand smoke (SHS) is harmful, many people still assume that marijuana SHS is benign. Debates about whether smoke-free laws should include marijuana are becoming increasingly widespread as marijuana is legalized and the cannabis industry grows. Lack of evidence for marijuana SHS causing acute cardiovascular harm is frequently mistaken for evidence that it is harmless, despite chemical and physical similarity between marijuana and tobacco smoke. We investigated whether brief exposure to marijuana SHS causes acute vascular endothelial dysfunction.

***Methods and Results*—**We measured endothelial function as femoral artery flow-mediated dilation (FMD) in rats before and after exposure to marijuana SHS at levels similar to real-world tobacco SHS conditions. One minute of exposure to marijuana SHS impaired FMD to a comparable extent as impairment from equal concentrations of tobacco SHS, but recovery was considerably slower for marijuana. Exposure to marijuana SHS directly caused cannabinoid-independent vasodilation that subsided within 25 minutes, whereas FMD remained impaired for at least 90 minutes. Impairment occurred even when marijuana lacked cannabinoids and rolling paper was omitted. Endothelium-independent vasodilation by nitroglycerin administration was not impaired. FMD was not impaired by exposure to chamber air.

***Conclusions*—**One minute of exposure to marijuana SHS substantially impairs endothelial function in rats for at least 90 minutes, considerably longer than comparable impairment by tobacco SHS. Impairment of FMD does not require cannabinoids, nicotine, or rolling paper smoke. Our findings in rats suggest that SHS can exert similar adverse cardiovascular effects regardless of whether it is from tobacco or marijuana. **(*J Am Heart Assoc*. 2016;5:e003858 doi: 10.1161/JAHA.116.003858)**

Key Words: artery • cannabis • endothelium • flow-mediated dilation • marijuana • nitric oxide synthase • secondhand smoke • smoking • vasodilation

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There is widespread belief that, unlike tobacco smoke, marijuana smoke is benign.[1] While the psychoactive substance in marijuana is tetrahydrocannabinol (THC) rather than nicotine, marijuana smoke is still the result of biomass combustion and contains many of the same toxins as tobacco smoke,[2] including fine particles that cause cardiovascular morbidity and mortality.[3–5] Tobacco secondhand smoke (SHS) alone is responsible for ≈50 000 deaths in the United States each year, with ≈46 000 from cardiovascular disease,[6–8] and implementation of laws prohibiting smoking in public places and workplaces is followed by drops in hospital admissions for acute myocardial infarction, other cardiac events, stroke, and pulmonary diseases.[9] However, due to the illegality of marijuana, it has been difficult to prospectively study the effects of marijuana smoke, and the rare secondhand marijuana smoke studies have focused on whether exposed people test positive

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on drug tests.[10–12] The increasing number of states legalizing medicinal and recreational marijuana, and increasing potential for corporate expansion within the cannabis industry,[13] make it important to understand the health consequences of secondhand exposure to marijuana smoke.

Vascular health can be evaluated by measuring arterial flow-mediated dilation (FMD), the extent to which arteries vasodilate in response to increased blood flow.[14–16] FMD ensures sufficient blood flow to peripheral tissues and the heart. Decline in FMD precedes the development of atherosclerosis and is likely important in its pathogenesis.[14,16–19] FMD is quantified in humans by ultrasound as the percent vasodilation of the brachial artery in response to restoration of blood flow after transient occlusion.[14] Brachial artery FMD is a well-established clinical prognostic indicator of endothelial function that correlates with endothelium-dependent vasodilation of the coronary arteries[17] and other measures of cardiovascular health.[14,16,19,20] Decreased brachial FMD correlates with adverse cardiovascular outcomes that are increased by cigarette smoke, including myocardial infarction and atherosclerosis.[21–23] FMD is impaired in tobacco smokers relative to nonsmokers.[24] People who report frequent SHS exposure exhibit poor FMD even when smoke is not present during the testing,[24,25] and a 30-minute exposure to SHS at real-world levels impairs FMD in humans.[26–28] The nicotine in tobacco is not responsible for the entire adverse effect of tobacco smoke on FMD,[29] and vasodilatory function is also impaired by diesel exhaust and by smoke from incense and candles.[30,31] These observations, along with the similar chemical composition of tobacco and marijuana smoke,[2] led us to hypothesize that marijuana smoke would also impair FMD.

We developed an animal model that uses micro-ultrasound and a simple reversible surgical occlusion of blood flow to the leg to measure FMD in the femoral arteries of living rats,[32] analogous to the measurement of brachial artery FMD in humans. We extensively validated this technique physiologically and used it to demonstrate age-related changes in the mechanisms underlying FMD,[32] and the beneficial vascular effects of pharmacological preservation of bioavailable intracellular nitric oxide.[33] Subsequently, we showed that 30 minutes of tobacco SHS exposure at real-world levels impairs FMD in rats, and that even 1 minute of SHS impairs FMD.[34] We observed similar impairment from exposure to tobacco SHS from little cigars.[35] We, therefore, used this rat model to determine whether marijuana SHS also has adverse effects on the vasculature.

Methods

Animals

Female Sprague-Dawley rats (Simonsen Laboratory, CA; n=8/group) were used at 9 to 10 weeks of age, with body weights of 200 to 250 g. Rats were anesthetized under ketamine/xylazine with intraperitoneal injection. Starting doses were ketamine (100 mg/kg)/xylazine (5 mg/kg). Repeated injections were required with one third to one half doses at a time (approximately every 30 minutes). Experiments were terminal. All procedures were approved by the University of California, San Francisco Institutional Animal Care and Use Committee.

FMD Measurement

FMD was measured in living rats as we have described previously in detail[32] by an investigator blinded to the exposure condition when 2 or more groups were compared. As described in the Results section, some groups were added to the experiment afterward for confirmatory purposes and those could not be blinded, but the diameter measurement was performed by an automated system. Briefly, after surgical isolation of the common iliac artery, an arterial loop occluder consisting of a 5–0 Prolene filament was positioned under the artery and passed through 15-cm PE-90 tubing to enable transient occlusion of blood flow. After a 15-minute equilibration, the artery was transiently occluded for 5 minutes, followed by release of the occluder and reperfusion of the artery. A series of diameter images of the femoral artery and accompanying Doppler blood flow images were recorded with a 35-MHz ultrasound transducer (Vevo660, VisualSonics, Toronto, Canada) before transient surgical occlusion (baseline), immediately after blood reflow, and then every 30 s until 5 minutes. Diameter measurement was performed offline from the recorded loops using an automated system (Brachial Analyzer 5; Medical Imaging Applications, Coralville, IA).[32] All diameter readings were taken at diastole. FMD was calculated as % change: $(\text{peak diameter}_{\text{postischemia}} - \text{diameter}_{\text{baseline}})/\text{diameter}_{\text{baseline}} \times 100$. The rats were kept at 37°C on a thermal blanket throughout to avoid inconsistent vasodilation from anesthesia-induced hypothermia.

Marijuana Cigarettes, Approvals, and Security Considerations

Acquisition and possession of marijuana was approved by the Drug Enforcement Agency, the Food and Drug Administration, the Research Advisory Panel of California, and the University of California, San Francisco Office of Environmental Health and Safety. Marijuana cigarettes (regular marijuana at 4.5% tetrahydrocannabinol [THC] and "placebo" THC-free marijuana at 0.01% THC, each weighing 0.9 g) were supplied by RTI International (Research Triangle Park, NC), contracted through the National Institute on Drug Abuse. Marijuana was from sinsemilla (seedless) plants with stems removed, and consisted of leaf fragments, small leaves, bracts, and buds, and was grown in the absence of pesticides. The cigarettes were machine rolled

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with the same dimensions as standard tobacco cigarettes and fit in our cigarette smoking machine without further modification. Upon arrival, marijuana cigarettes were individually wrapped in plastic wrap and numbered, and were stored in airtight containers at −20°C. In accordance with requirements from the Drug Enforcement Agency, the cigarettes were stored in a padlocked freezer with high-security lock and a code-deactivated open-door alarm that communicated with the University of California Police Department, physically attached to a heavy Steelcase desk, in a controlled-access room outfitted with a solid door with high-security lock, and hinge pins that were nonremovable from the outside. Prior to each experiment, marijuana cigarettes were humidified overnight at room temperature by placing them in an airtight container over 50 mL of saturated sodium chloride solution as per instructions on use from RTI, in a locked desk drawer. Logs documenting removal of cigarettes from the freezer and desk were kept as required by the Drug Enforcement Agency. Cigarettes were used within 5 minutes after humidification.

Tobacco Cigarettes

Marlboro Red cigarettes were humidified overnight by placement over 16% glycerol in water, as in our previous tobacco studies.[34,35]

Exposure of Rats to SHS

We used a modified cigarette smoking system described previously for tobacco SHS experiments.[34] Briefly, the system collects sidestream smoke from the burning tip of the cigarette in a 21-L Plexiglas exposure chamber as a ventilator pump simulates human puffing. (Sidestream smoke comprises the majority of SHS and is a well-accepted laboratory model for it, and is referred to as SHS here.) A Sidepak AM510 personal aerosol monitor (TSI, Shoreview, MN), calibrated for cigarette smoke particles and excluding those >2.5 μm, monitors the concentration of respirable suspended particles (RSP) in the exposure chamber and exhausts back into the chamber. Smoke is collected in the chamber and the cigarette is extinguished, and excess smoke is then vented from the chamber to obtain the desired starting concentration. Air in the chamber is mixed with a small fan. The wall of the chamber contains a gasket through which the nose of an anesthetized rat is inserted to breathe the smoky air. Because the system requires the cigarette to be extinguished before exposure of the rat, adsorption of smoke particles to surfaces in the exposure chamber causes a continued progressive decrease in the levels over time; thus, most of the exposure occurs over the first several minutes.

Tobacco cigarettes were smoked according to standard conditions (ISO Standard 3308:2012, one 35-mL puff of 2-s duration once/min). Marijuana cigarettes were smoked using the same protocol, with the exception that the puff duration was 1 s for our initial 30-minute exposure experiment due to an instrument calibration error discovered afterward. The difference between a 1-s puff and a 2-s puff is not expected to have a substantial effect on the sidestream smoke generated.

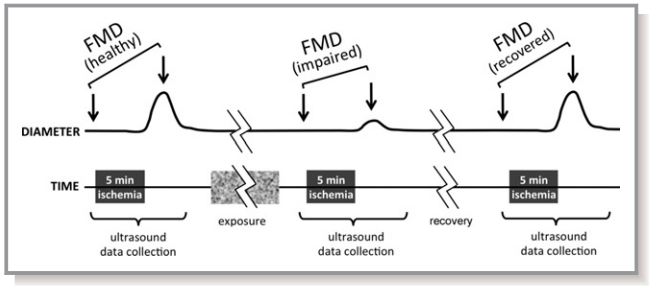


Figure 1. Experimental design for FMD measurement and smoke exposures. FMD was measured by micro-ultrasound measurements of femoral artery diameter before and after transient (5 minutes) surgical occlusion of the common iliac artery. Anesthetized rats were exposed to SHS for varying durations and FMD was measured 3 times (before exposure, 10 minutes after end of exposure to evaluate impairment, and 30 minutes later to evaluate recovery). As described in the Results section for specific experiments, the smoke exposure was either for 30 minutes or 1 minute, and initial FMD impairment or baseline diameter changes were measured either within 10 minutes or 25 to 30 minutes after the end of exposure. In some cases, FMD recovery was assessed every 30 minutes over a total duration of 90 minutes. FMD indicates flow-mediated vasodilation; SHS, secondhand smoke.

For each experiment, a single cigarette was lit, smoked for 3 minutes, and extinguished, and particle concentration in the exposure chamber was adjusted until the desired RSP starting concentration was reached (Figure 1). At that time, an individual anesthetized rat, after baseline FMD measurement, was exposed for the specified duration and was then returned to the ultrasound system for postsmoke FMD measurement. Negative controls consisted of the same duration of exposure to nonsmoky air in the exposure chamber. As in our tobacco study,[34] it took roughly 10 minutes after the end of the exposure period to prepare the rat for an initial postexposure FMD measurement. For some experiments, we measured FMD again 30 minutes later to evaluate recovery.

Generation of Marijuana Smoke in the Absence of Paper Smoke

We wrapped a piece of stainless steel mesh (0.0055-inch wire diameter, 80 × 80 openings/inch, 0.007-inch opening width; McMaster-Carr, Los Angeles, CA) around a marijuana cigarette, then opened the piece of mesh with the cigarette remaining on top of it, sliced the paper longitudinally, and slid the paper out while keeping the rod of marijuana intact,

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preventing the packed marijuana rod from loosening so that the burning of the mesh-rolled cigarette would be as similar as possible to that of a paper-rolled cigarette. The mesh was then rewrapped around the marijuana and the resulting rod was inserted into the cigarette hole in the smoke system. The regular protocol for smoking cigarettes was used from that point.

Endothelium-Independent Vasodilation Induced by Nitroglycerin

Endothelium-independent vasodilation was induced by intravenous injection of nitroglycerin at 8.8×10^{-5} mol/L as a 0.1-mL/100 g bolus into the tail vein.

Statistics

Power calculation based on standard deviations from within-group comparisons in several of our previous repeated-measures FMD experiments determined that n=8/group was sufficient to detect FMD change of 3.5 percentage points (absolute values) at a power of 0.8 and significance level of 0.05. For comparisons involving multiple groups and times, we fit a 2-factor (exposure condition and time) repeated-measures analysis of variance to all the data at once using a mixed model estimated with restricted maximum likelihood estimation with an unstructured covariance matrix of residuals, then tested for differences over time and across exposure conditions using contrasts and pairwise comparisons, adjusted for multiple comparisons using the Šidák

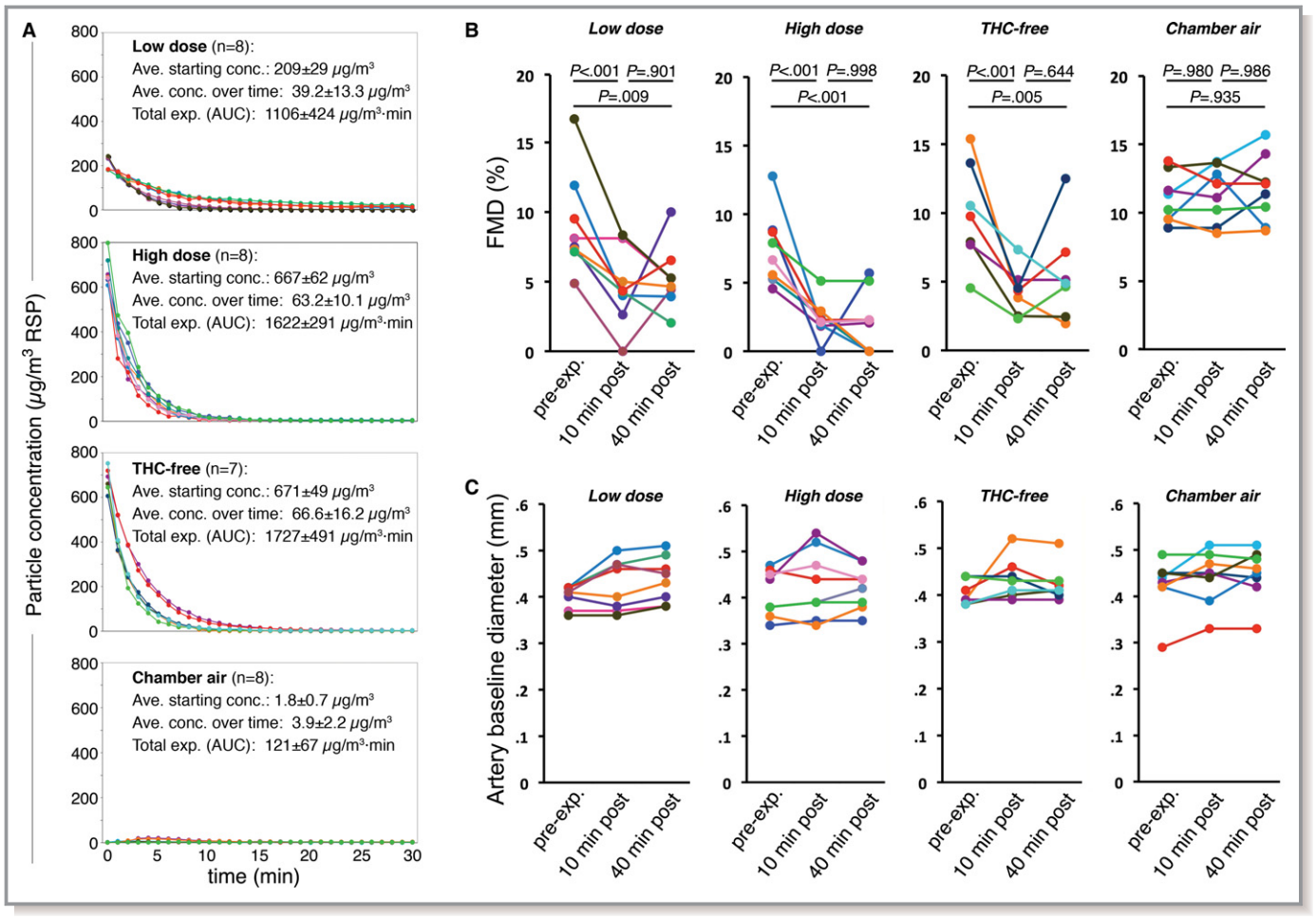


Figure 2. Impairment of FMD by exposure to marijuana SHS at declining levels over a 30-minute period. A, RSP levels over 30 minutes for each rat. Mean starting concentration, mean concentration over time, and total exposure derived from the area under the curve (AUC) are listed for each group ±SD. 670 and 210 μg/m^3 correspond roughly to high and moderate levels of tobacco SHS in restaurants that allow smoking. B, Impaired FMD and (C) unchanged baseline artery diameter. Each line corresponds to an individual rat; colors track individual animals through panels A, B, and C. See Table for mean FMD values. There were no significant differences between the extents of FMD impairment by high-dose, low-dose, and THC-marijuana smoke exposure, and no significant differences between the baseline diameter levels for the different exposure groups. FMD indicates flow-mediated vasodilation; RSP, respirable suspended particles; SHS, secondhand smoke; THC, tetrahydrocannabinol.

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method. Residuals were tested for normality using normal probability plots. Calculations were done with Stata 13.1. Simple comparisons of pre-exposure to postexposure measurements were analyzed using Student paired *t* test.

Results

Marijuana SHS With and Without THC Impaired FMD

As in our tobacco cigarette SHS study,[34] we exposed groups of rats to 30 minutes of marijuana SHS at 2 starting concentrations (≈670 and ≈210 μg/m^3 RSP), typical of high and moderate tobacco SHS levels in smoky restaurants,[36] and to smoke-free air in the exposure chamber as a negative control (Figure 2A). Because THC can cause vasodilation directly, which might interfere with a functional assay based on vasodilation, we included an extra control group exposed to SHS from THC-free marijuana (in which cannabinoids were removed) at ≈670 μg/m^3 RSP.

Marijuana SHS at both doses, but not control chamber air, significantly and substantially impaired FMD (Figure 2B, Table). FMD had not recovered at 40 minutes postexposure. Exposure to THC-free marijuana SHS impaired FMD as much as exposure to regular marijuana SHS, confirming that the impairment was not caused by THC.

Mindful of the potential vasodilatory effects of THC,[37] we also compared the baseline (pre-occlusion) artery diameter before and after smoke exposure to detect any vasodilation not due to the transient occlusion and restoration of flow. Significant baseline vasodilation was not observed in any group (Figure 2C, Table).

Table. Group Means for Graphs in Figures 2 Through 6

	% Vasodilation (FMD or NTG)			Baseline Diameter (mm)		
Condition	Pre-Exp.	10 Minutes Post	40 Minutes Post	Pre-Exp.	10 Minutes Post	40 Minutes Post
30-minutes exposure, Figure 2B and 2C						
Marijuana (low level)	9.1±1.3	4.6±1.0*	5.3±0.8*	0.42±0.003	0.46±0.02	0.47±0.02
Marijuana	7.5±0.9	2.4±0.5*	2.2±0.8*	0.41±0.02	0.43±0.03	0.42±0.02
THC-free	9.9±1.4	4.3±0.6*	5.5±1.3*	0.40±0.01	0.44±0.02	0.42±0.02
Air	11.0±0.6	11.4±0.7	11.7±0.9	0.42±0.02	0.44±0.02	0.45±0.02
30-minutes exposure, Figure 3B						
THC-free high (paperless)	13.2±3.3	2.5±1.0*	—	0.37±0.009	0.39±0.014	—
1-minute exposure, Figure 4A						
Air	12.9±1.3	12.3±1.1	—	0.38±0.015	0.39±0.017	—
Marijuana	13.7±1.3	8.1±1.6*	—	0.38±0.015	0.41±0.017*	—
THC-free	15.1±1.4	7.7±0.9*	—	0.38±0.017	0.41±0.017*	—
1-minute exposure, Figure 4B						
Marijuana high, delayed	15.6±1.7	6.4±1.3*	—	0.36±0.011	0.38±0.020	—

Condition	Pre-Exp.	30 Minutes	60 Minutes	90 Minutes		Pre-Exp.	30 Minutes	60 Minutes	90 Minutes
1-minute exposure, Figure 4C									
Marijuana	15.9±1.7	8.3±1.7*	8.7±2.0*	10.7±1.3*	—	0.41±0.02	0.43±0.02	0.42±0.02	0.42±0.02

Condition	Pre-Exp. FMD	Post-Exp. FMD	NTG	Post-NTG FMD
1-minute exposure, Figure 5				
Marijuana	28.1±2.5	9.8±3.0*	23.3±4.2	8.9±2.8*

Condition	Pre-Exp.	10 Minutes Post	30 Minutes Post
1-minute exposure, Figure 6			
Tobacco	11.7±1.6	4.0±1.4*	8.5±2.5
Marijuana	12.5±1.3	4.9±0.9*	3.4±1.3*
Air	11.2±1.7	10.8±1.5	11.1±1.6

Errors are SEM. FMD indicates flow-mediated vasodilation; NTG, nitroglycerin; THC, tetrahydrocannabinol.
*P<0.05 vs pre-exp.

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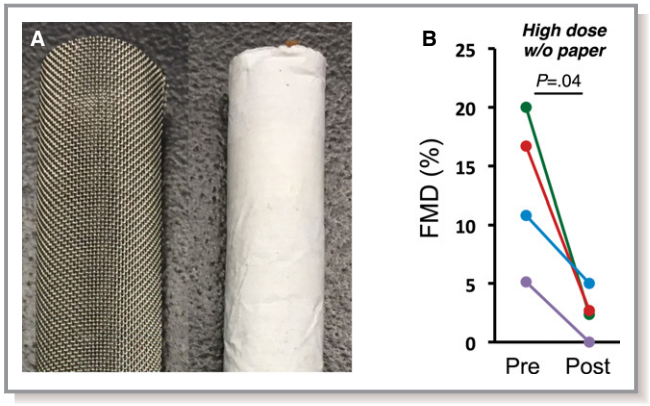


Figure 3. Rolling paper is not required for FMD impairment. A, Stainless steel mesh used for paperless cigarettes with a normal cigarette for comparison. B, FMD impairment in rats exposed to paperless THC-free marijuana SHS. FMD indicates flow-mediated vasodilation; SHS, secondhand smoke; THC, tetrahydrocannabinol.

SHS-Induced Impairment of FMD Did Not Require Rolling Paper

Our hypothesis that FMD is impaired by combustion products common to smoke from burned plant material raises the question of whether FMD is impaired by smoke from burned rolling paper, rather than the tobacco or marijuana. The question is relevant because some people smoke marijuana in pipes. We tested the hypothesis that impairment is dependent on paper smoke by assembling marijuana cigarettes in which the paper was replaced by a fine stainless steel mesh (Figure 3A) to mimic the properties of rolling paper, which is ventilated. In a confirmatory group of 4 rats, FMD was significantly impaired to a similar extent as that by regular marijuana cigarettes (Figure 3B, Table). Since these mesh cigarettes were prepared using the THC-free marijuana, the results confirm that FMD is impaired by SHS from marijuana lacking both THC and rolling paper.

One Minute of Marijuana SHS Impaired FMD

Because most of the exposure during our 30-minute period occurred during the first 10 minutes, the question remained of whether a very brief exposure impairs FMD. We previously reported that tobacco SHS exposure for 1 minute at the high restaurant level (≈670 μg/m^3 RSP) impairs FMD,[34] so we repeated that experiment with marijuana SHS at comparable particle concentration. FMD was substantially decreased by 1 minute of marijuana SHS with and without THC (Figure 4A, Table). Measurement of pre-occlusion baseline diameter revealed that the marijuana SHS directly induced vasodilation, even with the THC-free marijuana. This result was in contrast to our previous experiment (Figure 2) in which rats were exposed to 30 minutes of declining RSP levels that fell to roughly zero before postexposure FMD was measured, with no observed smoke-induced vasodilation. To reconcile this apparent contradiction, we exposed another group to marijuana SHS and waited a total of 25 minutes after the 1-minute exposure before measuring FMD. This allowed the baseline vasodilation to subside, but FMD still decreased (Figure 4B, Table), confirming that 1 minute of marijuana SHS exposure causes endothelial dysfunction that persists beyond any transient vasodilatory effects of the marijuana.

All cannabinoids are missing from the THC-free marijuana, and we did not observe significant baseline vasodilation after 1 minute of tobacco SHS in our previous report[34] (P=0.23; data not shown). The identity of the noncannabinoid vasodilator in marijuana is unknown.

Marijuana SHS-Induced Endothelial Dysfunction Lasted for at Least 90 Minutes

In our previous studies with tobacco SHS, FMD recovered completely by 30 minutes after the initial postexposure measurement.[34] In contrast, when we exposed rats to THC-free marijuana SHS for 1 minute and then measured FMD at 30-minute intervals, FMD remained depressed in most of the rats until at least 90 minutes later (Figure 4C, Table).

Impairment of FMD by Marijuana SHS Did Not Prevent Endothelium-Independent Vasodilation

To determine whether the substantial impairment of FMD involved functional or physical inhibition of vascular smooth muscle function, we performed a separate experiment in which FMD was impaired by 1 minute of marijuana SHS as before, and then after impaired FMD was confirmed, an intravenous bolus of nitroglycerin was injected to induce endothelium-independent vasodilation. This injection caused vasodilation even while FMD was still impaired, as confirmed by a subsequent FMD measurement after the nitroglycerin effect had subsided (Figure 5, Table). Therefore, the impairment of FMD by marijuana SHS was mediated by an endothelium-dependent mechanism, not a direct effect on the smooth muscle of the vessel wall.

Recovery of FMD Impaired by Marijuana SHS Was Slower Than Recovery From Tobacco SHS

We previously observed that impaired FMD recovered within 30 minutes after exposure to tobacco SHS.[34,35] In contrast, 1 minute of exposure to marijuana SHS in the experiment shown in Figure 4 caused impairment of FMD that lasted for at least 90 minutes. To follow up on this historical observation with a direct comparison, we exposed 3 groups

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of rats to 1 minute of chamber air, tobacco SHS, or marijuana SHS, with SHS in the latter 2 groups at ≈600 μg/m^3 RSP as before. As shown in Figure 6 and the Table, tobacco and marijuana SHS both reduced FMD to comparable levels at 10 minutes after the end of exposure (absolute FMD values of 4.0±1.4% and 4.9±0.92%, respectively; *P*=0.97) and by comparable percent reduction (relative reduction from baseline by 68.3±10.2% and 58.5±8.0%, respectively; *P*=0.46). However, recovery of FMD to pre-exposure values was essentially complete by 30 minutes postexposure to tobacco, consistent with our previous results,[34,35] whereas recovery from marijuana SHS exposure had not yet occurred at 30 minutes, consistent with the results in Figures 4 and 5 that marijuana caused impairment that persisted for as long as 90 minutes. The similar initial impairment of FMD by marijuana and tobacco SHS, coupled with the longer time to recovery from marijuana SHS exposure, together suggest that marijuana SHS exposure may cause more cardiovascular harm than tobacco SHS.

Discussion

There is growing awareness that marijuana use in general may lead to cardiovascular complications,[38–40] an effect normally ascribed to THC, but little attention has been paid specifically to the effects of the generic biomass combustion components. Our inclusion of control groups exposed to SHS from marijuana lacking cannabinoids confirms that THC was not required for the impairment of FMD. Similarly and notably, the finding that FMD is impaired by exposure to marijuana SHS, which is chemically similar to tobacco SHS but does not contain nicotine, confirms that the decrease in FMD caused by tobacco SHS is not dependent on nicotine. Together, our results demonstrate that in rats, FMD is impaired by 1 or more constituents of smoke not specific to marijuana or

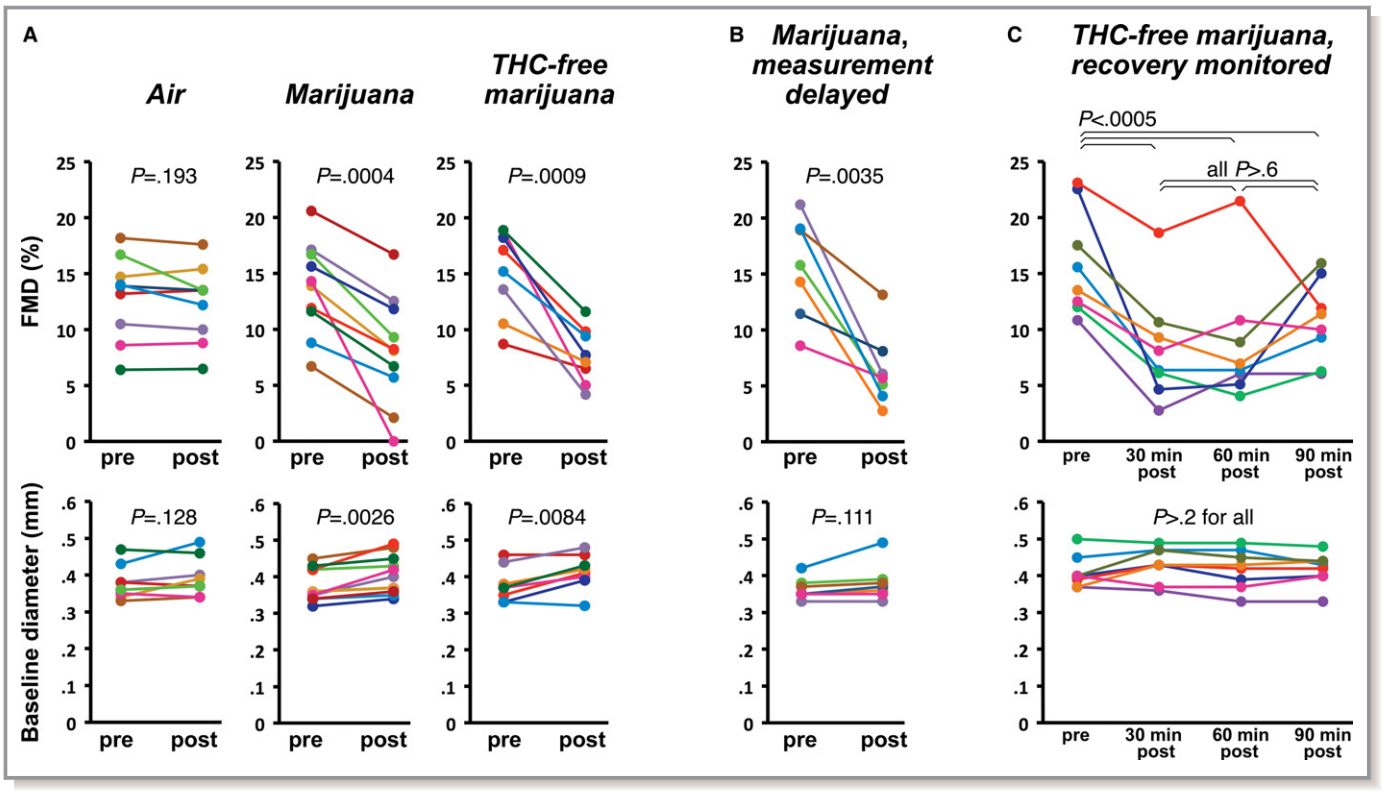


Figure 4. Impairment of FMD by 1 minute of exposure to marijuana SHS. See Table for group mean FMD and diameter values. A, FMD and baseline artery diameter in rats exposed to chamber air (0.73±0.055 μg/m^3; n=8), high-dose marijuana SHS (584±16 μg/m^3; n=10), or high-dose THC-free marijuana SHS (608±13 μg/m^3; n=8); errors are SD. Because smoke levels did not decline substantially over 1 minute, the average concentration over time is listed. Colors track individual rats through the FMD graphs and corresponding diameter graphs. FMD in rats exposed to SHS from regular marijuana or THC-free marijuana decreased, whereas baseline diameter increased significantly by 8.2% for regular marijuana and 9.2% for THC-free marijuana. B, Waiting for 25 minutes post-end of exposure before FMD measurement (562±16 μg/m^3; n=7) revealed substantial impairment of FMD without concomitant baseline vasodilation. C, FMD impairment for at least 90 minutes (617±10 μg/m^3; n=8) with no significant improvement. Removal of 1 potential outlier (red line) would result in a significant partial improvement at 90 minutes postexposure relative to 30 minutes (*P*=0.019), but all postexposure values would still be depressed relative to pre-exposure with *P*<0.0005. FMD indicates flow-mediated vasodilation; SHS, secondhand smoke; THC, tetrahydrocannabinol.

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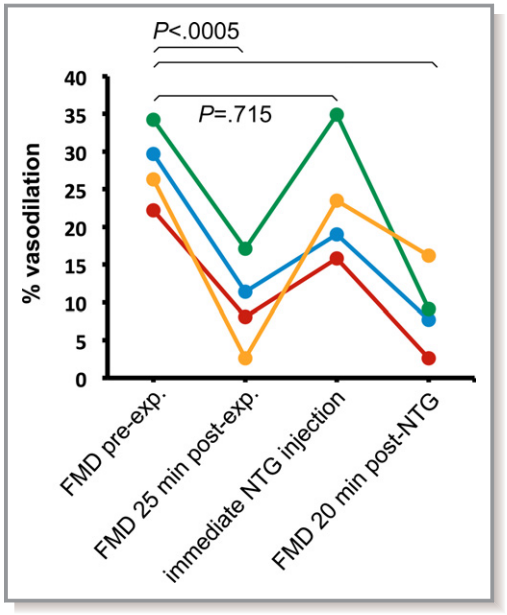


Figure 5. Endothelium-independent vasodilation is not impaired by SHS. Percent vasodilation is reported for 4 time points consisting of pre-exposure FMD, postexposure FMD (impaired), nitroglycerin-induced endothelium-independent dilation (NTG, not impaired), and subsequent FMD (still impaired). FMD indicates flow-mediated vasodilation; SHS, secondhand smoke.

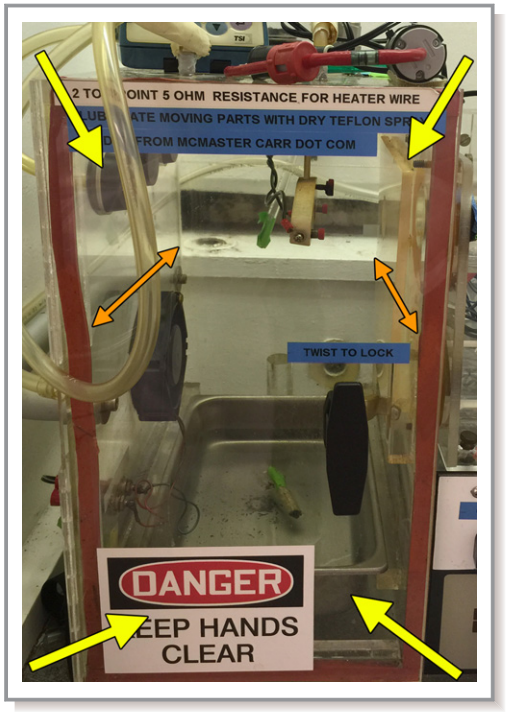


Figure 7. Smoke exposure chamber showing lack of visible smoke. Yellow arrows designate the corners of the exposure chamber. Double-headed orange arrows show depth of chamber, ≈30 cm.

tobacco, either the products of combustion or other generic plant chemicals that persist after combustion.

The mechanism by which tobacco smoke impairs endothelial function, and by extension, how marijuana smoke exerts similar effects, is incompletely understood. Chronic exposure to tobacco smoke results in changes in the serum that can directly lower the activity of endothelial nitric oxide synthase in cultured endothelial cells, thereby lowering the production of nitric oxide, in a manner involving increased oxidative stress.[41,42] However, the mechanism by which smoke induces these changes, and the identity of the mediators of the effect, are unclear. Given the chemical similarity between marijuana and tobacco smoke,[2] it is likely that the chemicals or the ultrafine particles leading to these changes in the endothelium are common to both kinds of smoke.

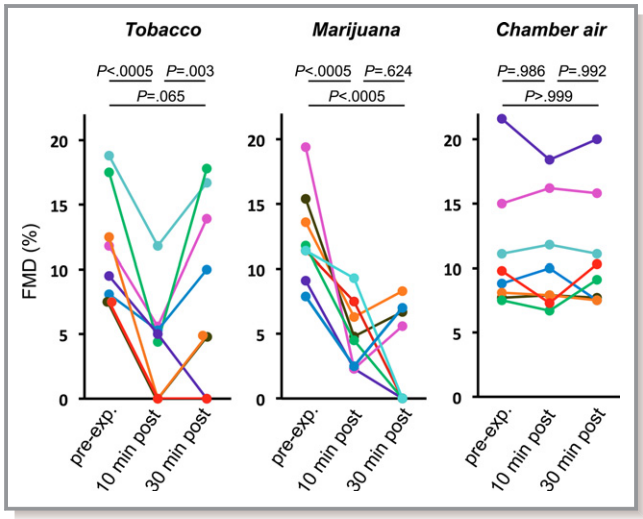


Figure 6. Impairment of FMD from 1 minute of marijuana SHS persists longer than impairment from tobacco SHS. Impairment of FMD recovered by 30 minutes after 1 minute of exposure to tobacco SHS (591±28 μg/m^3), but not after 1 minute of exposure to marijuana SHS (572±32 μg/m^3; n=8/group). FMD indicates flow-mediated vasodilation; SHS, secondhand smoke.

The gaps in our knowledge about how tobacco smoke exerts its adverse cardiovascular effects have not prevented the findings that tobacco SHS is harmful from having a considerable impact on public health policy, smoke-free laws, physician advice to their patients, and individual behavior. As legal marijuana use increases, public exposure to marijuana SHS may also increase. This demonstration that marijuana SHS exerts adverse effects on endothelial function in rats that are similar to effects of tobacco SHS on both rats and humans should help to inform similar policy and behavioral discussions. Recent policy debates in municipalities such as Ontario, which initially proposed to allow people with prescriptions to smoke marijuana in enclosed locations including theaters[43] and then reversed the policy,[44] exemplify the risks of assuming that marijuana SHS is harmless,

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and illustrate the importance of evidence that marijuana SHS shares at least some adverse health physiological effects with tobacco SHS.

While the public health community has strongly advised people to avoid tobacco SHS for many years, it has not made comparable pronouncements about marijuana SHS, primarily because the evidence has not been available that it could elicit similar adverse effects. The public's perception of risk from marijuana SHS has thus been limited to a few publicized studies. Marijuana SHS exposure was recently reported to lead to minor increases in heart rate and mild impairment of cognitive function in humans, but only under unventilated conditions with high smoke levels,[45] presumably due to the THC. Mittleman et al[38] reported that active marijuana use increased the risk of experiencing a heart attack roughly 5-fold within the next hour. Because THC has direct effects on heart rate and blood pressure, the authors focused on the potential link between the elevated heart attack risk and the THC. It is also possible that the increased heart attack risk was caused by the adverse effects of smoke on endothelial function.

A limitation of the study is that the typical ambient levels of marijuana SHS have not been systematically measured in real-world situations, in contrast to what is known about tobacco SHS. The exposure levels of tobacco SHS on which our conditions were based can reasonably be expected to exist for marijuana SHS at parties, rock concerts, and other situations in which multiple people are smoking marijuana at any given time, but this remains unconfirmed. Our understanding of the relative risks of exposure in different social situations would benefit greatly from a comprehensive study of particle levels under these circumstances. Nonetheless, the smoke concentrations in our study were low enough that the smoke was not visible during the exposures in the clear exposure chamber (Figure 7).

Since this was a rodent model, specific parameters such as the exposure times and exact durations of impairment may not completely match the corresponding properties of exposure in humans. However, the process of FMD in rats as we measured it shows great similarity to FMD in humans, as shown by extensive physiological and pharmacological validation as we have described previously.[32] Moreover, rats and humans show comparable responses to similar tobacco smoke exposure conditions.[26–28,34,35] Because our understanding of human cardiovascular consequences of marijuana use has been limited to retrospective association studies,[38–40] our ability to perform prospective, controlled rodent experiments fills a crucial gap in our understanding of the rapid consequences of marijuana SHS exposure that can be extrapolated to humans.

Increasing legalization of marijuana makes it more important than ever to understand the consequences of exposure to secondhand marijuana smoke. The similarity of the chemical composition of SHS from tobacco and marijuana, along with our observation that both kinds of smoke can impair endothelial function, indicate that marijuana SHS has adverse cardiovascular effects in rats and suggest that it may have similar adverse effects in humans. It is important that the public, medical personnel, and policymakers understand that exposure to secondhand marijuana smoke is not necessarily harmless. Our findings suggest that SHS should be avoided whether the source is tobacco or marijuana.

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Disclosures

None.

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National Institute on Drug Abuse
Advancing Addiction Science

Research Report
Revised Julio 2020

Marijuana Research Report

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Marijuana Research Report

Explores the latest research on marijuana, including the scope of marijuana use in the U.S., health consequences, its effects on everyday activities, and available treatments.

Letter From the Director



Photo by NIDA

Changes in marijuana policies across states legalizing marijuana for medical and/or recreational use suggest that marijuana is gaining greater acceptance in our society. Thus, it is particularly important for people to understand what is known about both the adverse health effects and the potential therapeutic benefits linked to marijuana.

Because marijuana impairs short-term memory and judgment and distorts perception, it can impair performance in school or at work and make it dangerous to drive. It also affects brain systems that are still maturing through young adulthood, so regular use by teens may have negative and long-lasting effects on their cognitive development, putting them at a competitive disadvantage and possibly interfering with their well-being in other ways. Also, contrary to popular belief, marijuana can be addictive, and its use during adolescence may make other forms of problem use or addiction more likely.

Whether smoking or otherwise consuming marijuana has therapeutic benefits that outweigh its health risks is still an open question that science has not resolved. Although many states now permit dispensing marijuana for medicinal purposes and there is mounting anecdotal evidence for the efficacy of marijuana-derived compounds, the U.S. Food and Drug Administration has not approved "medical marijuana." However, safe medicines based on cannabinoid chemicals derived from the marijuana plant have been available for decades and more are being developed.

This Research Report is intended as a useful summary of what the most up-to-date science has to

say about marijuana and its effects on those who use it at any age.

Nora D. Volkow, M.D.
Director
National Institute on Drug Abuse

See Also:

- Message from the NIDA Director - Marijuana's Lasting Effects on the Brain, (Archives) (March 2013)

What is marijuana?



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Marijuana—also called *weed, herb, pot, grass, bud, ganja, Mary Jane*, and a vast number of other slang terms—is a greenish-gray mixture of the dried flowers of *Cannabis sativa*. Some people smoke marijuana in hand-rolled cigarettes called *joints*; in pipes, water pipes (sometimes called *bongs*), or in *blunts* (marijuana rolled in cigar wraps).[1] Marijuana can also be used to brew tea and, particularly when it is sold or consumed for medicinal purposes, is frequently mixed into foods (*edibles*) such as brownies, cookies, or candies. Vaporizers are also increasingly used to consume marijuana. Stronger forms of marijuana include sinsemilla (from specially tended female plants) and concentrated resins containing high doses of marijuana's active ingredients, including honeylike *hash oil*, waxy *budder*, and hard amberlike *shatter*. These resins are increasingly popular among those who use them both recreationally and medically.

The main *psychoactive*(mind-altering) chemical in marijuana, responsible for most of the intoxicating effects that people seek, is *delta-9-tetrahydrocannabinol* (THC). The chemical is found in resin

produced by the leaves and buds primarily of the female cannabis plant. The plant also contains more than 500 other chemicals, including more than 100 compounds that are chemically related to THC, called *cannabinoids*.[2]

What is the scope of marijuana use in the United States?

Marijuana is the most commonly used addictive drug after tobacco and alcohol. In 2018, more than 11.8 million young adults reported marijuana use in the past year.[3] Its use is more prevalent among men than women.[4]

Marijuana use is widespread among adolescents and young adults. According to the Monitoring the Future survey—an annual survey of drug use and attitudes among the Nation's middle and high school students—most measures of marijuana use by 8th, 10th, and 12th graders peaked in the mid-to-late 1990s and then began a period of gradual decline through the mid-2000s before leveling off. However, in 2019, there was a significant increase in daily use in the younger grades. In addition, teens' perceptions of the risks of marijuana use have steadily declined over the past decade. In 2019, 11.8% of 8th graders reported marijuana use in the past year and 6.6% in the past month (current use). Among 10th graders, 28.8% had used marijuana in the past year and 18.4% in the past month. Rates of use among 12th graders were higher still: 35.7% had used marijuana during the year prior to the survey and 22.3% used in the past month; 6.4% said they used marijuana daily or near-daily.[5] With the growing popularity of vaping devices, teens have started vaping THC (the ingredient in marijuana that produces the high), with nearly 4% of 12th graders saying they vape THC daily.[5]

Medical emergencies possibly related to marijuana use have also increased. The Drug Abuse Warning Network (DAWN), a system for monitoring the health impact of drugs, estimated that in 2011, there were nearly 456,000 drug-related emergency department visits in the United States in which marijuana use was mentioned in the medical record (a 21% increase over 2009). About two-thirds of patients were male and 13% were between the ages of 12 and 17.[6] It is unknown whether this increase is due to increased use, increased *potency* of marijuana (amount of THC it contains), or other factors. It should be noted, however, that mentions of marijuana in medical records do not necessarily indicate that these emergencies were directly related to marijuana intoxication.

What are marijuana's effects?

When marijuana is smoked, THC and other chemicals in the plant pass from the lungs into the bloodstream, which rapidly carries them throughout the body to the brain. The person begins to experience effects almost immediately (see "How does marijuana produce its effects?"). Many people experience a pleasant euphoria and sense of relaxation. Other common effects, which may vary dramatically among different people, include heightened sensory perception (e.g., brighter colors), laughter, altered perception of time, and increased appetite.

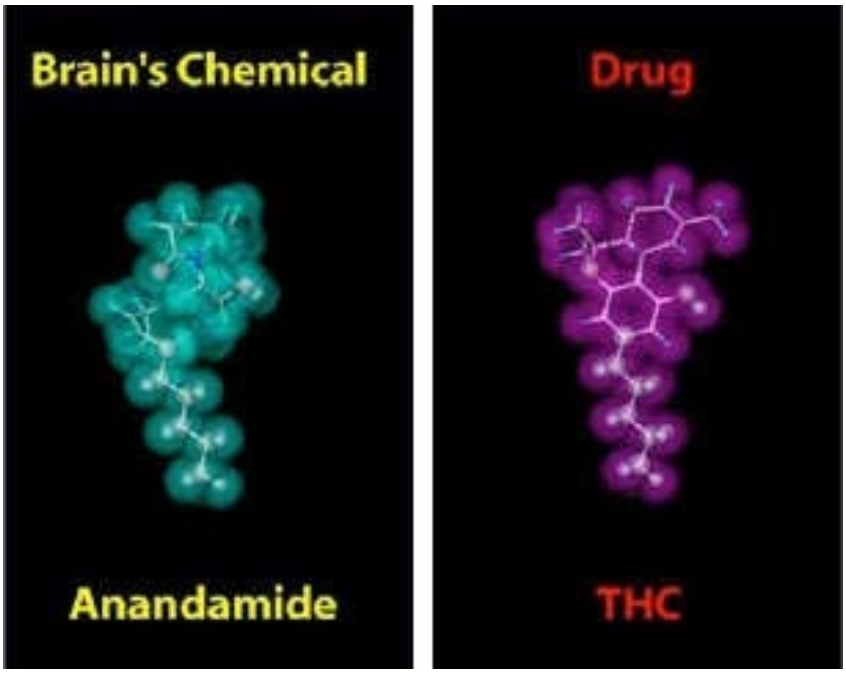
If marijuana is consumed in foods or beverages, these effects are somewhat delayed—usually appearing after 30 minutes to 1 hour—because the drug must first pass through the digestive system. Eating or drinking marijuana delivers significantly less THC into the bloodstream than smoking an equivalent amount of the plant. Because of the delayed effects, people may inadvertently consume more THC than they intend to.

Pleasant experiences with marijuana are by no means universal. Instead of relaxation and euphoria, some people experience anxiety, fear, distrust, or panic. These effects are more common when a person takes too much, the marijuana has an unexpectedly high potency, or the person is inexperienced. People who have taken large doses of marijuana may experience an acute psychosis, which includes hallucinations, delusions, and a loss of the sense of personal identity. These unpleasant but temporary reactions are distinct from longer-lasting psychotic disorders, such as schizophrenia, that may be associated with the use of marijuana in vulnerable individuals. (See "Is there a link between marijuana use and psychiatric disorders?")

Although detectable amounts of THC may remain in the body for days or even weeks after use, the noticeable effects of smoked marijuana generally last from 1 to 3 hours, and those of marijuana consumed in food or drink may last for many hours.

How does marijuana produce its effects?

THC’s chemical structure is similar to the brain chemical *anandamide*. Similarity in structure allows the body to recognize THC and to alter normal brain communication.



Courtesy of NIDA

THC’s chemical structure is similar to the brain chemical anandamide. Similarity in structure allows drugs to be recognized by the body and to alter normal brain communication.

Endogenous cannabinoids such as anandamide (see figure) function as *neurotransmitters* because they send chemical messages between nerve cells (*neurons*) throughout the nervous system. They affect brain areas that influence pleasure, memory, thinking, concentration, movement, coordination, and sensory and time perception. Because of this similarity, THC is able to attach to molecules called *cannabinoid receptors* on neurons in these brain areas and activate them, disrupting various mental and physical functions and causing the effects described earlier. The neural communication network that uses these cannabinoid neurotransmitters, known as the *endocannabinoid system*, plays a critical role in the nervous system’s normal functioning, so interfering with it can have profound effects.

For example, THC is able to alter the functioning of the hippocampus (see "Marijuana, Memory, and the Hippocampus") and orbitofrontal cortex, brain areas that enable a person to form new memories and shift his or her attentional focus. As a result, using marijuana causes impaired thinking and interferes with a person's ability to learn and perform complicated tasks. THC also disrupts functioning of the cerebellum and basal ganglia, brain areas that regulate balance, posture, coordination, and reaction time. This is the reason people who have used marijuana may not be able to drive safely (see "Does marijuana use affect driving?") and may have problems playing sports or engaging in other physical activities.

> People who have taken large doses of the drug may experience an acute psychosis, which includes hallucinations, delusions, and a loss of the sense of personal identity.

THC, acting through cannabinoid receptors, also activates the brain's reward system, which includes regions that govern the response to healthy pleasurable behaviors such as sex and eating. Like most other drugs that people misuse, THC stimulates neurons in the reward system to release the signaling chemical *dopamine* at levels higher than typically observed in response to natural rewarding stimuli. The surge of dopamine "teaches" the brain to repeat the rewarding behavior, helping account for marijuana's addictive properties.

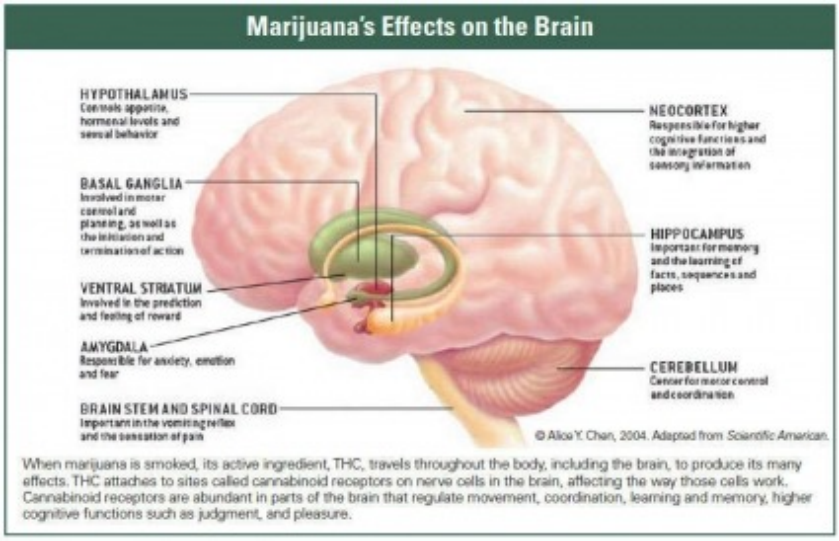


Diagram showing different parts of the brain and describing marijuana's effects on the brain

Does marijuana use affect driving?

Marijuana significantly impairs judgment, motor coordination, and reaction time, and studies have found a direct relationship between blood THC concentration and impaired driving ability.[7–9]



Photo by ©iStock.com/MadCircles

Marijuana is the illicit drug most frequently found in the blood of drivers who have been involved in vehicle crashes, including fatal ones.[10] Two large European studies found that drivers with THC in their blood were roughly twice as likely to be culpable for a fatal crash than drivers who had not used drugs or alcohol.[11'12] However, the role played by marijuana in crashes is often unclear because it can be detected in body fluids for days or even weeks after intoxication and because people frequently combine it with alcohol. Those involved in vehicle crashes with THC in their blood, particularly higher levels, are three to seven times more likely to be responsible for the incident than drivers who had not used drugs or alcohol. The risk associated with marijuana in combination with alcohol appears to be greater than that for either drug by itself.[8]

Several meta-analyses of multiple studies found that the risk of being involved in a crash significantly increased after marijuana use[13]—in a few cases, the risk doubled or more than doubled.[14–16] However, a large case-control study conducted by the National Highway Traffic Safety Administration found no significant increased crash risk attributable to cannabis after controlling for drivers' age, gender, race, and presence of alcohol.[17]

Is marijuana addictive?

Marijuana use can lead to the development of problem use, known as a marijuana use disorder, which takes the form of addiction in severe cases. Recent data suggest that 30% of those who use marijuana may have some degree of marijuana use disorder.[18] People who begin using marijuana before the age of 18 are four to seven times more likely to develop a marijuana use disorder than adults.[19]

Marijuana use disorders are often associated with *dependence*—in which a person feels withdrawal

symptoms when not taking the drug. People who use marijuana frequently often report irritability, mood and sleep difficulties, decreased appetite, cravings, restlessness, and/or various forms of physical discomfort that peak within the first week after quitting and last up to 2 weeks.[20,21] Marijuana dependence occurs when the brain adapts to large amounts of the drug by reducing production of and sensitivity to its own endocannabinoid neurotransmitters.[22,23]

Marijuana use disorder becomes addiction when the person cannot stop using the drug even though it interferes with many aspects of his or her life. Estimates of the number of people addicted to marijuana are controversial, in part because epidemiological studies of substance use often use dependence as a proxy for addiction even though it is possible to be dependent without being addicted. Those studies suggest that 9% of people who use marijuana will become dependent on it,[24,25] rising to about 17% in those who start using in their teens.[26,27]

In 2015, about 4.0 million people in the United States met the diagnostic criteria for a marijuana use disorder;[3] 138,000 voluntarily sought treatment for their marijuana use.[28]

Rising Potency

Marijuana potency, as detected in confiscated samples, has steadily increased over the past few decades. In the early 1990s, the average THC content in confiscated marijuana samples was less than 4%.[2] In 2018, it was more than 15%.[29] Marijuana concentrates can have much higher levels of THC (see Marijuana Concentrates DrugFacts). The increasing potency of marijuana, combined with the use of high-THC concentrates, raises concerns that the consequences of marijuana use today could be worse than in the past, particularly among those who are new to marijuana use and in young people, whose brains are still developing (see "What are marijuana's long-term effects on the brain?").

Researchers do not yet know the full extent of the consequences when the body and brain (especially the developing brain) are exposed to high concentrations of THC or whether the recent increases in emergency department visits by people testing positive for marijuana are related to rising potency. The extent to which people adjust for increased potency by using less or by smoking it differently is also unknown. Recent studies suggest that experienced people may adjust the amount they smoke and how much they inhale based on the believed strength of

> the marijuana they are using, but they are not able to fully compensate for variations in potency.[30,31]

What are marijuana's long-term effects on the brain?

Substantial evidence from animal research and a growing number of studies in humans indicate that marijuana exposure during development can cause long-term or possibly permanent adverse changes in the brain. Rats exposed to THC before birth, soon after birth, or during adolescence show notable problems with specific learning and memory tasks later in life.[32–34] Cognitive impairments in adult rats exposed to THC during adolescence are associated with structural and functional changes in the hippocampus.[35–37] Studies in rats also show that adolescent exposure to THC is associated with an altered reward system, increasing the likelihood that an animal will self-administer other drugs (e.g., heroin) when given an opportunity (see "Is marijuana a gateway drug?").

Imaging studies of marijuana's impact on brain structure in humans have shown conflicting results. Some studies suggest regular marijuana use in adolescence is associated with altered connectivity and reduced volume of specific brain regions involved in a broad range of executive functions such as memory, learning, and impulse control compared to people who do not use.[38,39] Other studies have not found significant structural differences between the brains of people who do and do not use the drug.[40]

Several studies, including two large longitudinal studies, suggest that marijuana use can cause functional impairment in cognitive abilities but that the degree and/or duration of the impairment depends on the age when a person began using and how much and how long he or she used.[41]

Among nearly 4,000 young adults in the Coronary Artery Risk Development in Young Adults study tracked over a 25-year period until mid-adulthood, cumulative lifetime exposure to marijuana was associated with lower scores on a test of verbal memory but did not affect other cognitive abilities such as processing speed or executive function. The effect was sizable and significant even after eliminating those involved with current use and after adjusting for confounding factors such as demographic factors, other drug and alcohol use, and other psychiatric conditions such as depression.[42]

Some studies have also linked marijuana use to declines in IQ, especially when use starts in adolescence and leads to persistent cannabis use disorder into adulthood. However, not all of the studies on the link between marijuana and IQ have reached the same conclusion, and it is difficult to prove that marijuana causes a decline in IQ when there are multiple factors that can influence the results of such studies, such as genetics, family environment, age of first use, frequency of use, having a cannabis use disorder, duration of use, and duration of the study. Key research in this area to date is described below.

A large longitudinal study in New Zealand found that persistent marijuana use disorder with frequent use starting in adolescence was associated with a loss of an average of 6 or up to 8 IQ points measured in mid-adulthood.[43] Those who used marijuana heavily as teenagers and quit using as adults did not recover the lost IQ points. People who only began using marijuana heavily in adulthood did not lose IQ points. Two shorter-duration prospective longitudinal twin studies found that youth who used marijuana showed significant declines in verbal ability (equivalent to 4 IQ points) and general knowledge between the preteen years (ages 9 to 12, before use) and late adolescence/early adulthood (ages 17 to 20); however those who went on to use marijuana at older ages already had lower scores on these measures at the start of the study, before they started using the drug. Also, no predictable difference was found between twins when one used marijuana and one did not.[44]

More research will be needed to answer definitively whether marijuana use causes long-term IQ losses and whether factors that weren't measured in the prior research, such as the increasing amounts of THC in cannabis and the emergence of new cannabis products, are relevant.

Also, the ability to draw definitive conclusions about marijuana's long-term impact on the human brain from past studies is often limited by the fact that study participants use multiple substances, and there is often limited data about the participants' health or mental functioning prior to the study. Over the

next decade, the National Institutes of Health is funding the Adolescent Brain Cognitive Development (ABCD) study—a major longitudinal study that will track a large sample of young Americans from late childhood (before first use of drugs) to early adulthood. The study will use neuroimaging and other advanced tools to clarify precisely how and to what extent marijuana and other substances, alone and in combination, affect adolescent brain development.

Marijuana, Memory, and the Hippocampus



Image by NIDA

Distribution of cannabinoid receptors in the rat brain. Brain image reveals high levels (shown in orange and yellow) of cannabinoid receptors in many areas, including the cortex, hippocampus, cerebellum, and nucleus accumbens (ventral striatum).

Memory impairment from marijuana use occurs because THC alters how the hippocampus, a brain area responsible for memory formation, processes information. Most of the evidence supporting this assertion comes from animal studies. For example, rats exposed to THC *in utero*, soon after birth, or during adolescence, show notable problems with specific learning/memory tasks later in life. Moreover, cognitive impairment in adult rats is associated with structural and functional changes in the hippocampus from THC exposure during adolescence.

As people age, they lose neurons in the hippocampus, which decreases their ability to learn new information. Chronic THC exposure may hasten age-related loss of hippocampal neurons. In one study, rats exposed to THC every day for 8 months (approximately 30% of their lifespan) showed a level of nerve cell loss at 11 to 12 months of age that equaled that of unexposed animals twice their age.

Is marijuana a gateway drug?

Some research suggests that marijuana use is likely to precede use of other licit and illicit substances[45] and the development of addiction to other substances. For instance, a study using longitudinal data from the National Epidemiological Study of Alcohol Use and Related Disorders found that adults who reported marijuana use during the first wave of the survey were more likely than adults who did not use marijuana to develop an alcohol use disorder within 3 years; people who used marijuana and already had an alcohol use disorder at the outset were at greater risk of their alcohol use disorder worsening.[46] Marijuana use is also linked to other substance use disorders including nicotine addiction.

Early exposure to cannabinoids in adolescent rodents decreases the reactivity of brain dopamine reward centers later in adulthood.[47] To the extent that these findings generalize to humans, this could help explain the increased vulnerability for addiction to other substances of misuse later in life that most epidemiological studies have reported for people who begin marijuana use early in life.[48] It is also consistent with animal experiments showing THC's ability to "prime" the brain for enhanced responses to other drugs.[49] For example, rats previously administered THC show heightened behavioral response not only when further exposed to THC but also when exposed to other drugs such as morphine—a phenomenon called *cross-sensitization*.[50]

These findings are consistent with the idea of marijuana as a "gateway drug." However, the majority of people who use marijuana do not go on to use other, "harder" substances. Also, cross-sensitization is not unique to marijuana. Alcohol and nicotine also prime the brain for a heightened response to other drugs[51] and are, like marijuana, also typically used before a person progresses to other, more harmful substances.

It is important to note that other factors besides biological mechanisms, such as a person's social environment, are also critical in a person's risk for drug use. An alternative to the gateway-drug hypothesis is that people who are more vulnerable to drug-taking are simply more likely to start with readily available substances such as marijuana, tobacco, or alcohol, and their subsequent social interactions with others who use drugs increases their chances of trying other drugs. Further research is needed to explore this question.

How does marijuana use affect school, work, and social life?



Image by ©iStock.com/AntonioGuillem

Research has shown that marijuana's negative effects on attention, memory, and learning can last for days or weeks after the acute effects of the drug wear off, depending on the person's history with the drug.[52] Consequently, someone who smokes marijuana daily may be functioning at a reduced intellectual level most or all of the time. Considerable evidence suggests that students who smoke marijuana have poorer educational outcomes than their nonsmoking peers. For example, a review of 48 relevant studies found marijuana use to be associated with reduced educational attainment (i.e., reduced chances of graduating).[53] A recent analysis using data from three large studies in Australia and New Zealand found that adolescents who used marijuana regularly were significantly less likely than their non-using peers to finish high school or obtain a degree. They also had a much higher chance of developing dependence, using other drugs, and attempting suicide.[54] Several studies have also linked heavy marijuana use to lower income, greater welfare dependence, unemployment, criminal behavior, and lower life satisfaction.[55,56]

To what degree marijuana use is directly causal in these associations remains an open question requiring further research. It is possible that other factors independently predispose people to both marijuana use and various negative life outcomes such as school dropout.[57] That said, people report a perceived influence of their marijuana use on poor outcomes on a variety of life satisfaction and

achievement measures. One study, for example, compared people involved with current and former long-term, heavy use of marijuana with a control group who reported smoking marijuana at least once in their lives but not more than 50 times.[58] All participants had similar education and income backgrounds, but significant differences were found in their educational attainment: Fewer of those who engaged in heavy cannabis use completed college, and more had yearly household incomes of less than $30,000. When asked how marijuana affected their cognitive abilities, career achievements, social lives, and physical and mental health, the majority of those who used heavily reported that marijuana had negative effects in all these areas of their lives.

Studies have also suggested specific links between marijuana use and adverse consequences in the workplace, such as increased risk for injury or accidents.[59] One study among postal workers found that employees who tested positive for marijuana on a pre-employment urine drug test had 55% more industrial accidents, 85% more injuries, and 75% greater absenteeism compared with those who tested negative for marijuana use.[60]

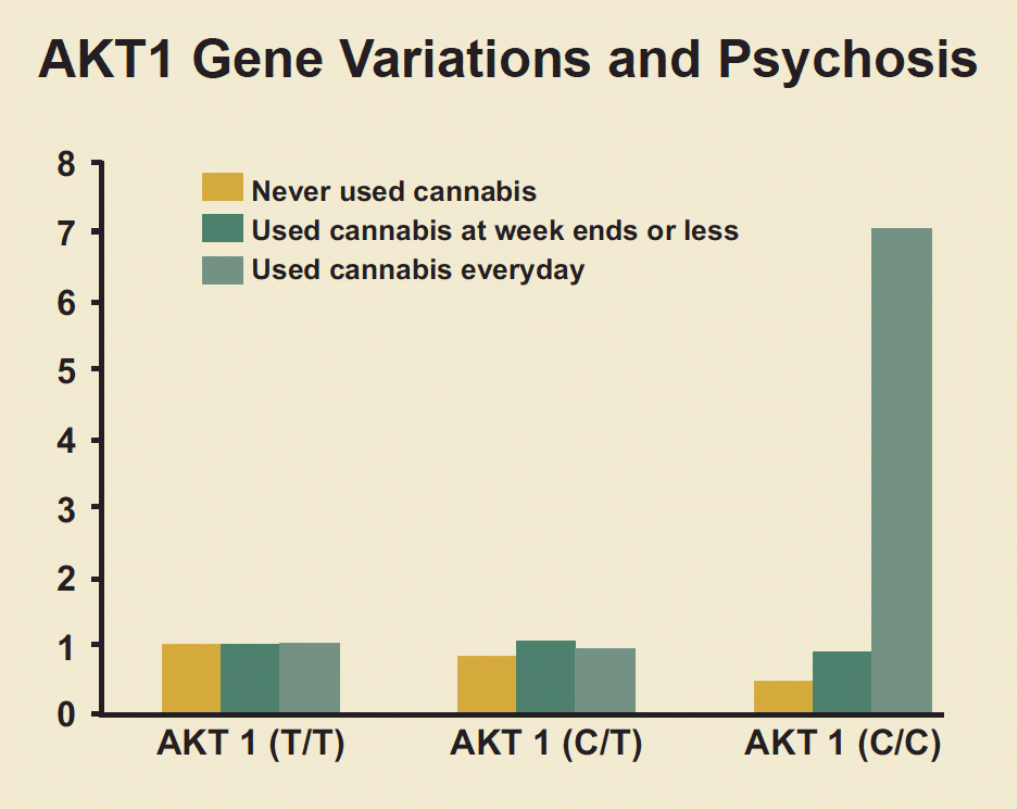
Is there a link between marijuana use and psychiatric disorders?

Several studies have linked marijuana use to increased risk for psychiatric disorders, including psychosis (schizophrenia), depression, anxiety, and substance use disorders, but whether and to what extent it actually causes these conditions is not always easy to determine.[32] Recent research suggests that smoking high-potency marijuana every day could increase the chances of developing psychosis by nearly five times compared to people who have never used marijuana.[113] The amount of drug used, the age at first use, and genetic vulnerability have all been shown to influence this relationship. The strongest evidence to date concerns links between marijuana use and psychiatric disorders in those with a preexisting genetic or other vulnerability.[61]

Research using longitudinal data from the National Epidemiological Survey on Alcohol and Related Conditions examined associations between marijuana use, mood and anxiety disorders, and substance use disorders. After adjusting for various confounding factors, no association between marijuana use and mood and anxiety disorders was found. The only significant associations were increased risk of alcohol use disorders, nicotine dependence, marijuana use disorder, and other drug

use disorders.[62]

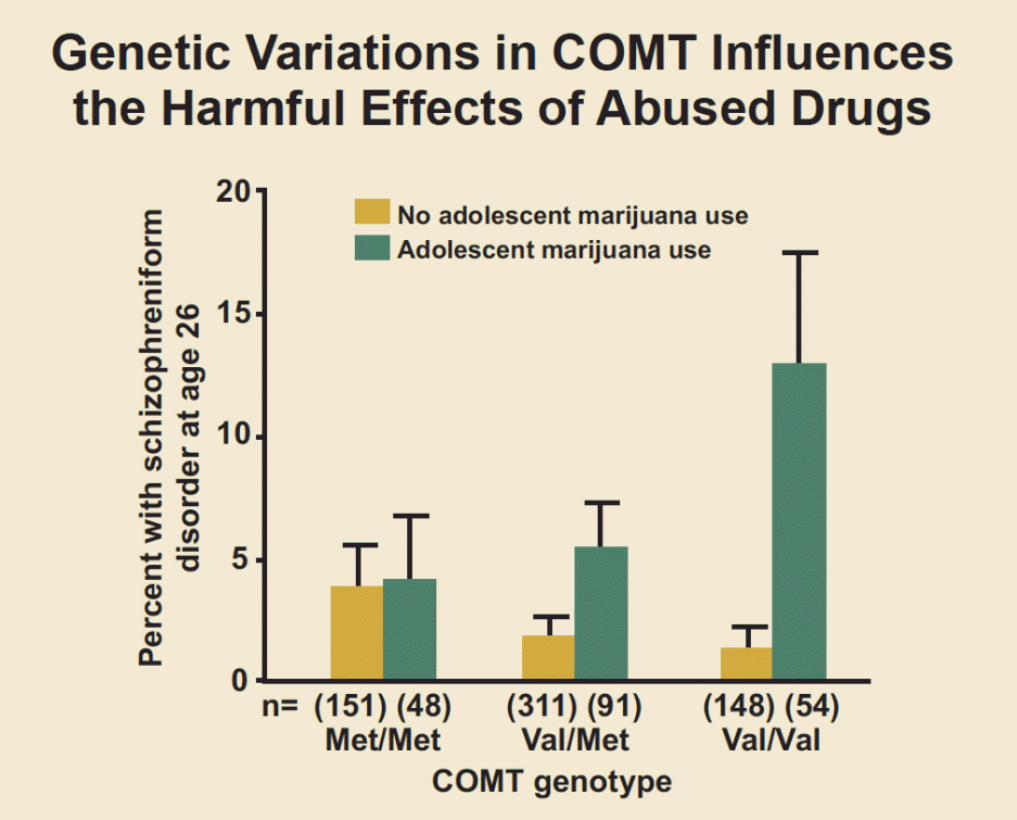
Recent research (see "AKT1 Gene Variations and Psychosis") has found that people who use marijuana and carry a specific variant of the *AKT1* gene, which codes for an enzyme that affects dopamine signaling in the *striatum*, are at increased risk of developing psychosis. The striatum is an area of the brain that becomes activated and flooded with dopamine when certain stimuli are present. One study found that the risk of psychosis among those with this variant was seven times higher for those who used marijuana daily compared with those who used it infrequently or used none at all.[63]



Source: Di Forti et al. Biol Psychiatry. 2012.

Whether adolescent marijuana use can contribute to developing psychosis later in adulthood appears to depend on whether a person already has a genetically based vulnerability to the disorder. The AKT1 gene governs an enzyme that affects brain signaling involving the neurotransmitter dopamine. Altered dopamine signaling is known to be involved in schizophrenia. AKT1 can take one of three forms in a specific region of the gene implicated in susceptibility to schizophrenia: T/T, C/T, and C/C. Those who use marijuana daily (green bars) with the C/C variant have a seven times higher risk of developing psychosis than those who use it infrequently or use none at all. The risk for psychosis among those with the T/T variant was unaffected by whether they used marijuana.

Another study found an increased risk of psychosis among adults who had used marijuana in adolescence and also carried a specific variant of the gene for *catechol-O-methyltransferase* (COMT), an enzyme that degrades neurotransmitters such as dopamine and norepinephrine[64] (see "Genetic Variations in COMT Influences the Harmful Effects of Abused Drugs"). Marijuana use has also been shown to worsen the course of illness in patients who already have schizophrenia. As mentioned previously, marijuana can produce an acute psychotic reaction in non-schizophrenic people who use marijuana, especially at high doses, although this fades as the drug wears off.



Source: Di Forti et al. Biol Psychiatry. 2012.

The influence of adolescent marijuana use on adult psychosis is affected by genetic variables. This figure shows that variations in a gene can affect the likelihood of developing psychosis in adulthood following exposure to cannabis in adolescence. The COMT gene governs an enzyme that breaks down dopamine, a brain chemical involved in schizophrenia. It comes in two forms: "Met" and "Val." Individuals with one or two copies of the Val variant have a higher risk of developing schizophrenic-type disorders if they used cannabis during adolescence (dark bars). Those with only the Met variant were unaffected by cannabis use.

Inconsistent and modest associations have been reported between marijuana use and suicidal thoughts and attempted suicide among teens.[65,66] Marijuana has also been associated with an *amotivational syndrome*, defined as a diminished or absent drive to engage in typically rewarding activities. Because of the role of the endocannabinoid system in regulating mood and reward, it has been hypothesized that brain changes resulting from early use of marijuana may underlie these

associations, but more research is needed to verify that such links exist and better understand them.

Adverse Consequences of Marijuana Use

Acute (present during intoxication)

- Impaired short-term memory
- Impaired attention, judgment, and other cognitive functions
- Impaired coordination and balance
- Increased heart rate
- Anxiety, paranoia
- Psychosis (uncommon)



Photo by ©getttyimages.com/Fuse

Persistent (lasting longer than intoxication, but may not be permanent)

- Impaired learning and coordination
- Sleep problems

Long-term (cumulative effects of repeated use)

- Potential for marijuana addiction
- Impairments in learning and memory with potential loss of IQ*
- Increased risk of chronic cough, bronchitis
- Increased risk of other drug and alcohol use disorders
- Increased risk of schizophrenia in people with genetic vulnerability**

**Loss of IQ among individuals with persistent marijuana use disorder who began using heavily during adolescence*

***These are often reported co-occurring symptoms/disorders with chronic marijuana use. However, research has not yet determined whether marijuana is causal or just associated with*

these mental problems.

What are marijuana's effects on lung health?

Like tobacco smoke, marijuana smoke is an irritant to the throat and lungs and can cause a heavy cough during use. It also contains levels of volatile chemicals and tar that are similar to tobacco smoke, raising concerns about risk for cancer and lung disease.[67]

Marijuana smoking is associated with large airway inflammation, increased airway resistance, and lung hyperinflation, and those who smoke marijuana regularly report more symptoms of chronic bronchitis than those who do not smoke.[67,68] One study found that people who frequently smoke marijuana had more outpatient medical visits for respiratory problems than those who do not smoke.[69] Some case studies have suggested that, because of THC's immune-suppressing effects, smoking marijuana might increase susceptibility to lung infections, such as pneumonia, in people with immune deficiencies; however, a large AIDS cohort study did not confirm such an association.[67] Smoking marijuana may also reduce the respiratory system's immune response, increasing the likelihood of the person acquiring respiratory infections, including pneumonia.[68] Animal and human studies have not found that marijuana increases risk for emphysema.[67]

Reports of Deaths Related to Vaping Marijuana

The Food and Drug Administration has alerted the public to hundreds of reports of serious lung illnesses associated with vaping, including several deaths. They are working with the Centers for Disease Control and Prevention (CDC) to investigate the cause of these illnesses. Many of the suspect products tested by the states or federal health officials have been identified as vaping products containing THC, the main psychotropic ingredient in marijuana. Some of the patients reported a mixture of THC and nicotine; and some reported vaping nicotine alone. No one substance has been identified in all of the samples tested, and it is unclear if the illnesses are related to one single compound. Until more details are known, FDA officials have warned people not to use any vaping products bought on the street, and they warn against modifying any

> products purchased in stores. They are also asking people and health professionals to report any adverse effects. The CDC has posted an information page for consumers.

Whether smoking marijuana causes lung cancer, as cigarette smoking does, remains an open question.[67,70] Marijuana smoke contains carcinogenic combustion products, including about 50% more benzoprene and 75% more benzanthracene (and more phenols, vinyl chlorides, nitrosamines, reactive oxygen species) than cigarette smoke.[67] Because of how it is typically smoked (deeper inhale, held for longer), marijuana smoking leads to four times the deposition of tar compared to cigarette smoking.[71] However, while a few small, uncontrolled studies have suggested that heavy, regular marijuana smoking could increase risk for respiratory cancers, well-designed population studies have failed to find an increased risk of lung cancer associated with marijuana use.[67]

One complexity in comparing the lung-health risks of marijuana and tobacco concerns the very different ways the two substances are used. While people who smoke marijuana often inhale more deeply and hold the smoke in their lungs for a longer duration than is typical with cigarettes, marijuana's effects last longer, so people who use marijuana may smoke less frequently than those who smoke cigarettes.

Additionally, the fact that many people use both marijuana and tobacco makes determining marijuana's precise contribution to lung cancer risk, if any, difficult to establish. Cell culture and animal studies have also suggested THC and CBD may have antitumor effects, and this has been proposed as one reason why stronger expected associations are not seen between marijuana use and lung cancer, but more research is needed on this question.[67]

What are marijuana's effects on other aspects of physical health?

Within a few minutes after inhaling marijuana smoke, a person's heart rate speeds up, the breathing passages relax and become enlarged, and blood vessels in the eyes expand, making the eyes look bloodshot. The heart rate—normally 70 to 80 beats per minute—may increase by 20 to 50 beats per

minute or may even double in some cases. Taking other drugs with marijuana can amplify this effect.

Limited evidence suggests that a person's risk of heart attack during the first hour after smoking marijuana is nearly five times his or her usual risk.[72] This observation could be partly explained by marijuana raising blood pressure (in some cases) and heart rate and reducing the blood's capacity to carry oxygen.[73] Marijuana may also cause *orthostatic hypotension* (head rush or dizziness on standing up), possibly raising danger from fainting and falls. Tolerance to some cardiovascular effects often develops with repeated exposure.[74] These health effects need to be examined more closely, particularly given the increasing use of "medical marijuana" by people with health issues and older adults who may have increased baseline vulnerability due to age-related cardiovascular risk factors (see "Is marijuana safe and effective as medicine?").

A few studies have shown a clear link between marijuana use in adolescence and increased risk for an aggressive form of testicular cancer (nonseminomatous testicular germ cell tumor) that predominantly strikes young adult males.[75,76] The early onset of testicular cancers compared to lung and most other cancers indicates that, whatever the nature of marijuana's contribution, it may accumulate over just a few years of use.

Studies have shown that in rare cases, chronic use of marijuana can lead to Cannabinoid Hyperemesis Syndrome—a condition marked by recurrent bouts of severe nausea, vomiting, and dehydration. This syndrome has been found to occur in persons under 50 years of age and with a long history of marijuana use. Cannabinoid Hyperemesis Syndrome can lead sufferers to make frequent trips to the emergency room, but may be resolved when a person stops using marijuana.[77]

Is marijuana safe and effective as medicine?

The potential medicinal properties of marijuana and its components have been the subject of research and heated debate for decades. THC itself has proven medical benefits in particular formulations. The U.S. Food and Drug Administration (FDA) has approved THC-based medications, dronabinol (Marinol®) and nabilone (Cesamet®), prescribed in pill form for the treatment of nausea in patients undergoing cancer chemotherapy and to stimulate appetite in patients with wasting syndrome due to AIDS.

In addition, several other marijuana-based medications have been approved or are undergoing

clinical trials. Nabiximols (Sativex®), a mouth spray that is currently available in the United Kingdom, Canada, and several European countries for treating the spasticity and neuropathic pain that may accompany multiple sclerosis, combines THC with another chemical found in marijuana called cannabidiol (CBD).

The FDA also approved a CBD-based liquid medication called Epidiolex® for the treatment of two forms of severe childhood epilepsy, Dravet syndrome and Lennox-Gastaut syndrome. It's being delivered to patients in a reliable dosage form and through a reproducible route of delivery to ensure that patients derive the anticipated benefits. CBD does not have the rewarding properties of THC.

Researchers generally consider medications like these, which use purified chemicals derived from or based on those in the marijuana plant, to be more promising therapeutically than use of the whole marijuana plant or its crude extracts. Development of drugs from botanicals such as the marijuana plant poses numerous challenges. Botanicals may contain hundreds of unknown, active chemicals, and it can be difficult to develop a product with accurate and consistent doses of these chemicals. Use of marijuana as medicine also poses other problems such as the adverse health effects of smoking and THC-induced cognitive impairment. Nevertheless, a growing number of states have legalized dispensing of marijuana or its extracts to people with a range of medical conditions.

An additional concern with "medical marijuana" is that little is known about the long-term impact of its use by people with health- and/or age-related vulnerabilities—such as older adults or people with cancer, AIDS, cardiovascular disease, multiple sclerosis, or other neurodegenerative diseases. Further research will be needed to determine whether people whose health has been compromised by disease or its treatment (e.g., chemotherapy) are at greater risk for adverse health outcomes from marijuana use.

Medical Marijuana Laws and Prescription Opioid Use Outcomes

A new study underscores the need for additional research on the effect of medical marijuana laws on opioid overdose deaths and cautions against drawing a causal connection between the two. Early research suggested that there may be a relationship between the availability of medical marijuana and opioid analgesic overdose mortality. In particular, a NIDA-funded study published in 2014 found that from 1999 to 2010, states with medical cannabis laws experienced

slower rates of increase in opioid analgesic overdose death rates compared to states without such laws.[78]

A 2019 analysis, also funded by NIDA, re-examined this relationship using data through 2017. Similar to the findings reported previously, this research team found that opioid overdose mortality rates between 1999-2010 in states allowing medical marijuana use were 21% lower than expected. When the analysis was extended through 2017, however, they found that the trend reversed, such that states with medical cannabis laws experienced an overdose death rate 22.7% higher than expected.[79] The investigators uncovered no evidence that either broader cannabis laws (those allowing recreational use) or more restrictive laws (those only permitting the use of marijuana with low tetrahydrocannabinol concentrations) were associated with changes in opioid overdose mortality rates.

These data, therefore, do not support the interpretation that access to cannabis reduces opioid overdose. Indeed, the authors note that neither study provides evidence of a causal relationship between marijuana access and opioid overdose deaths. Rather, they suggest that the associations are likely due to factors the researchers did not measure, and they caution against drawing conclusions on an individual level from ecological (population-level) data. Research is still needed on the potential medical benefits of cannabis or cannabinoids.

What are the effects of secondhand exposure to marijuana smoke?

People often ask about the possible psychoactive effect of exposure to secondhand marijuana smoke and whether a person who has inhaled secondhand marijuana smoke could fail a drug test. Researchers measured the amount of THC in the blood of people who do not smoke marijuana and had spent 3 hours in a well-ventilated space with people casually smoking marijuana; THC was present in the blood of the nonsmoking participants, but the amount was well below the level needed to fail a drug test. Another study that varied the levels of ventilation and the potency of the marijuana found that some nonsmoking participants exposed for an hour to high-THC marijuana (11.3% THC

concentration) in an unventilated room showed positive urine assays in the hours directly following exposure[80]; a follow-up study showed that nonsmoking people in a confined space with people smoking high-THC marijuana reported mild subjective effects of the drug—a "contact high"—and displayed mild impairments on performance in motor tasks.[81]

The known health risks of secondhand exposure to cigarette smoke—to the heart or lungs, for instance—raise questions about whether secondhand exposure to marijuana smoke poses similar health risks. At this point, very little research on this question has been conducted. A 2016 study in rats found that secondhand exposure to marijuana smoke affected a measure of blood vessel function as much as secondhand tobacco smoke, and the effects lasted longer.[82] One minute of exposure to secondhand marijuana smoke impaired flow-mediated dilation (the extent to which arteries enlarge in response to increased blood flow) of the femoral artery that lasted for at least 90 minutes; impairment from 1 minute of secondhand tobacco exposure was recovered within 30 minutes. The effects of marijuana smoke were independent of THC concentration; i.e., when THC was removed, the impairment was still present. This research has not yet been conducted with human subjects, but the toxins and tar levels known to be present in marijuana smoke (see "What are marijuana's effects on lung health?") raise concerns about exposure among vulnerable populations, such as children and people with asthma.

Can marijuana use during and after pregnancy harm the baby?

More research is needed on how marijuana use during pregnancy could impact the health and development of infants, given changing policies about access to marijuana, as well as significant increases over the last decade in the number of pregnant women seeking substance use disorder treatment for marijuana use.[83] One study found that about 20% of pregnant women 24-years-old and younger screened positive for marijuana. However, this study also found that women were about twice as likely to screen positive for marijuana use via a drug test than they state in self-reported measures. This suggests that self-reported rates of marijuana use in pregnant females may not be an accurate measure of marijuana use.[84] Additionally, in one study of dispensaries, nonmedical personnel at marijuana dispensaries were recommending marijuana to pregnant women for nausea, but medical experts warn against it.

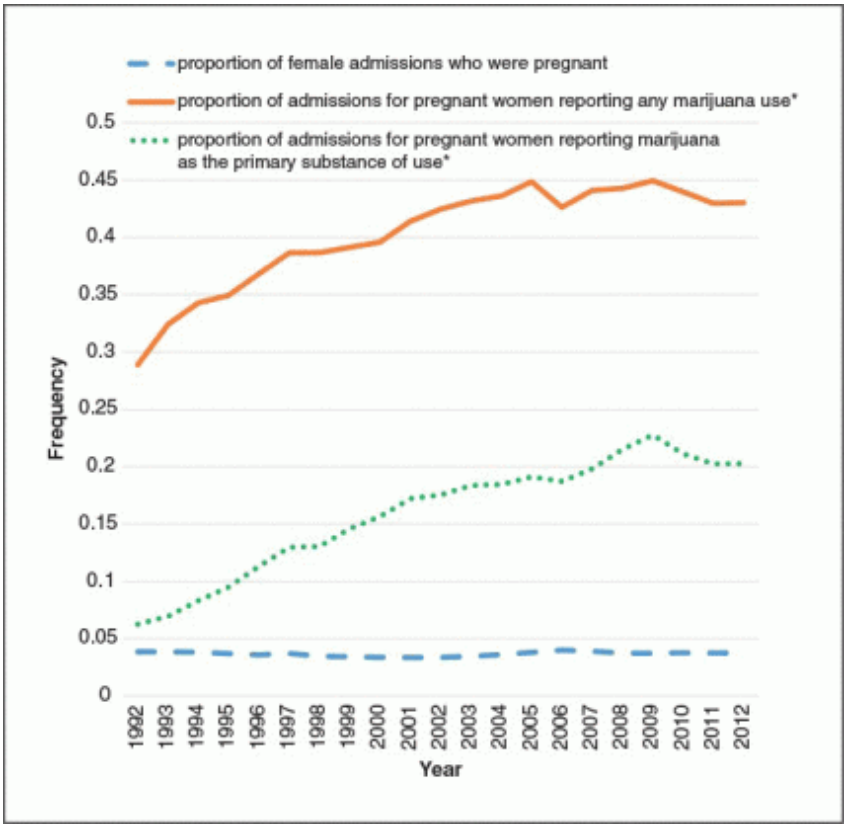


Photo by ©Thinkstock.com/Creatas Images

There is no human research connecting marijuana use to the chance of miscarriage,[85,86] although

animal studies indicate that the risk for miscarriage increases if marijuana is used early in pregnancy.[87]

Some associations have been found between marijuana use during pregnancy and future developmental and hyperactivity disorders in children.[88–91] Evidence is mixed as to whether marijuana use by pregnant women is associated with low birth weight[92–96] or premature birth,[95] although long-term use may elevate these risks.[94] Research has shown that pregnant women who use marijuana have a 2.3 times greater risk of stillbirth.[97] Given the potential of marijuana to negatively impact the developing brain, the American College of Obstetricians and Gynecologists recommends that obstetrician-gynecologists counsel women against using marijuana while trying to get pregnant, during pregnancy, and while they are breastfeeding.[98] It is important to note that despite the growing popularity of using marijuana in vaping devices, the Food and Drug Administration recommends that pregnant women should not use any vaping product, regardless of the substance.



Source: Martin et al., 2015

Recent Trends in Treatment Admissions for Marijuana Use During Pregnancy

Some women report using marijuana to treat severe nausea associated with their pregnancy;[99,100] however, there is no research confirming that this is a safe practice, and it is generally not recommended. Women considering using medical marijuana while pregnant should not do so without checking with their health care providers. Animal studies have shown that moderate concentrations of THC, when administered to mothers while pregnant or nursing, could have long-lasting effects on the child, including increasing stress responsivity and abnormal patterns of social interactions.[101] Animal studies also show learning deficits in prenatally exposed individuals.[33,102]

Human research has shown that some babies born to women who used marijuana during their pregnancies display altered responses to visual stimuli, increased trembling, and a high-pitched cry,[103] which could indicate problems with neurological development.[104] In school, marijuana-exposed children are more likely to show gaps in problem-solving skills, memory,[105] and the ability to remain attentive.[106] More research is needed, however, to disentangle marijuana-specific effects from those of other environmental factors that could be associated with a mother's marijuana use, such as an impoverished home environment or the mother's use of other drugs.[96] Prenatal marijuana exposure is also associated with an increased likelihood of a person using marijuana as a young adult, even when other factors that influence drug use are considered.[107] More information on marijuana use during pregnancy can be found in the NIDA's *Substance Use in Women Research Report*.

Very little is known about marijuana use and breastfeeding. One study suggests that moderate amounts of THC find their way into breast milk when a nursing mother uses marijuana.[108] Some evidence shows that exposure to THC through breast milk in the first month of life could result in decreased motor development at 1 year of age.[109] There have been no studies to determine if exposure to THC during nursing is linked to effects later in the child's life. With regular use, THC can accumulate in human breast milk to high concentrations.[92] Because a baby's brain is still forming, THC consumed in breast milk could affect brain development. Given all these uncertainties, nursing mothers are discouraged from using marijuana.[98,110] New mothers using medical marijuana should be vigilant about coordinating care between the doctor recommending their marijuana use and the pediatrician caring for their baby.

Available Treatments for Marijuana Use Disorders

Marijuana use disorders appear to be very similar to other substance use disorders, although the long-term clinical outcomes may be less severe. On average, adults seeking treatment for marijuana use disorders have used marijuana nearly every day for more than 10 years and have attempted to quit more than six times.[111] People with marijuana use disorders, especially adolescents, often also suffer from other psychiatric disorders (*comorbidity*).[112] They may also use or be addicted to other substances, such as cocaine or alcohol. Available studies indicate that effectively treating the mental health disorder with standard treatments involving medications and behavioral therapies may help reduce marijuana use, particularly among those involved with heavy use and those with more chronic mental disorders. The following behavioral treatments have shown promise:

- **Cognitive-behavioral therapy**: A form of psychotherapy that teaches people strategies to identify and correct problematic behaviors in order to enhance self-control, stop drug use, and address a range of other problems that often co-occur with them.
- **Contingency management**: A therapeutic management approach based on frequent monitoring of the target behavior and the provision (or removal) of tangible, positive rewards when the target behavior occurs (or does not).
- **Motivational enhancement therapy**: A systematic form of intervention designed to produce rapid, internally motivated change; the therapy does not attempt to treat the person, but rather mobilize his or her own internal resources for change and engagement in treatment.

Currently, the FDA has not approved any medications for the treatment of marijuana use disorder, but research is active in this area. Because sleep problems feature prominently in marijuana withdrawal, some studies are examining the effectiveness of medications that aid in sleep. Medications that have shown promise in early studies or small clinical trials include the sleep aid zolpidem (Ambien®), an anti-anxiety/anti-stress medication called buspirone (BuSpar®), and an anti-epileptic drug called gabapentin (Horizant®, Neurontin®) that may improve sleep and, possibly, executive function. Other agents being studied include the nutritional supplement N-acetylcysteine and chemicals called FAAH inhibitors, which may reduce withdrawal by inhibiting the breakdown of the body's own cannabinoids. Future directions include the study of substances called *allosteric modulators* that interact with cannabinoid receptors to inhibit THC's rewarding effects.

Where can I get further information about marijuana?

To learn more about marijuana and other drugs, visit the NIDA website at **drugabuse.gov** or contact the DrugPubs Research Dissemination Center at 877-NIDA-NIH (877-643-2644; TTY/TDD: 240-645-0228).

The NIDA website includes:

- information about drugs and related health consequences
- NIDA publications, news, and events
- resources for health care professionals
- funding information (including program announcements and deadlines)
- international activities
- links to related websites (access to websites of many other organizations in the field)
- information in Spanish (en español)

NIDA websites and webpages

- drugabuse.gov
- teens.drugabuse.gov
- drugabuse.gov/drugs-abuse/marijuana
- drugabuse.gov/related-topics/hivaids
- researchstudies.drugabuse.gov
- irp.drugabuse.gov

For physician information

- NIDAMED: drugabuse.gov/nidamed

Other websites

Information about marijuana is also available through the following websites:

- Substance Abuse and Mental Health Services Administration (SAMHSA)

- Drug Enforcement Administration (DEA)
- Monitoring the Future
- Partnership for Drug-Free Kids

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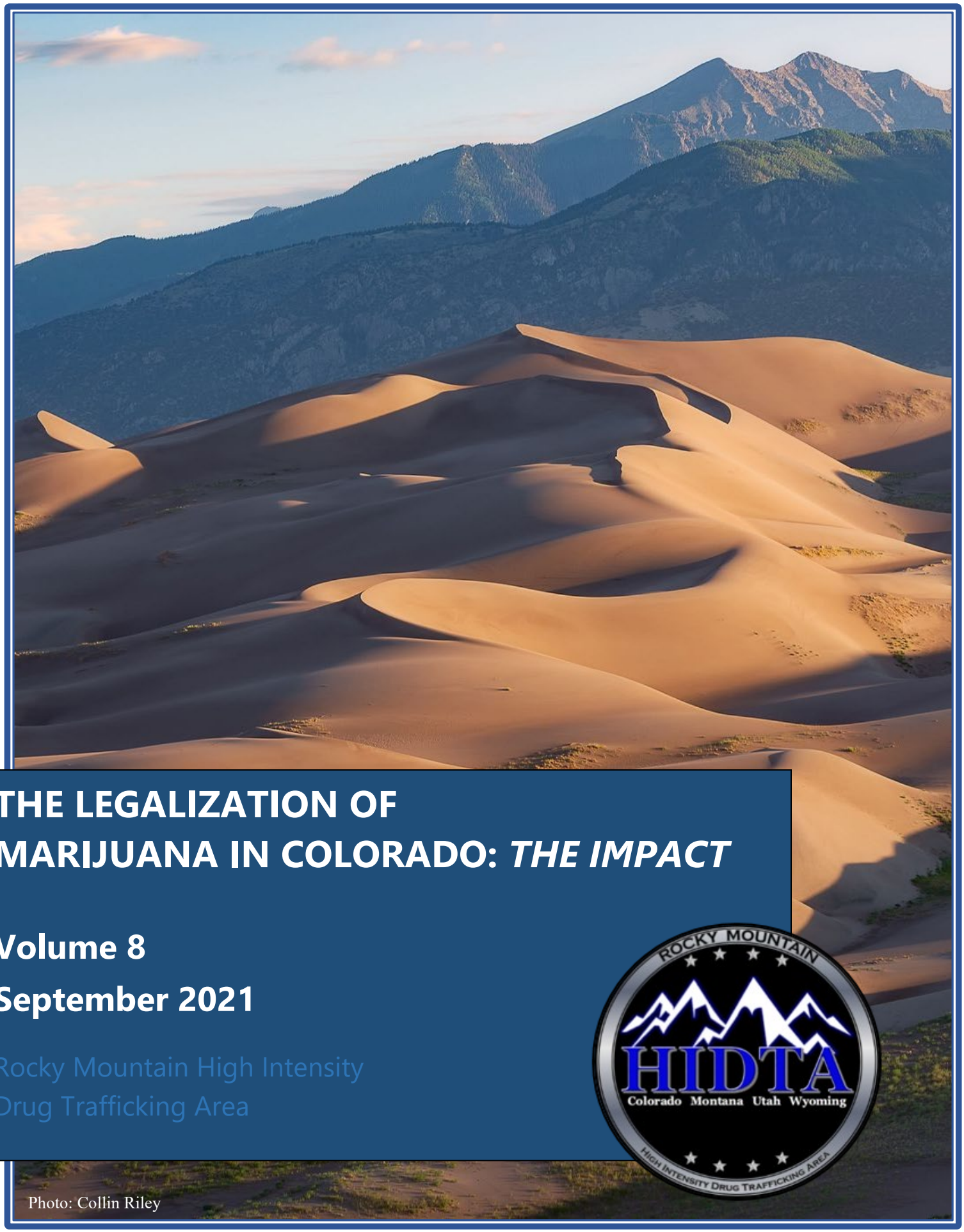
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THE LEGALIZATION OF MARIJUANA IN COLORADO: *THE IMPACT*

Volume 8

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Rocky Mountain High Intensity Drug Trafficking Area

Photo: Collin Riley

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PREPARED BY THE ROCKY MOUNTAIN HIDTA
INVESTIGATIVE SUPPORT CENTER
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Executive Summary

The Rocky Mountain High Intensity Drug Trafficking Area (RMHIDTA) program has published annual reports every year since 2013 tracking the impact of legalizing recreational marijuana in Colorado. The purpose is to provide data and information so that policy makers and citizens can make informed decisions on the issue of marijuana legalization.

Section I: Traffic Fatalities & Impaired Driving

- Since recreational marijuana was legalized in 2013, traffic deaths where drivers tested positive for marijuana **increased 138%** while all Colorado traffic deaths **increased 29%.**
- Since recreational marijuana was legalized, traffic deaths involving drivers who tested positive for marijuana **more than doubled** from 55 in 2013 to 131 people killed in 2020.
- Since recreational marijuana was legalized, the percentage of all Colorado traffic deaths involving drivers who tested positive for marijuana **increased from 11%** in 2013 **to 20%** in 2020.

Section II: Marijuana Use

Since recreational marijuana was legalized in 2013:

- Past month marijuana use for ages 12 and older **increased 26%** and is **61%** higher than the national average, currently ranked **3rd** in the nation.
- Past month adult marijuana use (ages 18 and older) **increased 20%** and is **62% higher** than the national average, currently ranked **3rd** in the nation.
- Past month college age marijuana (ages 18-25) use **increased 10%** and is **53% higher** than the national average, currently ranked **3rd** in the nation.
- Past month youth marijuana (ages 12-17) use **decreased 22%** and is **39% higher** than the national average, currently ranked **7th** in the nation.

Section III: Public Health

- Marijuana *only* exposures **increased 185%** from 2013 when recreational marijuana was legalized compared to 2020.
- Treatment for marijuana use for all ages **decreased 34%** from 2013 to 2020.
- The percent of suicide incidents in which toxicology results were positive for marijuana has **increased** from **14%** in 2013 to **29%** in 2020.

Section IV: Black Market

- RMHIDTA Colorado Drug Task Forces (10) conducted **294 investigations** of black-market marijuana in Colorado resulting in:
    - **168** felony arrests
    - **5.54** tons of marijuana seized
    - **86,502** marijuana plants seized
    - **21** different states the marijuana was destined
- Seizures of marijuana reported to the El Paso Intelligence Center (EPIC) in Colorado **increased 48%** from an average of 174 parcels (2009-2012) when marijuana was commercialized to an average of 257 parcels (2013-2020) during the time recreational marijuana become legalized.

Section V: Societal Impact

- Marijuana tax revenue represent approximately **0.98%** of Colorado's FY 2020 budget.
- **66%** of local jurisdictions in Colorado have banned medical and recreational marijuana businesses.

Introduction

Purpose

The purpose of this annual report is to document the impact of the legalization of marijuana for medical and recreational use in Colorado. Colorado serves as an experimental lab for the nation to determine the impact of legalizing marijuana. This is an important opportunity to gather and examine meaningful data and identify trends. Citizens and policymakers nationwide may want to delay any decisions on this important issue until there is sufficient and accurate data to make informed decisions. Readers are encouraged to review previous volumes of this report for a comprehensive understanding of the topic. These reports were prepared to identify data and trends related to the legalization of marijuana so that informed decisions can be made regarding this issue.

Background

It is important to note that, for purposes of the debate on legalizing marijuana in Colorado, there are three distinct timeframes to consider: the early medical marijuana era (2000-2008), the medical marijuana commercialization era (2009–current) and the recreational marijuana era (2013–current).

- **2000 – 2008, Early Medical Marijuana Era:** In November 2000, Colorado voters passed Amendment 20 which permitted a qualifying patient, and/or caregiver of a patient, to possess up to 2 ounces of marijuana and grow 6 marijuana plants for medical purposes. During that time there were between 1,000 and 4,800 medical marijuana cardholders and no known dispensaries operating in the state.
- **2009 – Current, Medical Marijuana Commercialization Era:** Beginning in 2009 due to a number of events, marijuana became de facto legalized through the commercialization of the medical marijuana industry. By the end of 2012, there were over 100,000 medical marijuana cardholders and 500 licensed dispensaries operating in Colorado. There were also licensed cultivation operations and edible manufacturers.
- **2013 – Current, Recreational Marijuana Legalization Era:** In November 2012, Colorado voters passed Constitutional Amendment 64 which legalized marijuana for recreational purposes for anyone over the age of 21. The amendment also allowed for licensed marijuana retail stores, cultivation operations and edible manufacturers. Retail marijuana businesses became operational January 1, 2014.

NOTE:

Data, if available, will compare post-2009 when medical marijuana became commercialized and after 2013 when recreational marijuana became legalized.

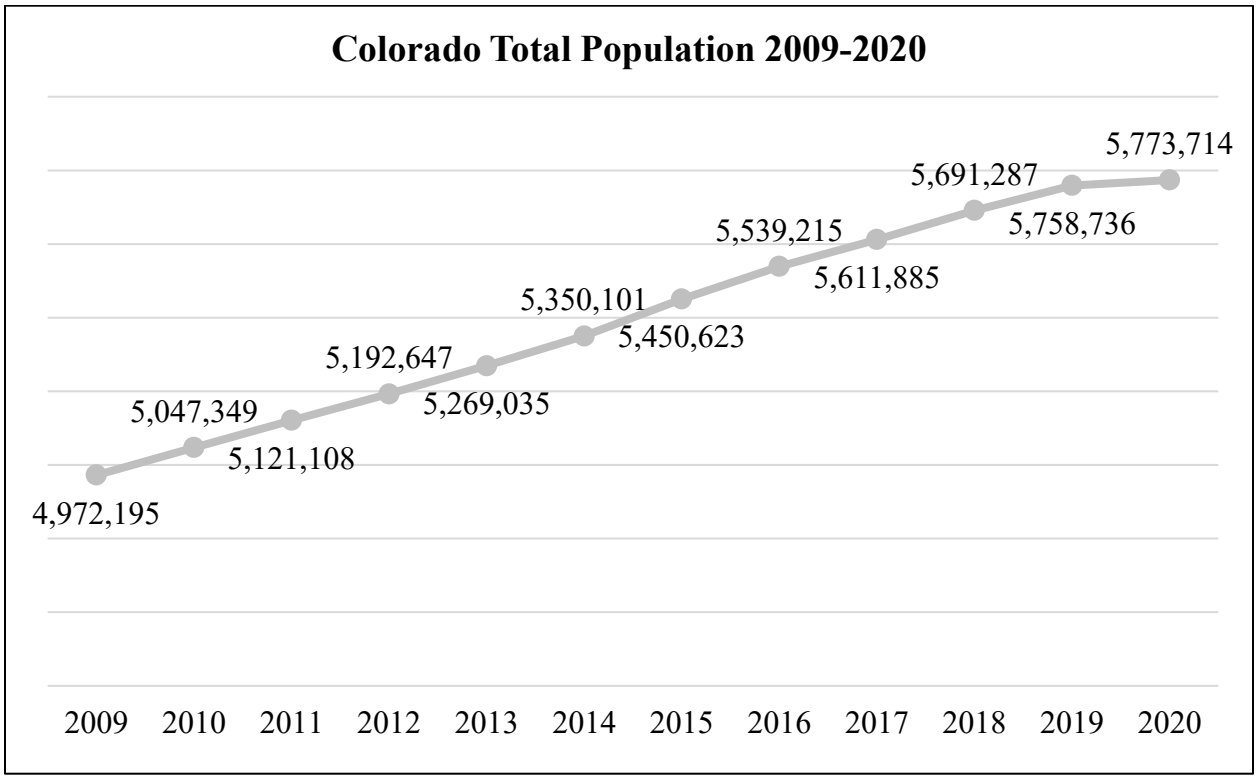
Multi-year comparisons are generally better indicators of trends. One-year fluctuations do not necessarily reflect a new trend.

Percentage comparisons may be rounded to the nearest whole number.

Percent changes found within graphs were calculated and added by RMHIDTA.

This report will cite datasets with terms such as "marijuana-related" or "tested positive for marijuana." That does not necessarily prove that marijuana was the cause of the incident.

Throughout this report, rate per 100,000 is included to proportionately analyze various statistics. Below is Colorado's total population from 2009 to 2020 for reference:



Section I: Traffic Fatalities & Impaired Driving

Some Findings

- Since recreational marijuana was legalized in 2013, traffic deaths where drivers tested positive for marijuana **increased 138%** while all Colorado traffic deaths **increased 29%.**
- Since recreational marijuana was legalized, traffic deaths involving drivers who tested positive for marijuana **more than doubled** from 55 in 2013 to 131 people killed in 2020.
- Since recreational marijuana was legalized, the percentage of all Colorado traffic deaths involving drivers who tested positive for marijuana **increased from 11%** in 2013 **to 20%** in 2020.

Definitions by Rocky Mountain HIDTA

Driving Under the Influence of Drugs (DUI/D): This term includes an individual under the influence of alcohol, marijuana, or other drugs along with any This is an important measurement since the driver's ability to operate a vehicle was sufficiently impaired that it brought his or her driving to the attention of law enforcement. The erratic driving and the subsequent evidence that the subject was under the influence of marijuana helps confirm the causation factor.

Marijuana-Related: Also called "marijuana mentions," is any time marijuana shows up in the toxicology report. It could be marijuana only or marijuana with other drugs and/or alcohol.

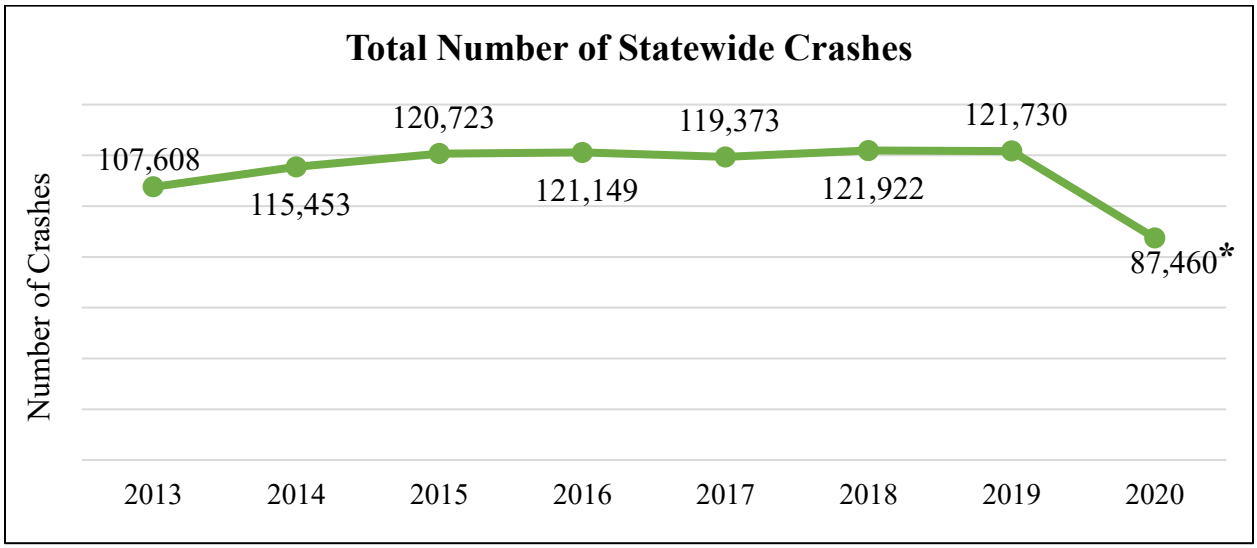
Marijuana Only: When toxicology results show marijuana and no other drugs or alcohol.

Fatalities: Any death resulting from a traffic crash involving a motor vehicle.

Drivers: An occupant who is in physical control of a transport vehicle. For an out-of-control vehicle, an occupant who was in control until control was lost.

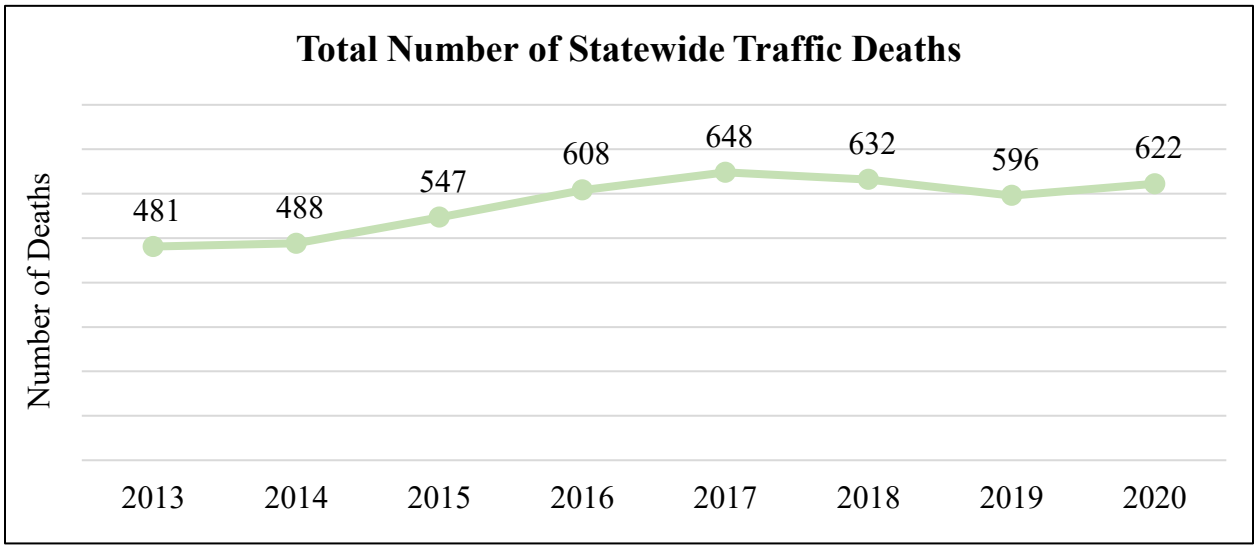
Operators: Anyone in control of their own movements such as a driver, pedestrian, or bicyclist.

Traffic Fatalities



SOURCE: Colorado Department of Transportation (CDOT)

***NOTE:** Colorado Governor Polis reported a 60% reduction in vehicle traffic in March 2020 based on automatic traffic reporters. Reference: Finley, B. (2020, April 5). *Colorado sees "significant declines" in air pollution as coronavirus ramps down driving, industrial activity*. The Denver Post.



SOURCE: CDOT 2013-2020

- In 2020, there were a total of 622 traffic deaths. Of which:
  - 402 were drivers
  - 112 were passengers
  - 93 were pedestrians
  - 15 were bicyclists

SOURCE: National Highway Traffic Safety Administration (NHTSA), Fatality Analysis Reporting System (FARS), 2009-2011 and CDOT 2012-2020

Traffic Deaths Related to Marijuana When a DRIVER Tested Positive for Marijuana			
Crash Year	**Total Statewide Fatalities**	**Fatalities with Drivers Testing Positive for Marijuana**	**Percentage Total Fatalities**
2013	481	55	11.4%
2014	488	75	15.4%
2015	547	98	17.9%
2016	608	125	20.6%
2017	648	138	21.3%
2018	632	115	18.2%
2019	596	127	21.3%
2020	622	131	20.1%

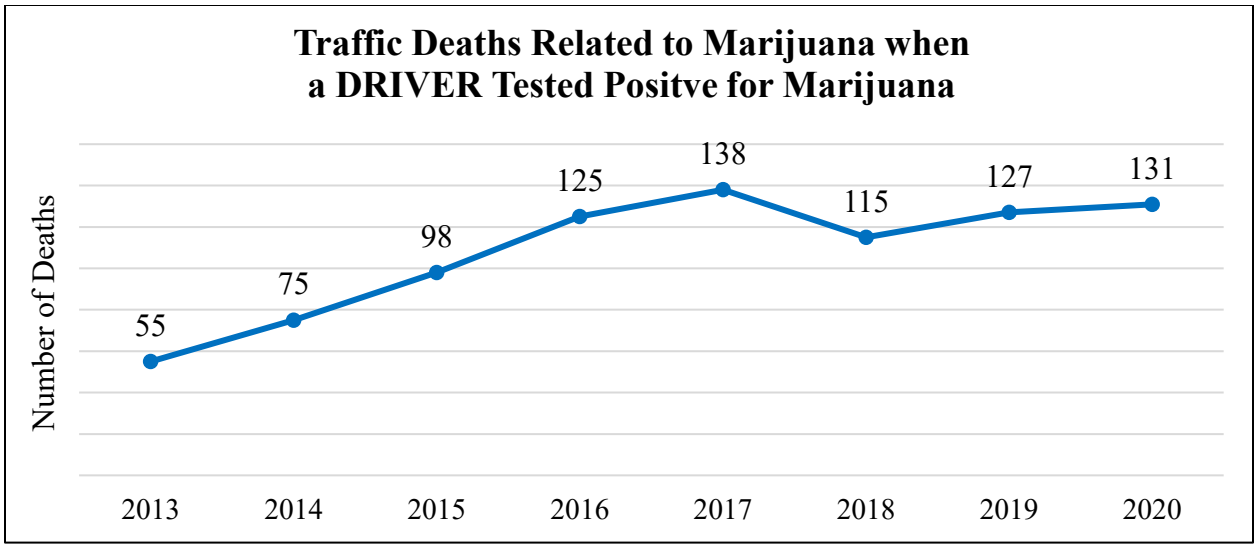
NOTE: Due to changes in reporting, data from before 2013 was not included.

- In 2020, 131 marijuana-related traffic deaths:
  - 104 were drivers
  - 21 were passengers
  - 4 were pedestrians
  - 2 was a bicyclist

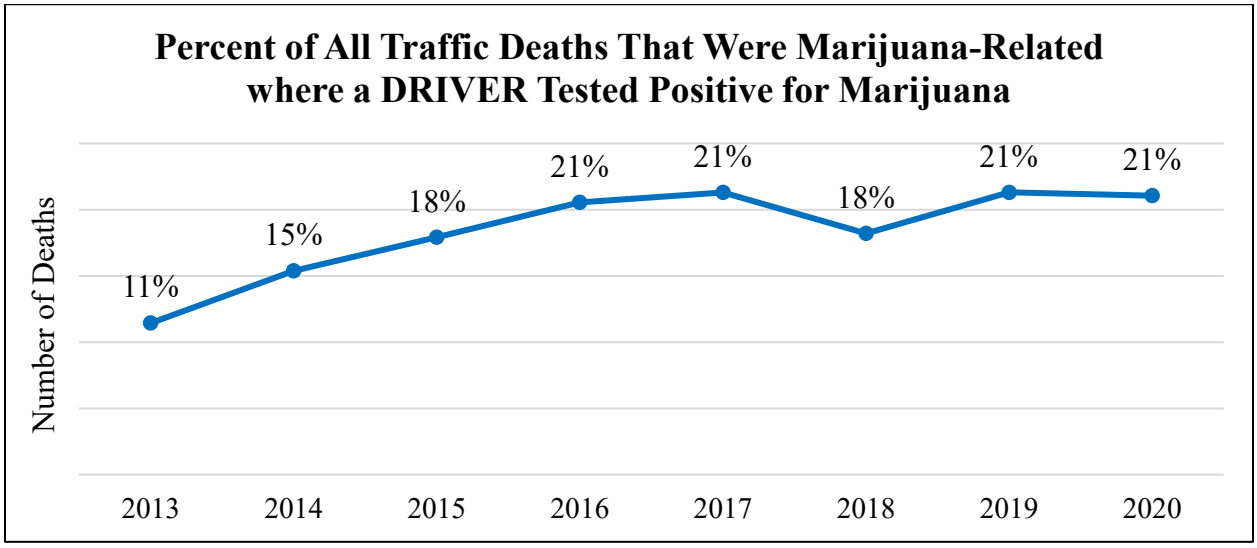
SOURCE: CDOT 2013-2020

NOTE: In 2020, 49% of drivers' blood was tested after being involved in a fatal crash.

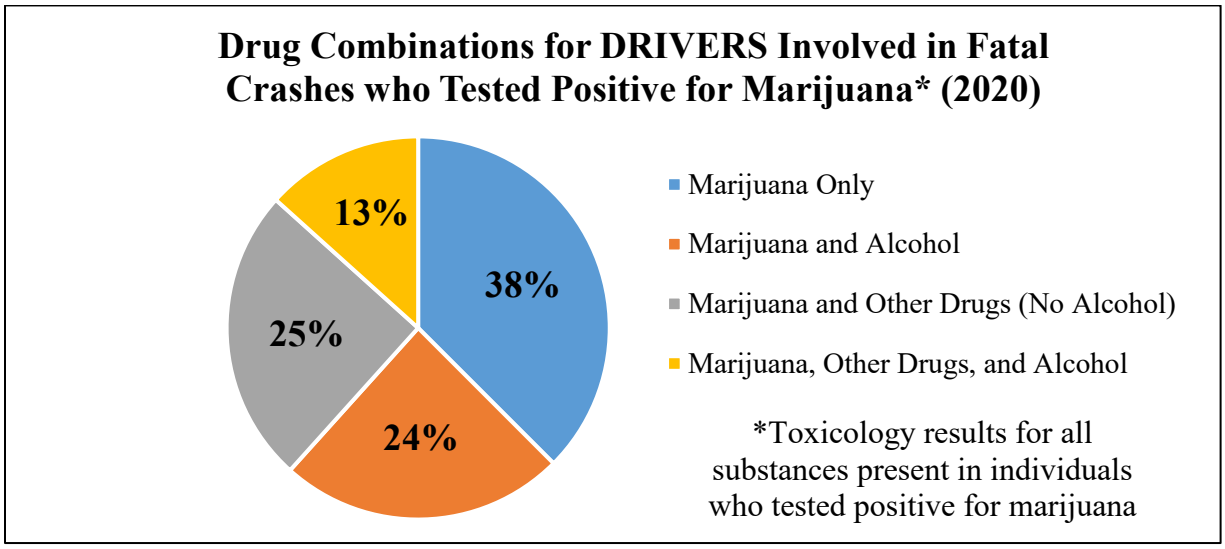
- In 2020, of the 120 drivers in fatal wrecks who tested positive for marijuana use, 117 were found to have Delta 9 tetrahydrocannabinol or THC, the psychoactive ingredient in marijuana, in their blood. This would indicate use within hours according to state data. Of those, 69% were over 5 nanograms per milliliter, the state permissible inference level for driving.
  - Similar to findings from the August 2017 article by David Migoya, "Exclusive: Traffic fatalities linked to marijuana are up sharply in Colorado. Is legalization to blame?" *The Denver Post*.



SOURCE: CDOT 2013-2020



SOURCE: CDOT 2013-2020



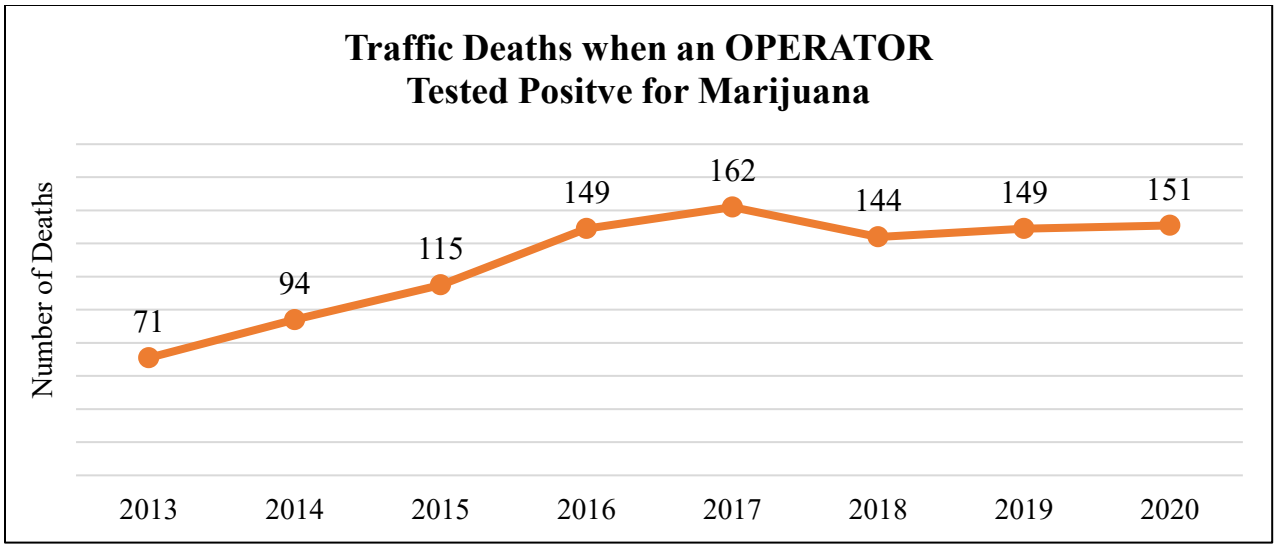
SOURCE: CDOT 2013-2020

Traffic Deaths Related to Marijuana Where an OPERATOR Tested Positive for Marijuana			
Crash Year	**Total Statewide Fatalities**	**Fatalities with Operators Testing Positive for Marijuana**	**Percentage Total Fatalities**
2013	481	71	14.8%
2014	488	94	19.3%
2015	547	115	21.0%
2016	608	149	24.5%
2017	648	162	25.0%
2018	632	144	23.0%
2019	596	149	25.0%
2020	622	151	24.3%

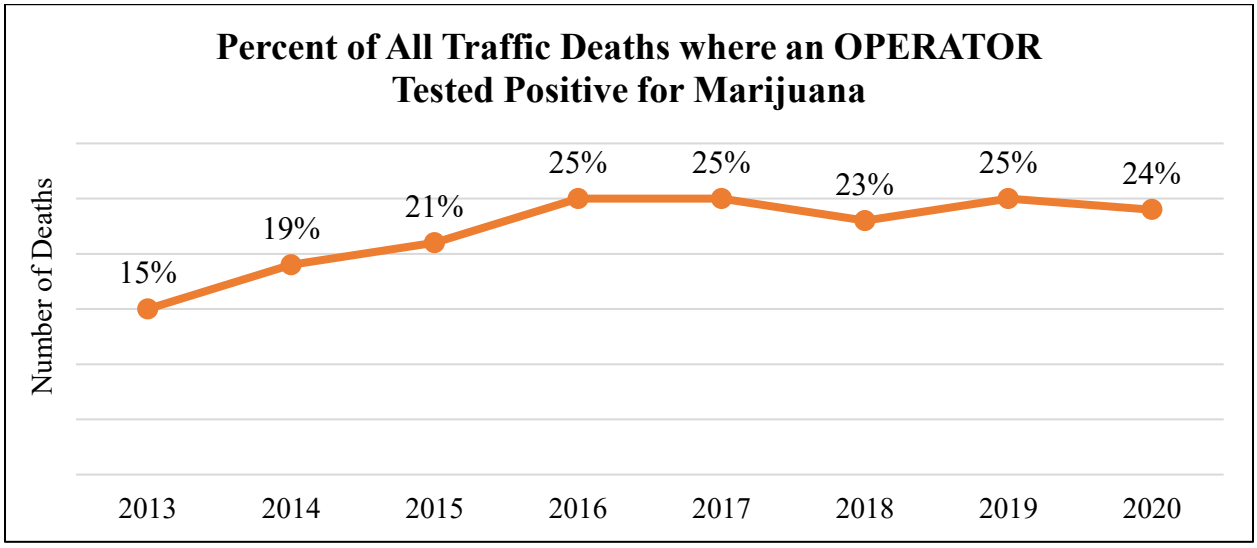
- Of the 151 marijuana-related traffic deaths:
  - 104 were drivers
  - 22 were pedestrians
  - 21 were passengers
  - 4 were bicyclists

SOURCE: CDOT 2013-2020

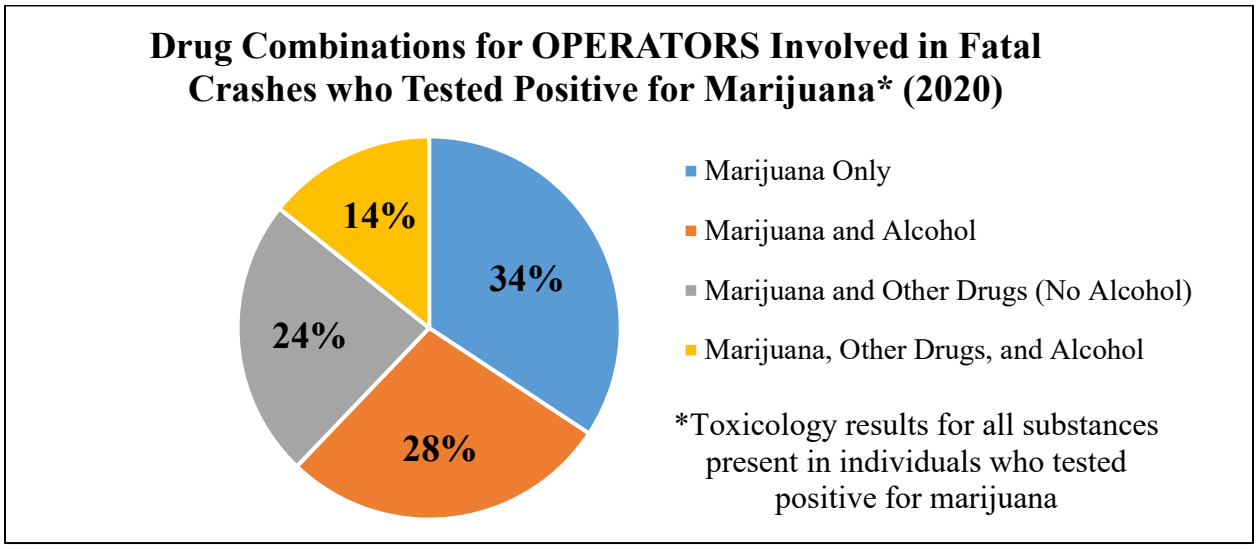
NOTE: In 2020, 51% of operators' blood was tested after being involved in a fatal crash.



SOURCE: CDOT 2013-2020



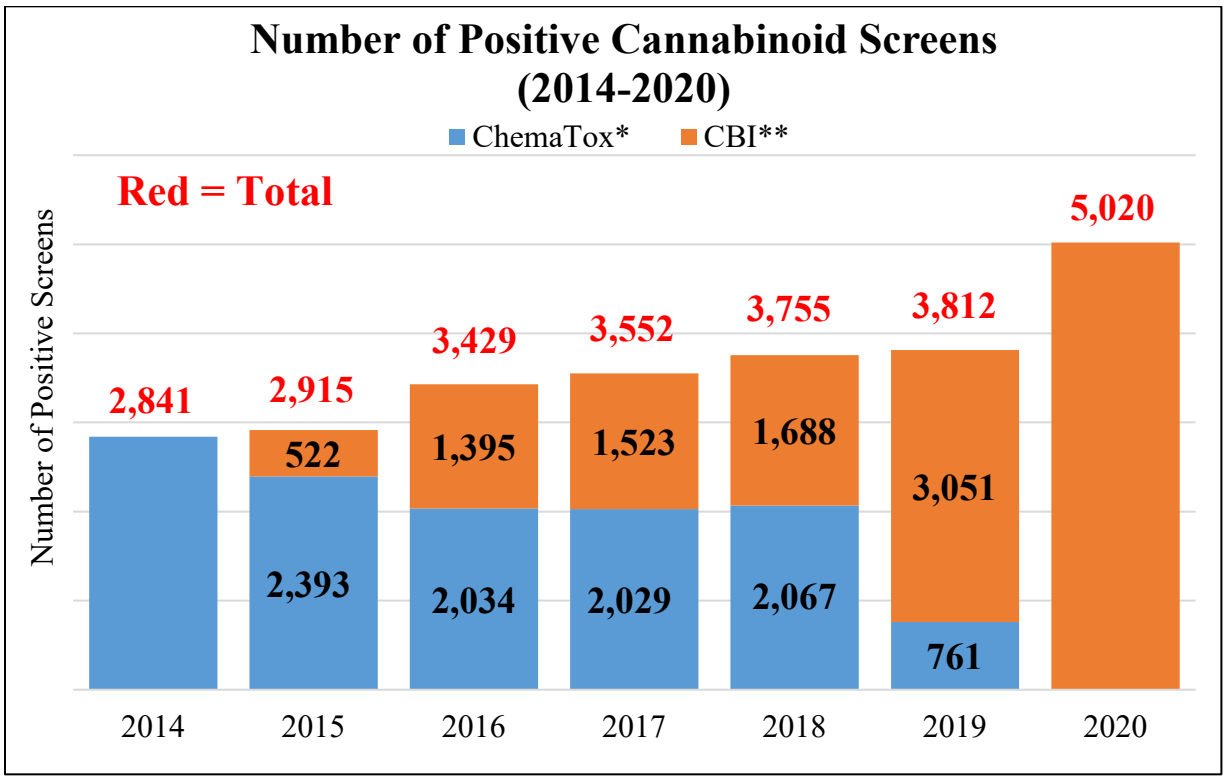
SOURCE: CDOT 2013-2020



SOURCE: CDOT 2013-2020

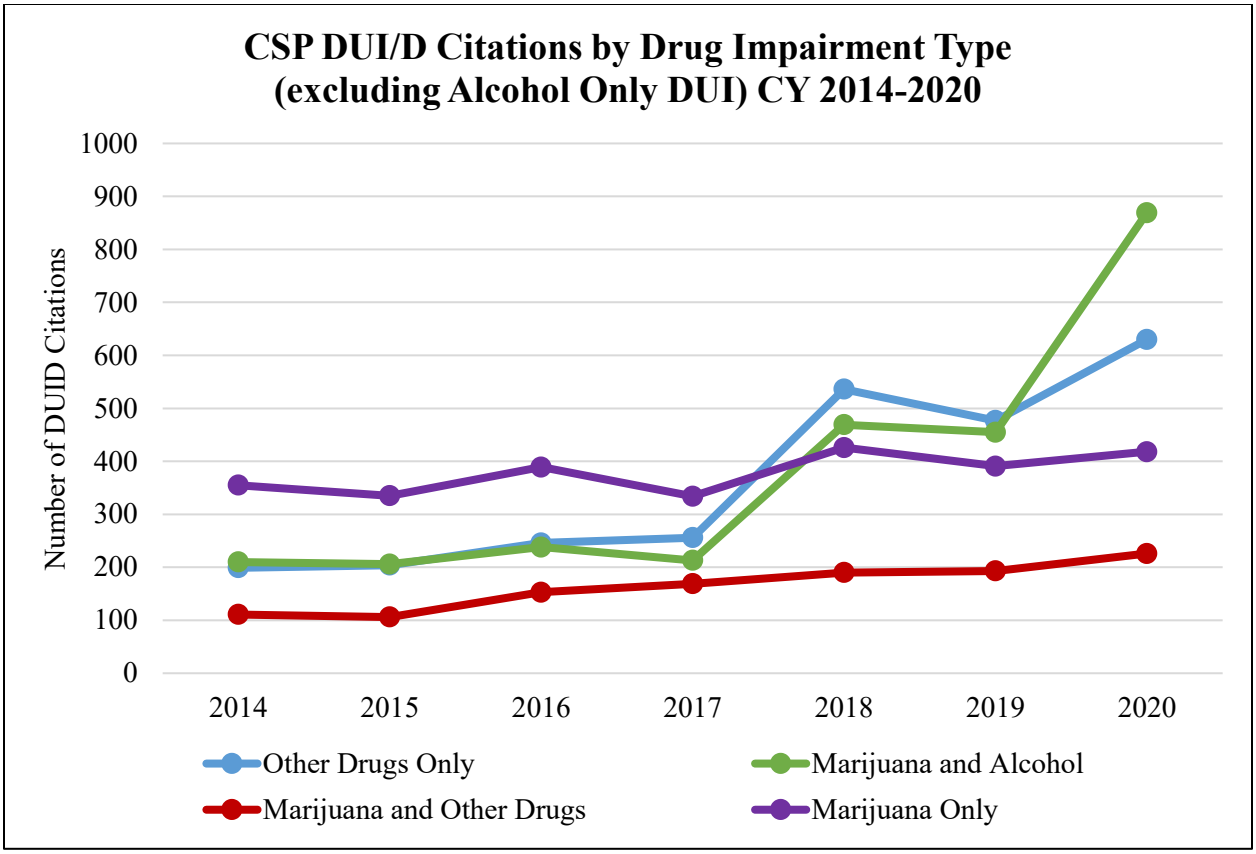
Impaired Driving

When a driver is arrested for impaired driving related to alcohol (usually 0.08 or higher blood alcohol content), typically tests for other drugs (including marijuana) are not requested since there is no additional punishment if the test comes back positive.



SOURCE: Colorado Bureau of Investigation and ChemaTox

***NOTE:** ChemaTox discontinued testing July 2019.
****NOTE:** The Colorado Bureau of Investigation began toxicology operations July 1, 2015, and became the sole agency in the state to conduct toxicology reports July 1, 2019. The vast majority of the screens are DUID submissions from Colorado law enforcement.

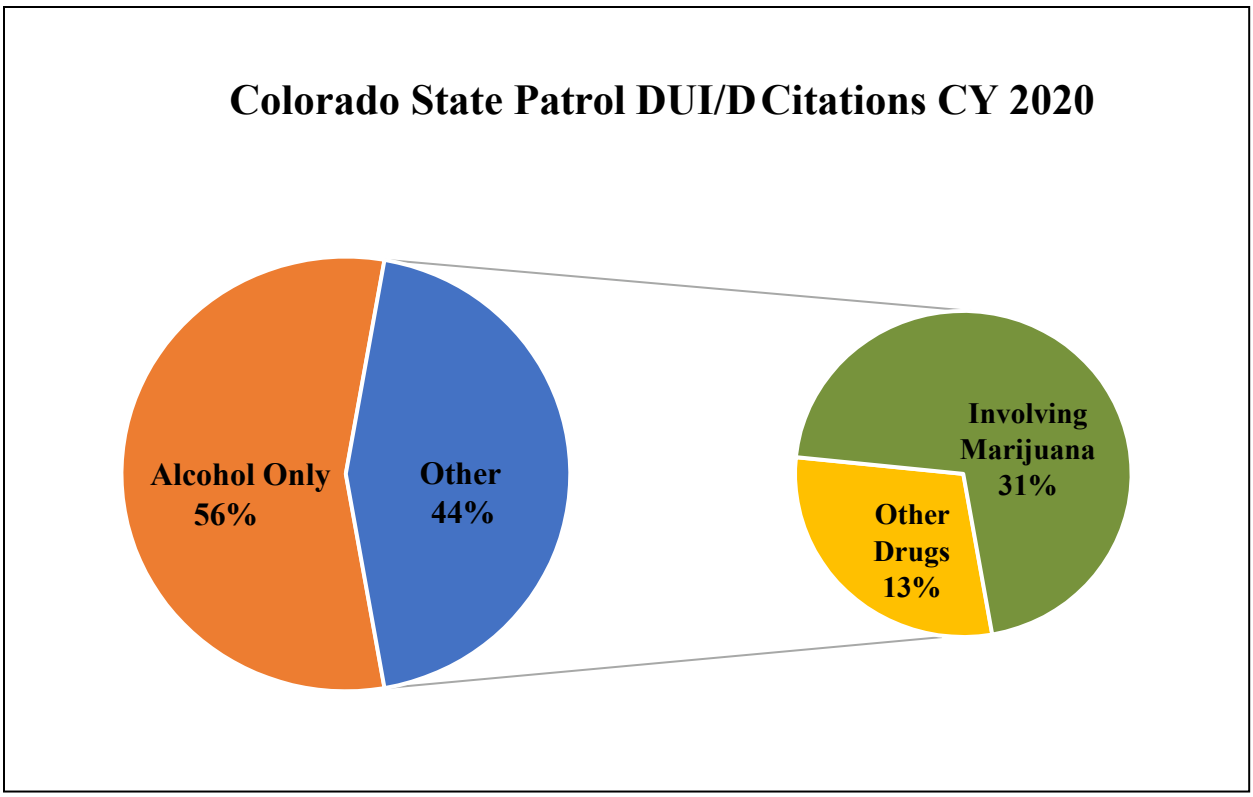


SOURCE: CSP RDW; only displaying data available as of 07/23/2021

DUI/D Citations by Drug Impairment Type							
	2014	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Other Drugs	199	204	246	256	536	477	630
Marijuana and Alcohol	210	206	238	213	469	455	869
Marijuana and Other Controlled Substances	111	106	153	169	190	193	226
Marijuana Only	355	335	389	334	426	391	418
Alcohol Only	4,620	3,948	3,528	3,817	3,541	3,727	2,674
Total Marijuana Involved Citations	**676**	**647**	**780**	**716**	**1,085**	**1,039**	**1,513**
Total DUI/D Citations	**5,495**	**4,799**	**4,554**	**4,789**	**5,162**	**5,245**	**4,817**

SOURCE: CSP RDW; only displaying data available as of 07/23/2021

NOTE: "Citations in the Colorado State Patrol (CSP) Reporting Data Warehouse (RDW) are defined as one per involved person when the involved person has at least one charge as denoted in the RDW (excluding oral and written warnings), that occurred during a traffic stop unique on date, time, location road, mile point round, and driver's license number. Impaired (DUI/D) citations were identified in the CSP RDW by the following common codes: 753, 754, 755, 765, 785, 800, 801, 802, 805, 806, 807, 808, 809, 810, 812, 813, 814, 815, 820, 821, or MPC." -Colorado State Patrol



SOURCE: CSP RDW; only displaying data available as of 07/23/20210

Impaired Driving Information

THC Positive Drivers Involved in Fatal Crashes in Washington

In Washington, the AAA Foundation for Traffic Safety studied fatal crashes from 2008 to 2017 to determine the impact of the legalization of recreational marijuana. The percentage of drivers involved in a fatal crash was 88% from 2008 to 2017 compared to only 29% of drivers involved in non-fatal crashes. Of the fatal crashes, an average of 8.8% of drivers were THC-positive from 2008 to 2012. Then after recreational marijuana was legalized, the average increased to 18% of drivers testing positive for THC from 2013 to 2017. The highest level was reached in 2017 with 21% of drivers testing positive for THC that were involved in a fatal crash.

Source: Tefft, B.C. & Arnold, L.S. (2020). *Cannabis Use Among Drivers in Fatal Crashes in Washington State Before and After Legalization* (Research Brief). Washington, D.C.: AAA Foundation for Traffic Safety.

Analysis of the Impact of Recreational Marijuana Legalization on Traffic Fatalities in Colorado and Washington

In 2019, researchers examined the impact of recreational marijuana legalization on traffic fatalities in Washington and Colorado. Fatality Analysis Reporting System (FARS) from 2000 to 2016 was analyzed to compare fatal crashes where at least the driver tested positive for marijuana with the alcohol related cases. The initial finding were that marijuana-related deaths increased in Washington and Colorado compared to the rest of the country after marijuana was legalized in these two states in 2012. The rate of increase was significantly faster than the other states as well. In their final analysis, the authors were unable to determine whether the legalization of recreational marijuana alone led to the large increase in traffic fatalities in the two states.

Their conclusion states that in Colorado, "the amount of marijuana sold in recreational stores [grew] dramatically, […] from 36,031 pounds in 2014 to 102,871 pounds in 2016. However, it is difficult to discern how much of this growth in legal recreational weed came at the expense of sales in black market or medical marijuana. Indeed, recreational marijuana can be viewed as a close substitute to black market or medical marijuana, with differences in price, quality, and ease of access. The relatively small effects we estimate are consistent with crowding-out, and could explain why we do not observe spillover effects on alcohol-related traffic accidents as other studies have found (Anderson, Hansen, and Rees 2013). Furthermore, Colorado has recently allowed consumption of marijuana in public spaces. This might increase the potential for negative externalities of recreational marijuana relative to medical marijuana. Despite that concern, we find limited overall evidence the fatalities are significantly increasing in Colorado and Washington following the legalization of recreational marijuana" (Hansen et al, 2019).

Source: Hansen, B., Miller, K., and Weber, C. (2019). *Early evidence on recreational marijuana legalization and traffic fatalities.* Economic Inquiry, 58(2), 547-568.

Relationship between Recreational Marijuana and Alcohol-Related Behaviors in Colorado

Some theorized that legalizing recreational marijuana would decrease the levels of alcohol consumption, while others believed that there was a positive relationship between the two. These conflicting hypotheses have generated further interest on how the legalization of recreational

marijuana impacted alcohol-related behavior in states like Colorado. Analysis of the tax revenue from alcohol sales in Colorado determined an increase in liquor tax revenue related to alcohol and alcohol-related motor vehicle crash fatalities after the legalization of recreational marijuana in Colorado. Alcohol-related crash fatalities increased by nearly two and a half fatalities per month within the state. The tax revenue increase of almost $200,000 per month cannot definitively be linked to any changes of alcohol-related societal problems.

Source: Chamlin, M. (2021). *An examination of the unintended consequences of the legalization of recreational marijuana on alcohol-related behaviors.* Journal of Crime and Justice, 1-11

DUI Numbers Increase During Pandemic

During the height of the early stages of the pandemic from January to April 2020, DUI related deaths doubled compared to 2019 according to the Colorado State Patrol. In addition, alcohol and marijuana-related crashes increased by 32 percent during the same timeframe. The cause of this increase was unknown especially during the stay-at-home order that closed many bars. Some hypothesized that the drivers under the influence were able to drive at higher speeds with less cars on the road, leading to the increase in crashes.

Source: Grewe, L. (2020, May 26). *Despite pandemic, DUI numbers up significantly in 2020*. KKTV.

Traffic Deaths Increase Even with Less Miles Travelled

During the first half of 2020, the number of total miles travelled decreased by 17 percent compared to the first half of 2019. Despite this, the traffic deaths increased by one percent from 256 to 259 deaths. Furthermore, this increase was significant as the fatality rate increased by 20 percent due to the large decrease in miles travelled. This trend was confirmed from analysis in 22 other states.

Source: Minor, N. (2020, September 2). *Colorado's roads are emptier, but deadlier so far this year.* CPR News.

Section II: Marijuana Use

Some Findings

Since recreational marijuana was legalized in 2013:

- Past month marijuana use for ages 12 and older **increased 26%** and is **61%** higher than the national average, currently ranked **3rd** in the nation.
- Past month adult marijuana use (ages 18 and older) **increased 20%** and is **62% higher** than the national average, currently ranked **3rd** in the nation.
- Past month college age marijuana (ages 18-25) use **increased 10%** and is **53% higher** than the national average, currently ranked **3rd** in the nation.
- Past month youth marijuana (ages 12-17) use **decreased 22%** and is **39% higher** than the national average, currently ranked **7th** in the nation.

Data Consideration

Healthy Kids Colorado Survey (HKCS) data is collected in the odd years and released in even years. For this reason, HKCS data is not included in this report. Please refer to Volume 7 for the most recent numbers.

Youth Risk Behavior Surveillance System (YRBSS) data is collected in the odd years and released in even years. For this reason, YRBSS data is not included in this report. Please refer to Volume 7 for the most recent numbers.

National Survey on Drug Use and Health (NSDUH) data is averaged between two years for a more accurate representation. The most recent data averaged 2018 and 2019.

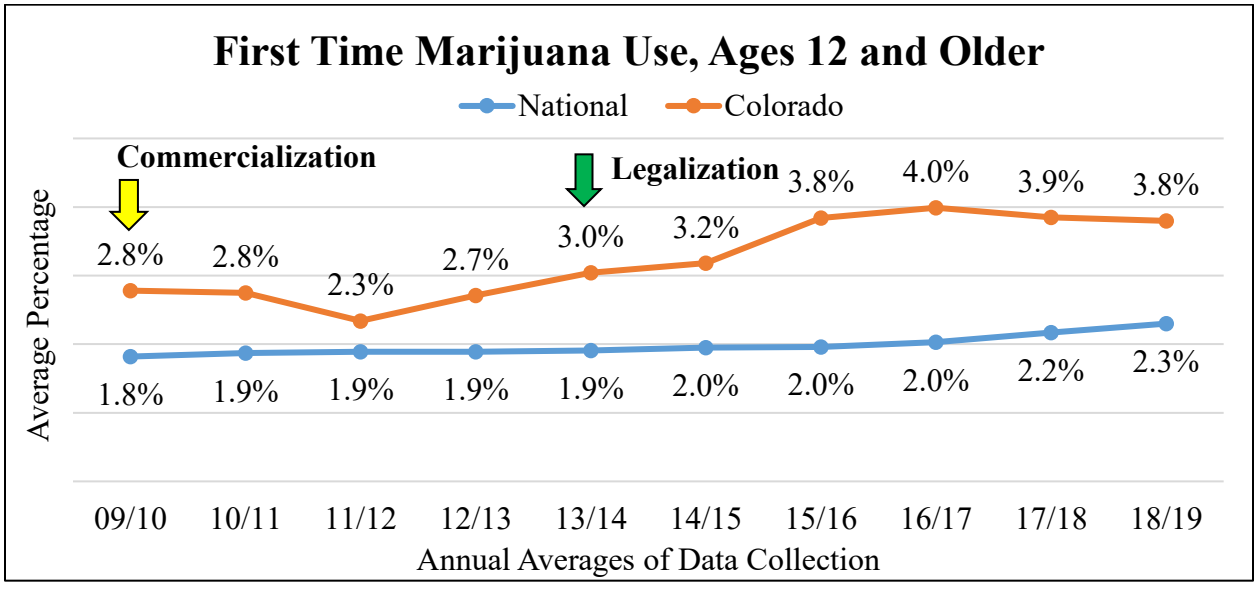
National Survey on Drug Use and Health (NSDUH) Data

Colorado Averages Compared to National Averages		
For Ages 12 and Older:	**Colorado**	**US**
Marijuana Past Month Use	17.4%	10.8%
Perceptions of Risk for Smoking Marijuana	17.7%	24.4%
Illicit Drug Use Other than Marijuana Past Month	4.7%	3.3%
Alcohol Past Month Use	60.0%	50.9%
Cigarette Past Month Use	16.3%	16.9%
Perceptions of Risk for Smoking Cigarettes	72.5%	71.5%

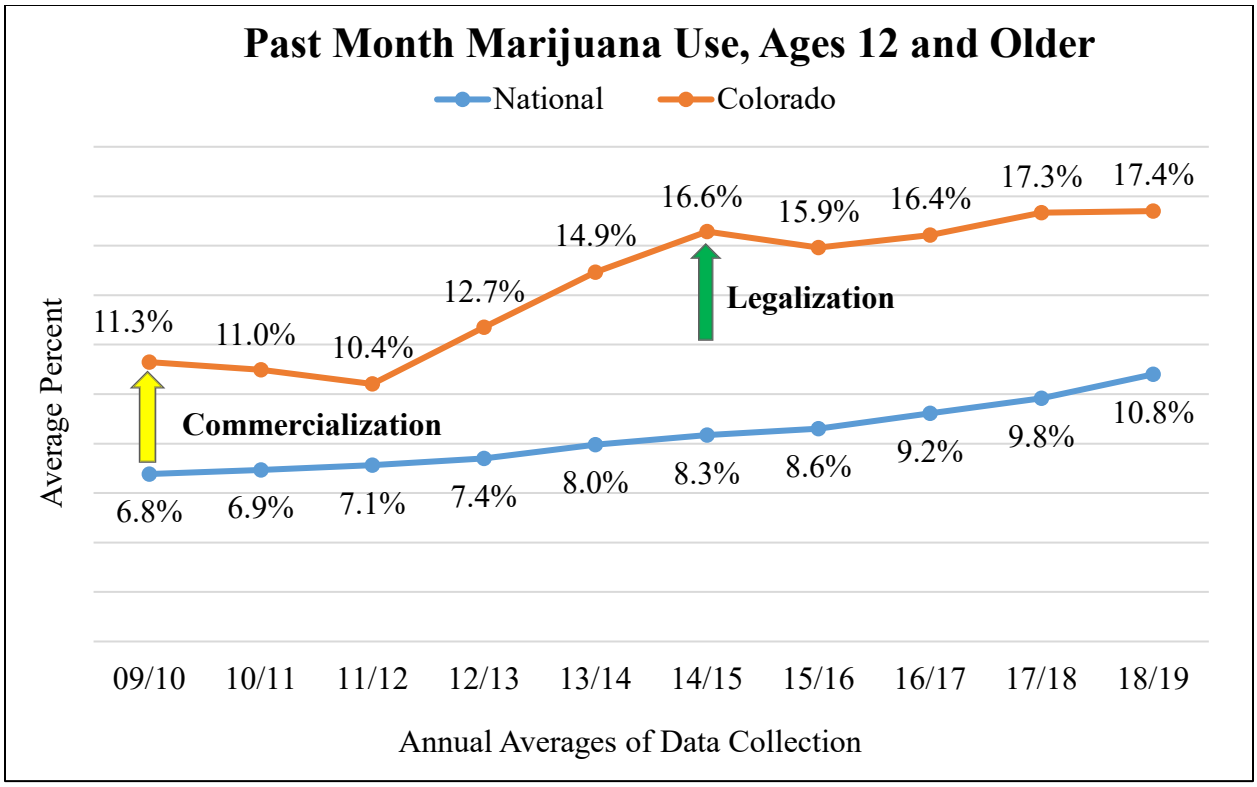
SOURCE: Substance Abuse and Mental Health Services Administration (SAMHSA), Center for Behavioral Health Statistics and Quality, NSDUH, 2018 and 2019

Marijuana First Time Use			
Age	**Colorado %**	**Colorado U.S. Ranking**	**National %**
12 years +	3.8%	3rd	2.3%
12 – 17	8.0%	4th	5.7%
18 years +	2.9%	5th	1.7%
18 – 25	12.5%	6th	8.4%
26+	1.2%	6th	0.7%

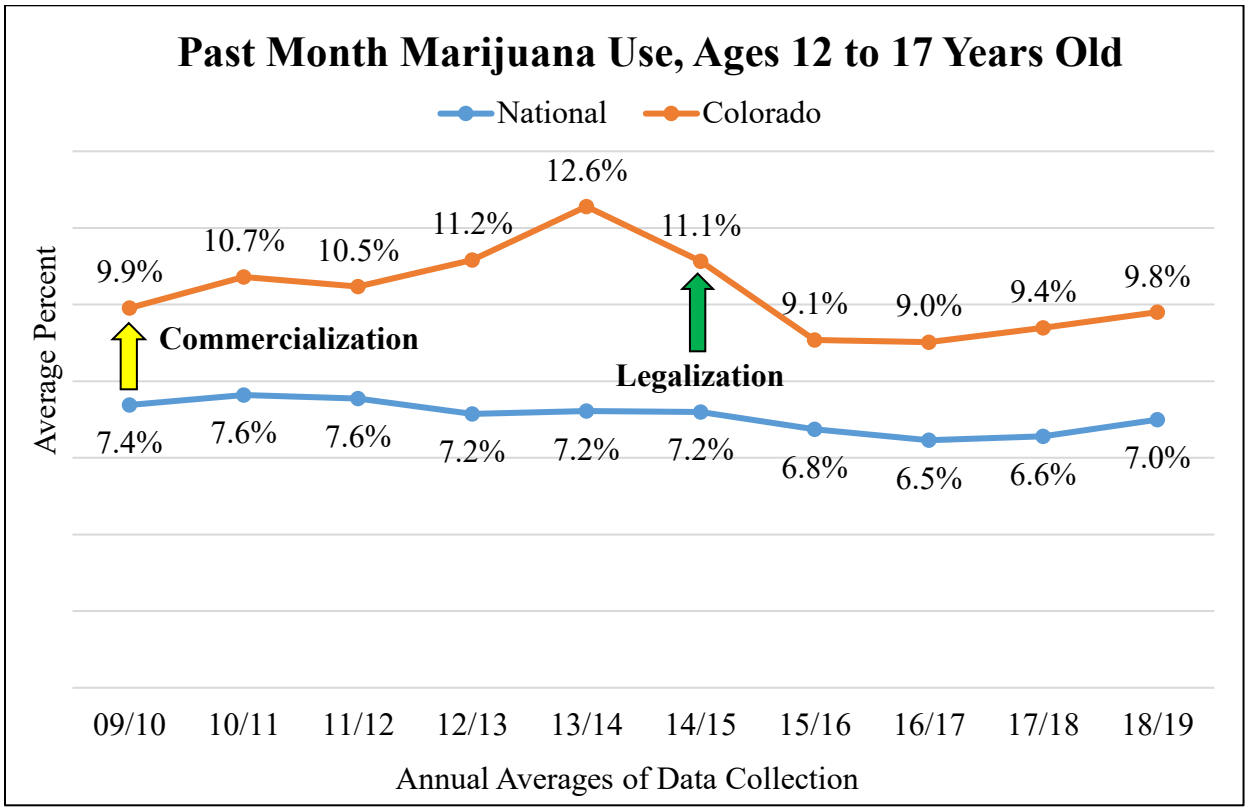
SOURCE: SAMHSA, Center for Behavioral Health Statistics and Quality, NSDUH, 2018 and 2019



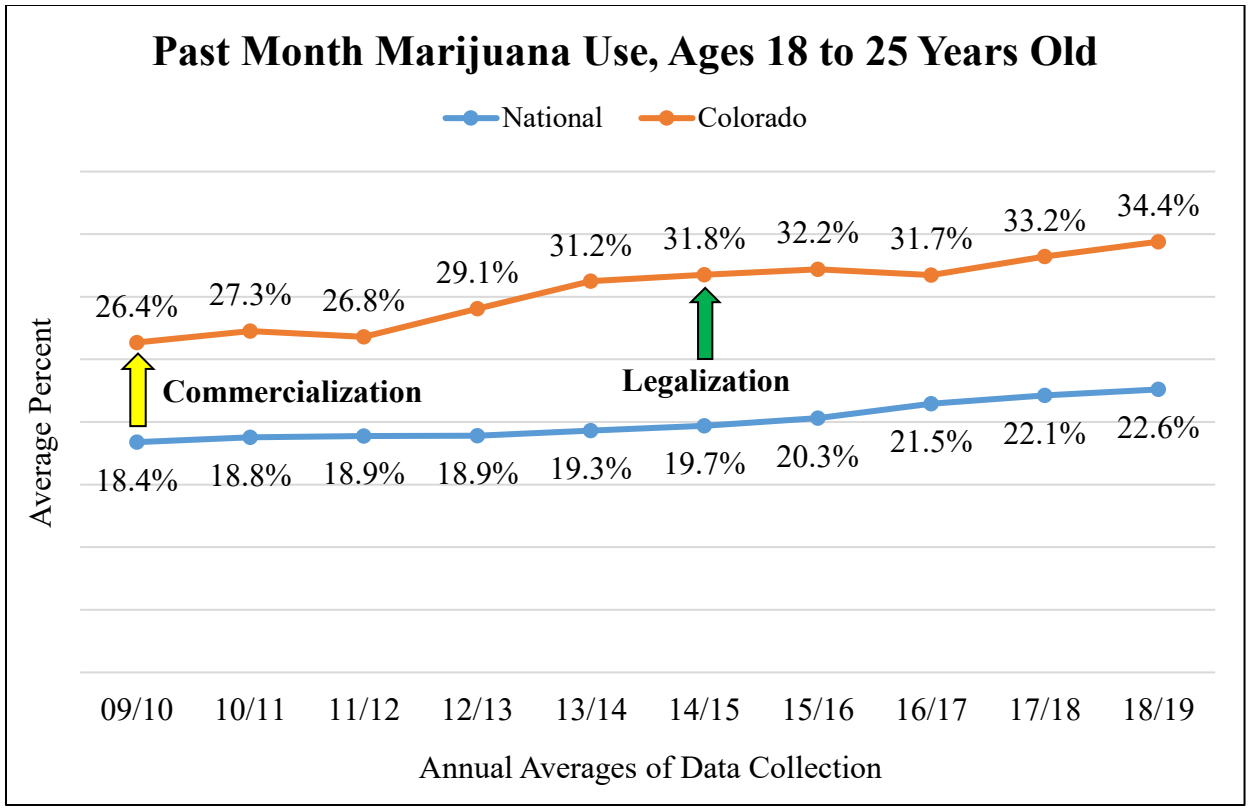
SOURCE: SAMHSA, Center for Behavioral Health Statistics and Quality, NSDUH, 2018 and 2019



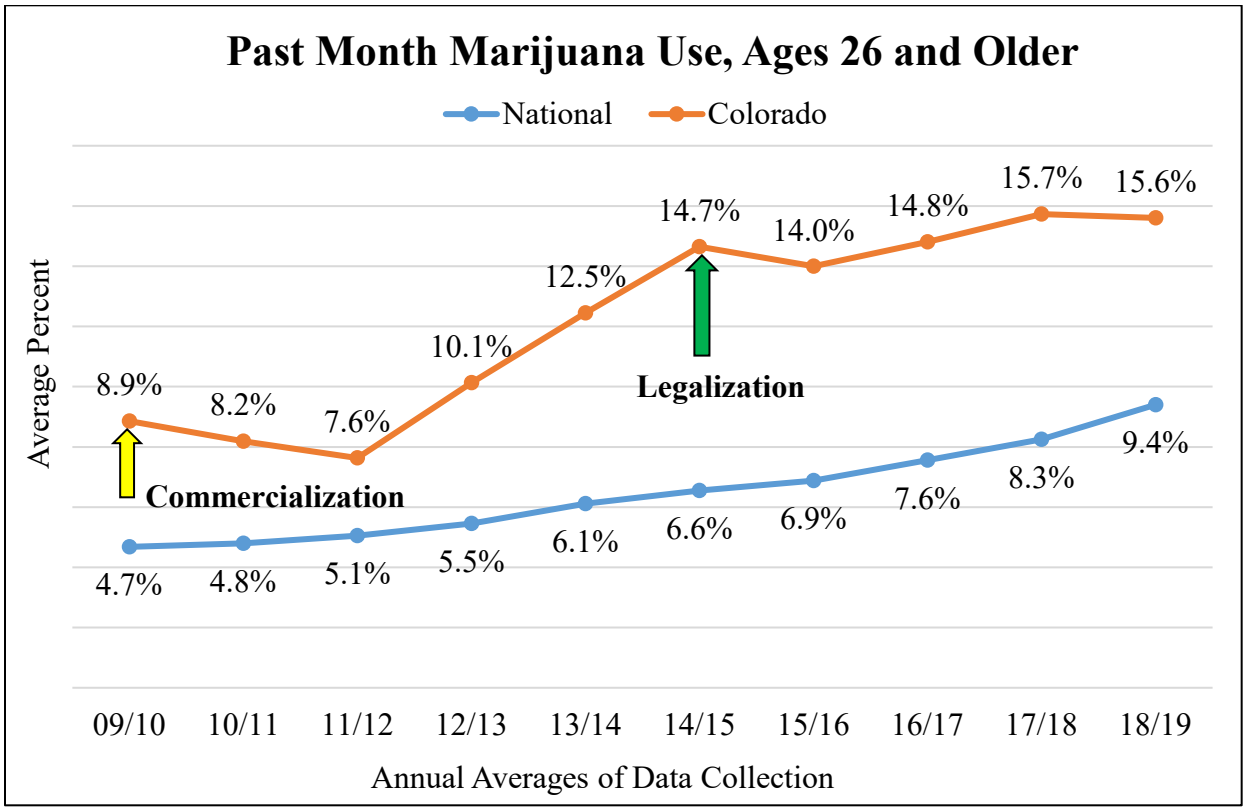
Source: SAMHSA, Center for Behavioral Health Statistics and Quality, NSDUH, 2018 and 2019



Source: SAMHSA, Center for Behavioral Health Statistics and Quality, NSDUH, 2018 and 2019

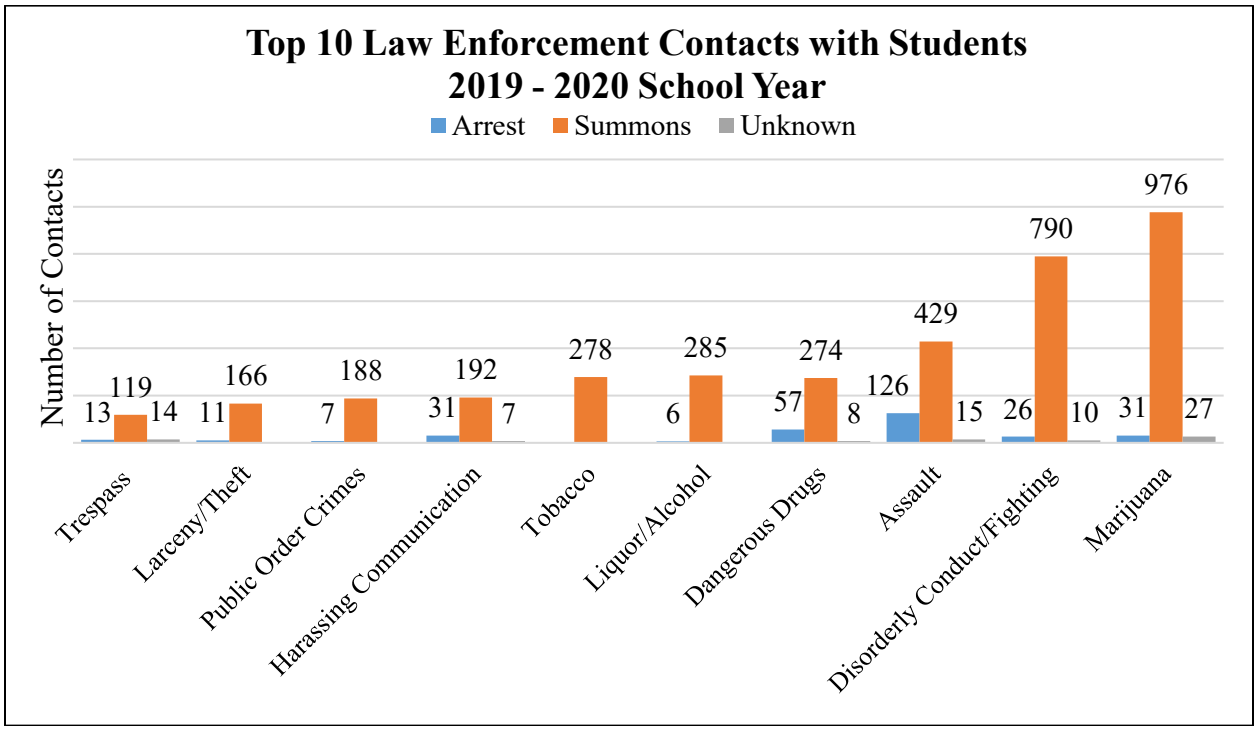


Source: SAMHSA, Center for Behavioral Health Statistics and Quality, NSDUH, 2018 and 2019



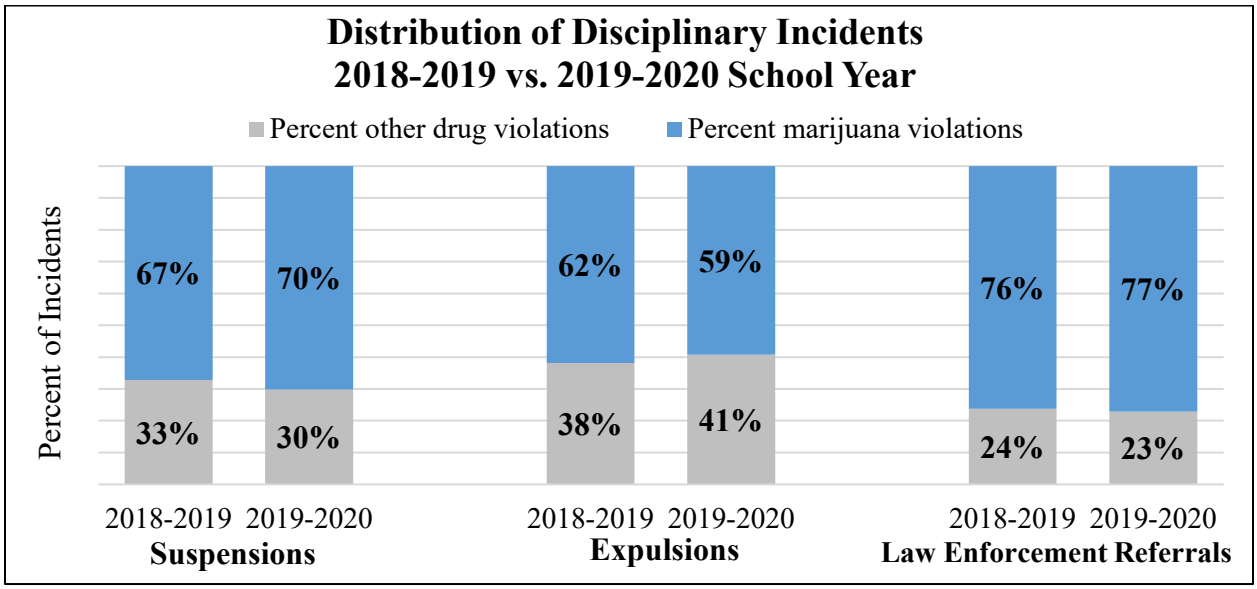
Source: SAMHSA, Center for Behavioral Health Statistics and Quality, NSDUH, 2018 and 2019

Marijuana in Schools



SOURCE: Colorado Division of Criminal Justice

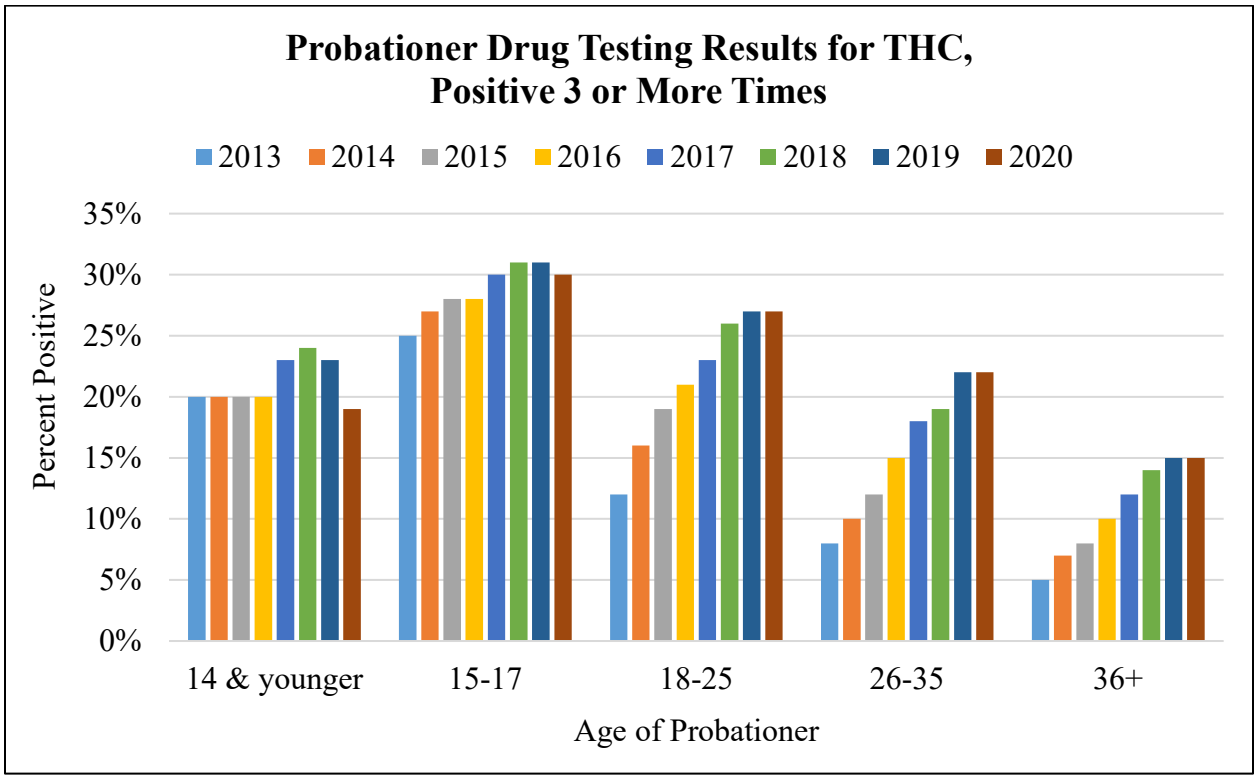
NOTE: The number of contacts from the 2019 to 2020 school year may not represent a complete school year due to the beginning of lockdowns associated with COVID-19 in March 2020.



SOURCE: Colorado Department of Education

NOTE: Law Enforcement Referrals may or may not have been in addition to another reported action taken (suspension, expulsion, or other).

Probationer Marijuana Use



SOURCE: Colorado State Judicial Branch, Division of Probation Services

NOTE: Data reflects drug test results for probationers required to undergo drug testing. This does not reflect all probationers in Colorado. Probationers who have a medical marijuana card are not prohibited from using marijuana while on probation. It is possible that some positive results may come from probationers using marijuana for medical reasons.

Marijuana Use Information

Analysis of Marijuana Use by College Students from 2008 to 2018

One of the largest questions after legalizing recreational marijuana was the impact on young adults across the country. A long-term study was created to compare marijuana use in states that passed recreational marijuana legalization (RML) compared to non-RML states. Researchers chose several post-secondary institutions and students between 18 to 26 years old were surveyed across ten academic years in 48 states. This resulted in seven RML states with nearly 235,000 participants from 135 institutions compared to 41 non-RML states with almost 600,000 students from 454 institutions.

The results indicated that "the 30-day prevalence of marijuana use increased more among college students exposed to RML relative to students attending college in non-RML states and students in RML states prior to legalization. These findings are generally consistent with those from prior studies of Oregon and Washington college students, but are a considerable extension, given that they are based on 135 institutions in seven RML states instead of one to two institutions in a single RML state. The mounting evidence for increases in college students' marijuana use that has coincided with RML is all the more interesting in the context of the more mixed results regarding such changes among adolescents. For many young adults, the transition to college involves sudden declines in parental monitoring, exposure to older peer groups and a culture of heavy drinking and other substance use. Although heavy drinking by college students has declined nation-wide in recent years, the prevalence of marijuana use has increased" (Bae et al, 2021). Additionally, the increases in RML states were more pronounced in women, participants 21 years and older, and students living off-campus.

Source: Bae, H. and Kerr, D. (2021). *Marijuana use trends among college students in states with and without legalization of recreational use: initial and longer-term changes from 2008 to 2018*. Addiction, 115(6), 1115-1124.

Relationship between Neighborhood Disorder, Marijuana Use, and Life Expectancy for Young Men Involved in the Criminal Justice System

Researchers surveyed over 1,200 young males from the Crossroads study that are involved in the justice system to examine their perception of risk-taking relative to their expectations on life expectancy. In the study, the measurements were neighborhood disorder, life expectancy, substance use, offending, and risky sexual behavior. Specific to marijuana use, the results indicated that the young men living in more disordered neighborhoods used marijuana more frequently, different findings than binge drinking and cigarette use. No causal relationship was determined between life expectancy and marijuana use.

The authors stated in the conclusion, "a possible explanation for this finding is that adolescents do not perceive using marijuana as risky or harmful. Findings from the National Institute on Drug Abuse 2013 Monitoring the Future survey indicate that while cigarette use and alcohol use have steadily declined in recent years, rates of marijuana use have remained consistently high, in large part due to adolescents' attitudes toward marijuana risks. Only 20.6% of 12th graders perceived occasional marijuana use as harmful and only 44.1% considered daily use to be detrimental (Johnston et al., 2014). If youth tend not to view marijuana as being harmful in the long run, then

it is likely that decisions to use marijuana are not informed by youths' expectations for their futures. That is, even among adolescents who expect long lives, they may be just as likely as those with short life expectancies to engage in marijuana use because they may not perceive it as a risky behavior" (Kan et al, 2020).

Source: Kan, E., Peniche, M., Steinberg, L., Knowles, A., Frick, P., and Cauffman, E. (2020). *Neighborhood disorder and risk-taking among justice-involved youth—the mediating role of life expectancy*. Journal of Research on Adolescence, 31(2), 282-298.

Examining the Validity of the Marijuana Gateway Hypothesis

Proposed during the 1970s, the marijuana gateway hypothesis was created to explain the escalation of risk from the use of tobacco and alcohol to marijuana, then to harder drugs. As a result of this hypothesis, marijuana use was harshly punished throughout the country even to today with many states legalizing recreational and medical marijuana. At this point, there has been a lack of research supporting the causal relationship between marijuana use and other drugs. The researchers in this study focused on further examining the relationship to determine the validity of the marijuana gateway hypothesis. While those who use marijuana before 21 were 157 times more likely to engage in subsequent hard drug use, most marijuana users never escalate to hard drug use. "Some studies have found moderate estimates wherein approximately 29% of marijuana users continue on to harder drug use" (Jorgensen and Wells, 2021). They state there must be a distinction between chronic users with more occasional users when examining the likelihood of escalating to harder drugs.

Data was gathered and analyzed from the National Longitudinal Study of Adolescent to Adult Health. The results showed a meaningful association between heavy marijuana use and light illicit drug use. "Considering the findings from all 18 tests together, it can be concluded that the hypothesis that marijuana is a gateway drug is unsupported. Summarily, if marijuana "really" is a gateway drug we would expect to see stronger and more consistent causal gateway effects" (Jorgensen and Wells, 2021). Additionally, the conclusion stated that if marijuana was to be considered a gateway drug that necessitates harsh punishments, the same would be needed for tobacco and alcohol.

Source: Jorgensen, C. and Wells, J. (2021). *Is marijuana really a gateway drug? A nationally representative test of the marijuana gateway hypothesis using a propensity score matching design*. Journal of Experimental Criminology, 17(3).

Changes in Marijuana Use from 2005 to 2018 across the United States

The study compares marijuana use by adults from 2005 to 2011 (pre-recreational marijuana legalization) to 2012 to 2018 (post-recreational marijuana legalization). Data was utilized from the US National Health and Nutrition Examination Survey (NHANES) from 2005 to 2018 across the country. While lifetime marijuana use and first use before the age of 18 was fairly consistent over the 14 years, there was a sizable increase in past-year marijuana use. This use was higher and more common for younger people, males, participants below the poverty line, non-Hispanic blacks. Despite this, the increase in past-year use increased across all demographics including education, race, gender, and income.

Source: Mitchell, W., Bhatia, R., and Zebardast, N. (2020). *Retrospective cross-sectional analysis of the changes in marijuana use in the USA, 2005–2018*. BMJ Open, 1-6.

Section III: Public Health

Some Findings

- Marijuana *only* exposures **increased 185%** from 2013 when recreational marijuana was legalized compared to 2020.
- Treatment for marijuana use for all ages **decreased 34%** from 2013 to 2020.
- The percent of suicide incidents in which toxicology results were positive for marijuana has **increased** from **14%** in 2013 to **29%** in 2020.

Definitions by Rocky Mountain HIDTA

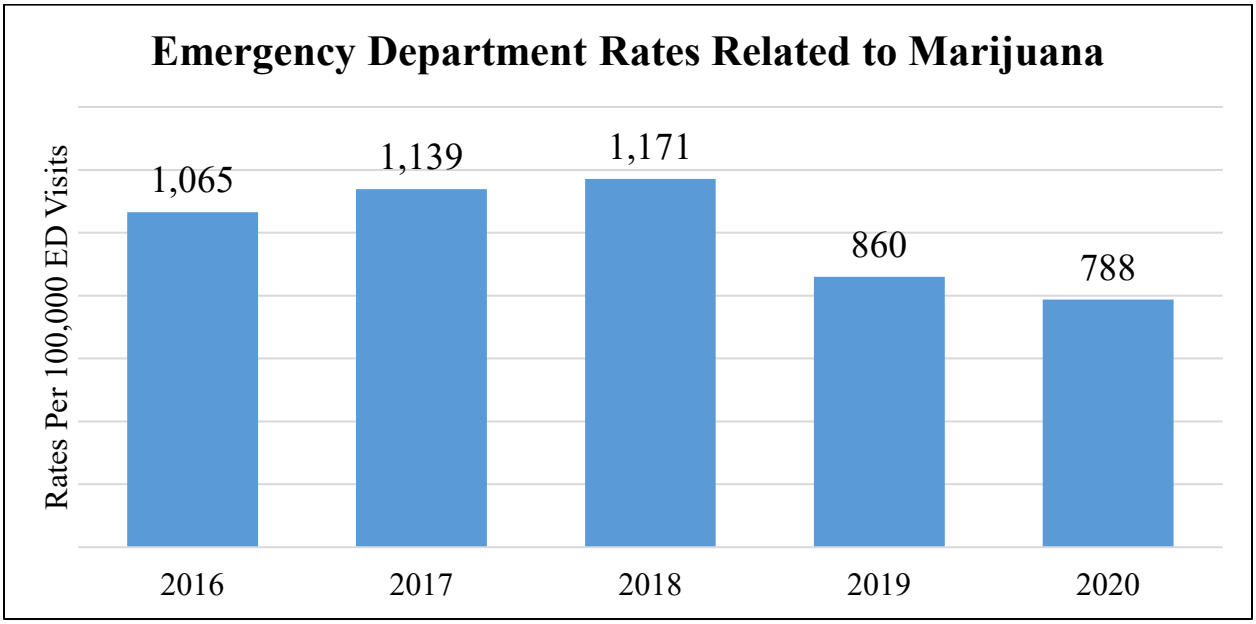
Marijuana-Related: Also referred to as "marijuana mentions." Data could be obtained from lab tests, patient self-admission or some other form of validation obtained by the provider. Being marijuana-related does not necessarily prove marijuana was the cause of the emergency department admission or hospitalization.

International Classification of Disease (ICD): A medical coding system used to classify diseases and related health problems.

**In 2015, ICD-10 (the tenth modification) was implemented in place of ICD-9. Although ICD-10 will allow for better analysis of disease patterns and treatment outcomes for the advancement of medical care, comparison of trends before and after the conversion can be made difficult and/or impossible. The number of codes increased from approximately 13,600 codes to approximately 69,000 codes. For this reason, emergency department visits and hospitalizations related to marijuana use were restricted to 2016 to 2020 in this report.

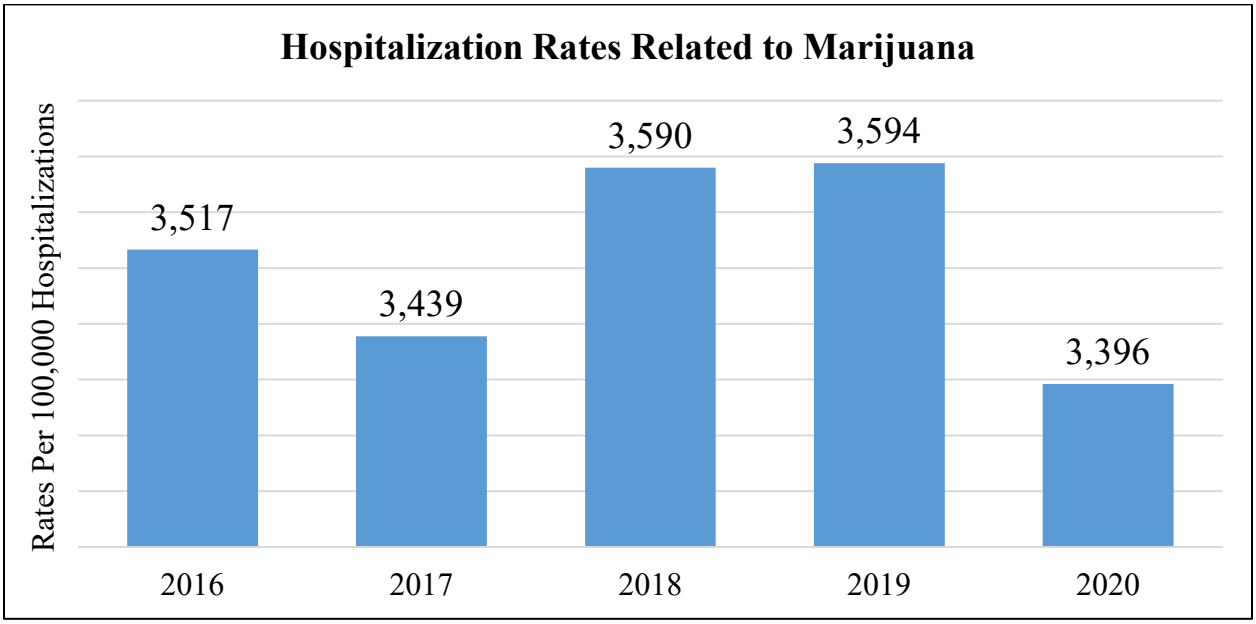
For more information regarding public health research gaps and data quality issues, please visit https://marijuanahealthinfo.colorado.gov/research-gaps.

Emergency Department Data



SOURCE: Emergency Department Discharge Dataset, as analyzed by the Colorado Department of Public Health and Environment; 2016-2020

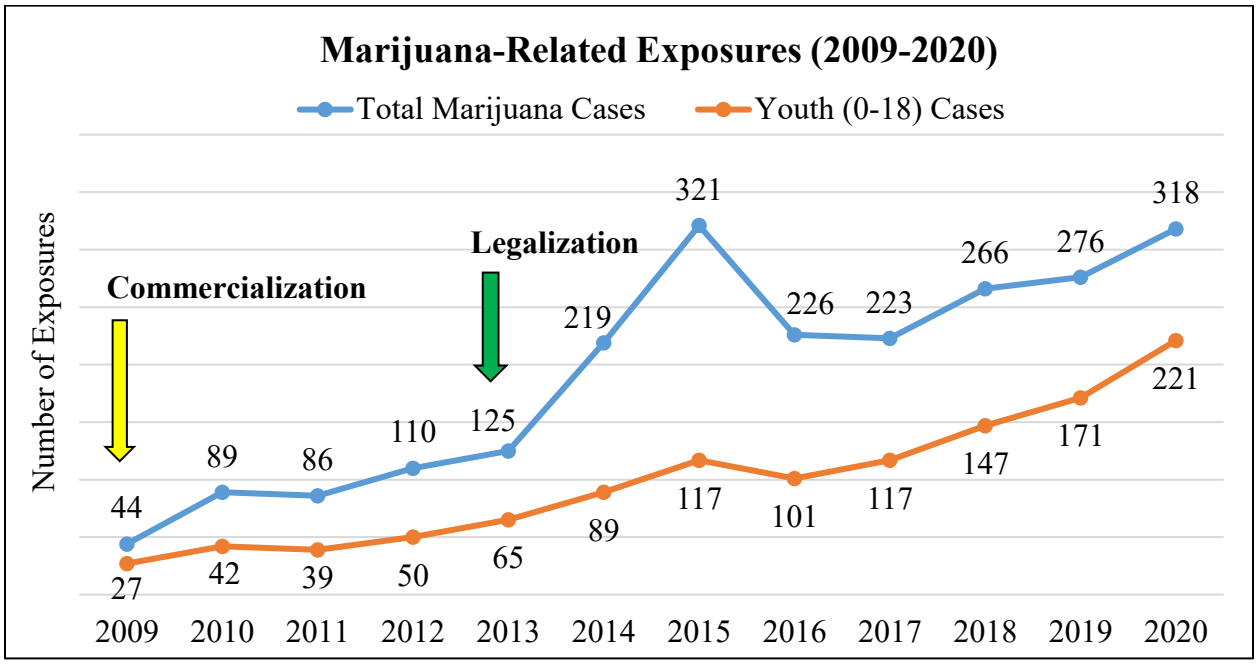
NOTE: Due to changes in the way the hospitalizations and emergency department visits data were coded, data before 2015 was not included for trend analysis.



SOURCE: Emergency Department Discharge Dataset, as analyzed by the Colorado Department of Public Health and Environment; 2016-2020

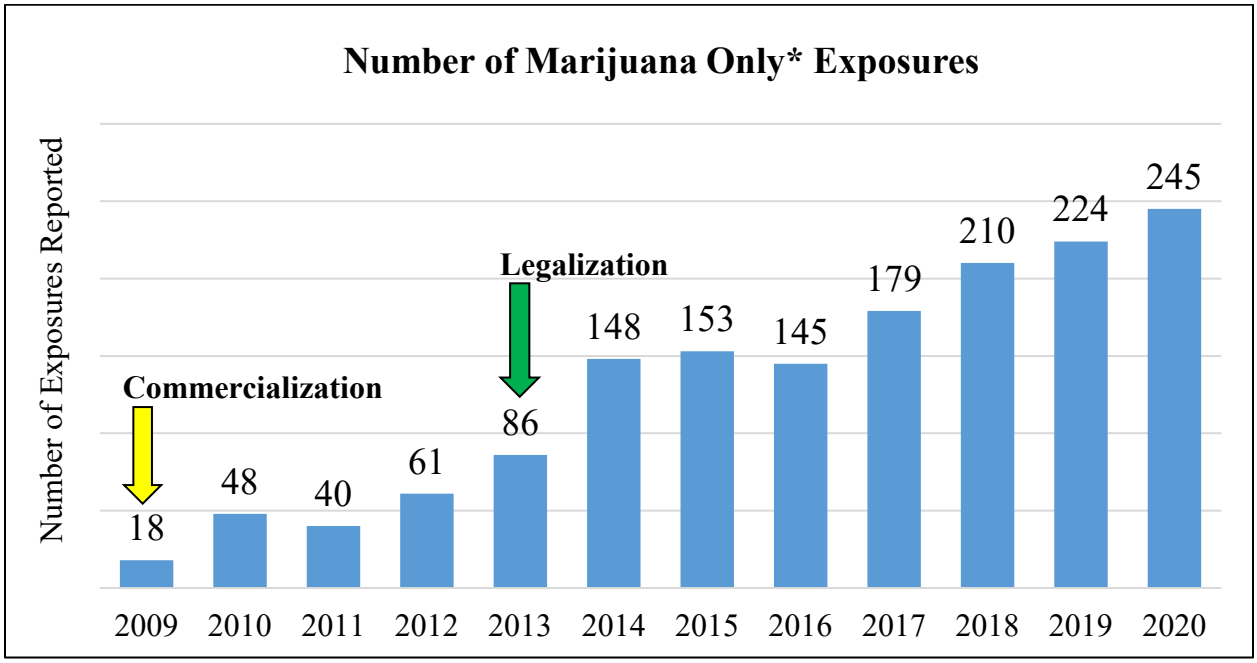
NOTE: Due to changes in the way the hospitalizations and emergency department visits data were coded, data before 2015 was not included for trend analysis.

Poison Control/Marijuana Exposure Data



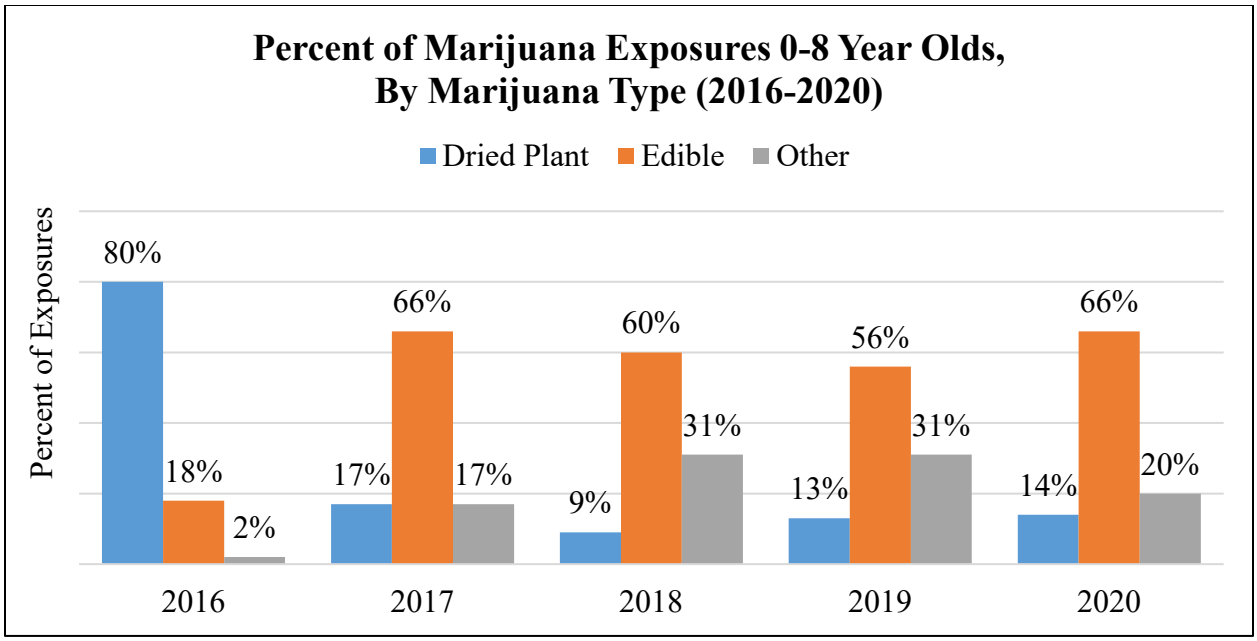
SOURCE: Rocky Mountain Poison and Drug Center

NOTE: Total marijuana-related exposure cases include unknown ages.



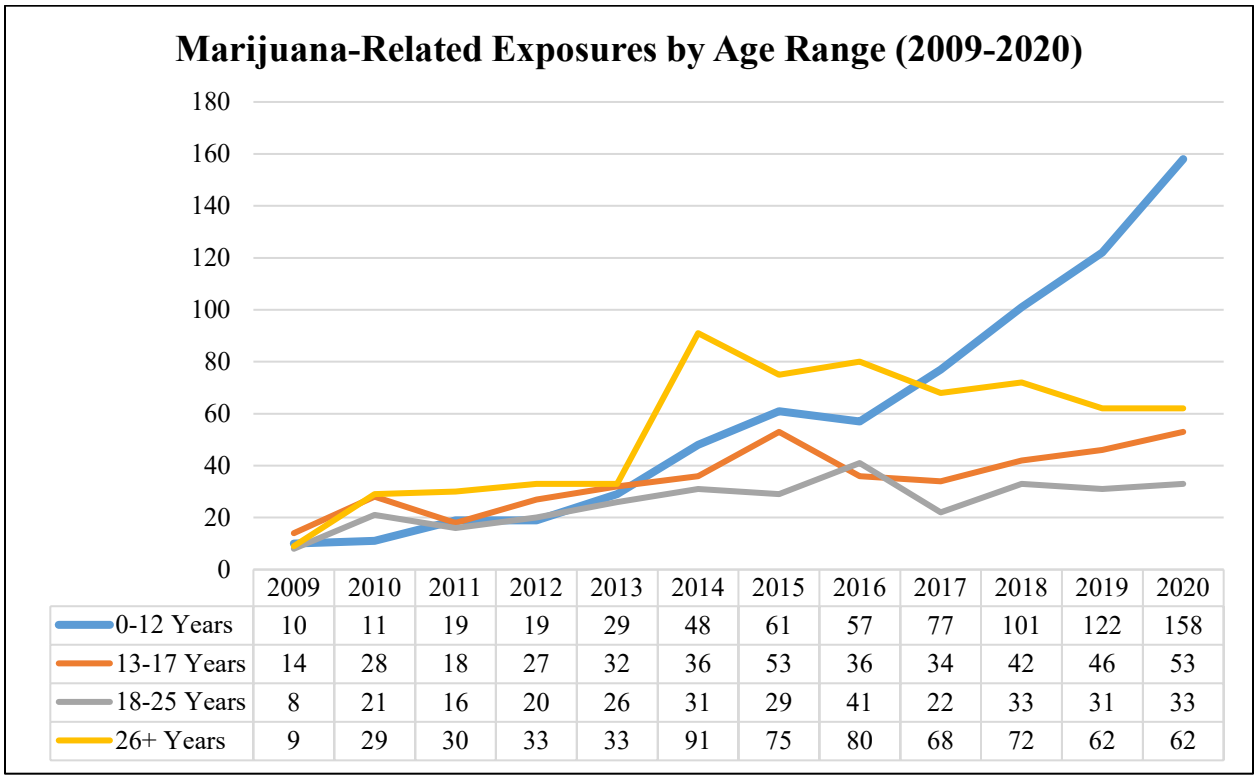
SOURCE: Rocky Mountain Poison and Drug Center

***NOTE:** Marijuana was the only substance referenced in the call to the poison and drug center.



SOURCE: Rocky Mountain Poison and Drug Center

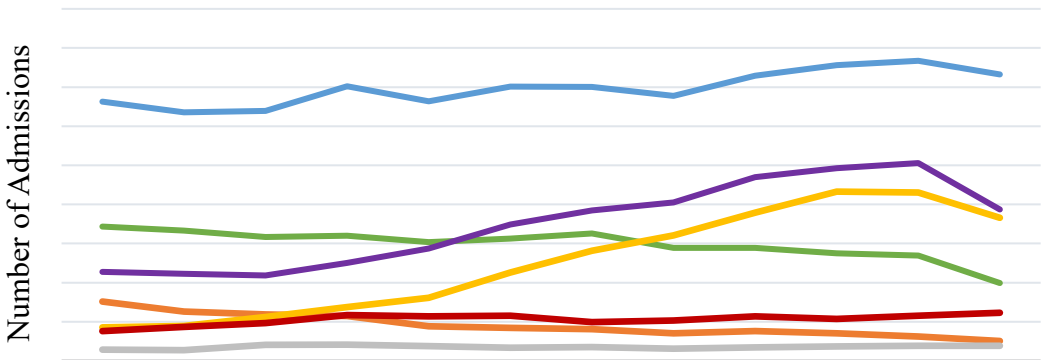
NOTE: The code for marijuana edibles did not go into effect until 2016. Therefore, any cases of edible marijuana exposure which occurred prior to 2016 were coded under "dry plant." Other marijuana includes oral pills/capsules, concentrated extracts (to include oils and tinctures), topical preparations, marijuana devices, and unknown/other forms of mariiuana.



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
0-12 Years	10	11	19	19	29	48	61	57	77	101	122	158
13-17 Years	14	28	18	27	32	36	53	36	34	42	46	53
18-25 Years	8	21	16	20	26	31	29	41	22	33	31	33
26+ Years	9	29	30	33	33	91	75	80	68	72	62	62

SOURCE: Rocky Mountain Poison and Drug Center

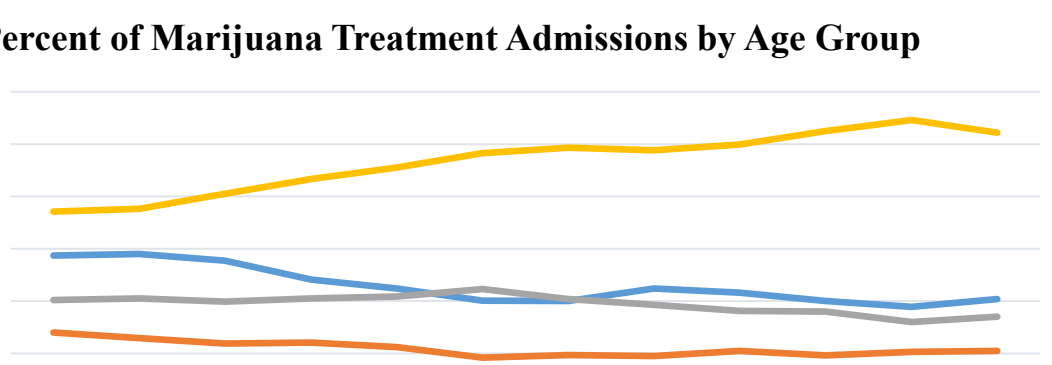
Treatment Data



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Marijuana	6,868	6,665	6,342	6,408	6,065	6,257	6,520	5,783	5,785	5,498	5,394	3,980
Cocaine	3,034	2,523	2,380	2,288	1,775	1,681	1,618	1,414	1,518	1,402	1,252	1,017*
Meth	4,557	4,450	4,368	5,007	5,746	6,972	7,700	8,110	9,389	9,859	10,115	7,743
Heroin	1,713	1,790	2,237	2,746	3,225	4,520	5,634	6,420	7,581	8,655	8,610	7,323*
Rx Opioids	1,522	1,739	1,934	2,339	2,277	2,304	1,987	2,059	2,271	2,138	2,307	2,460
Alcohol	13,263	12,710	12,788	14,035	13,277	14,023	14,013	13,544	14,587	15,124	15,345	14,653
Other	572	548	827	830	761	667	710	620	692	734	773	768

SOURCE: Colorado Department of Health Services, Office of Behavioral Health

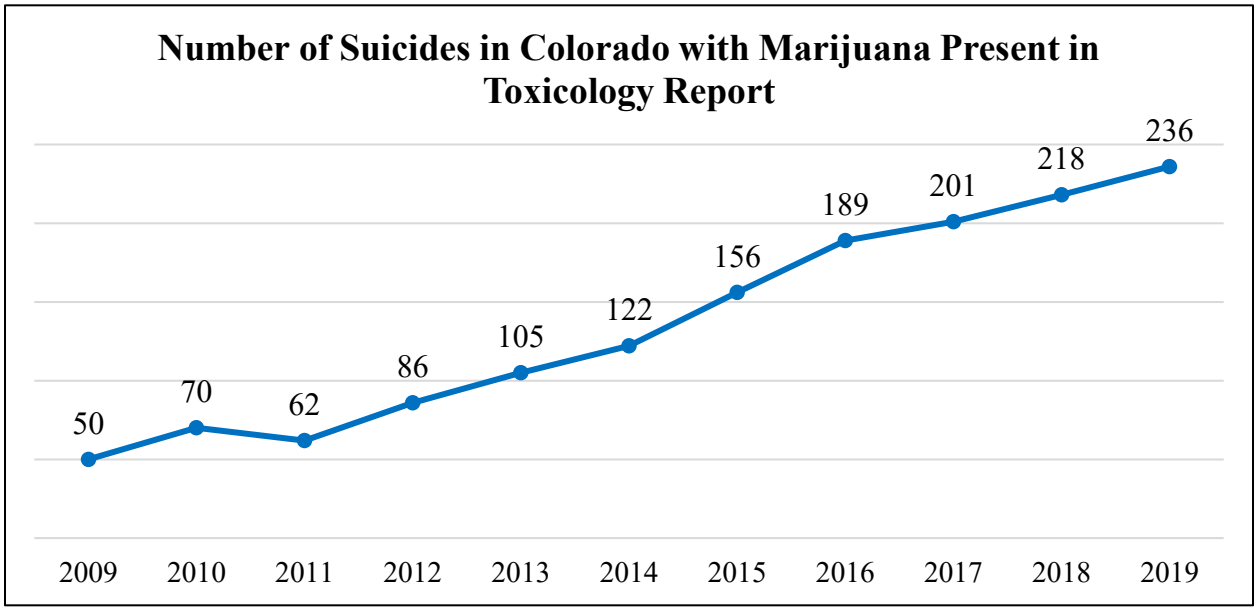
***NOTE:** Treatment admissions for cocaine and heroin in 2020 do not include the 12-17 age group as there were less than 30 admissions and were therefore omitted.



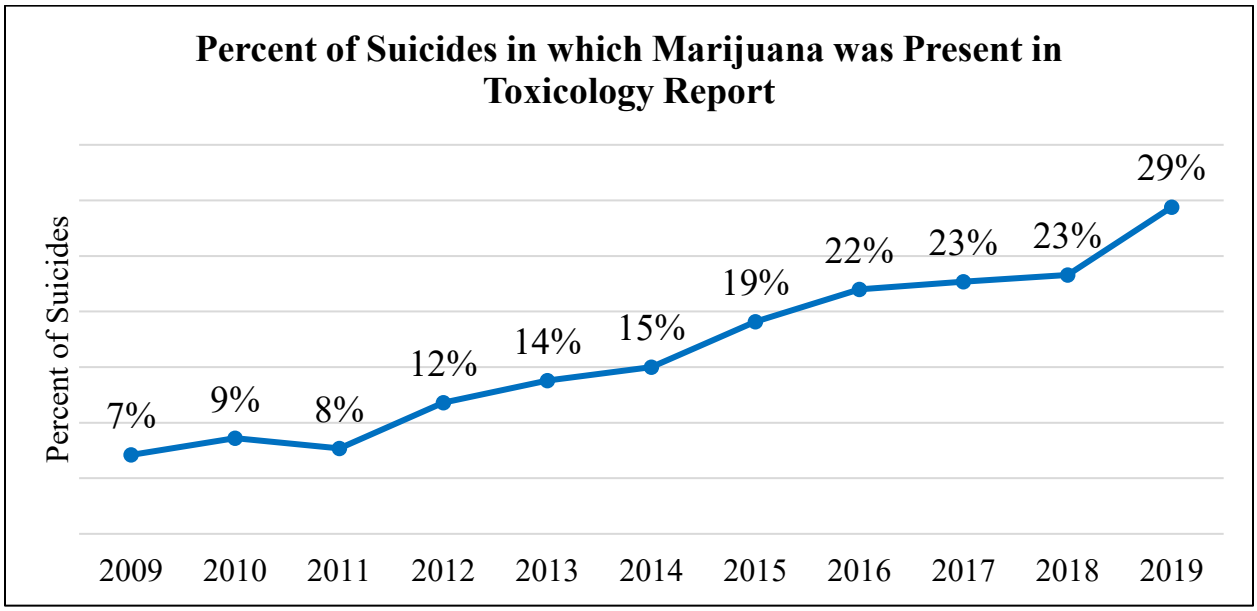
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
12-17	28.7	29.0	27.7	24.1	22.4	20.1	20.0	22.4	21.6	20.0	18.9	20.4
18-20	14.0	12.9	11.9	12.1	11.2	9.2	9.7	9.5	10.5	9.6	10.3	10.5
21-25	20.2	20.5	19.9	20.5	20.9	22.3	20.4	19.3	18.1	18.0	16.0	17
26+	37.1	37.6	40.5	43.3	45.5	48.3	49.3	48.8	49.9	52.5	54.6	52.2

SOURCE: Center for Behavioral Health Statistics and Quality, SAMHSA, Treatment Episode Data Set (TEDS). Based on administrative data reported by states to TEDS pulled on July 8, 2021.

Suicide Data



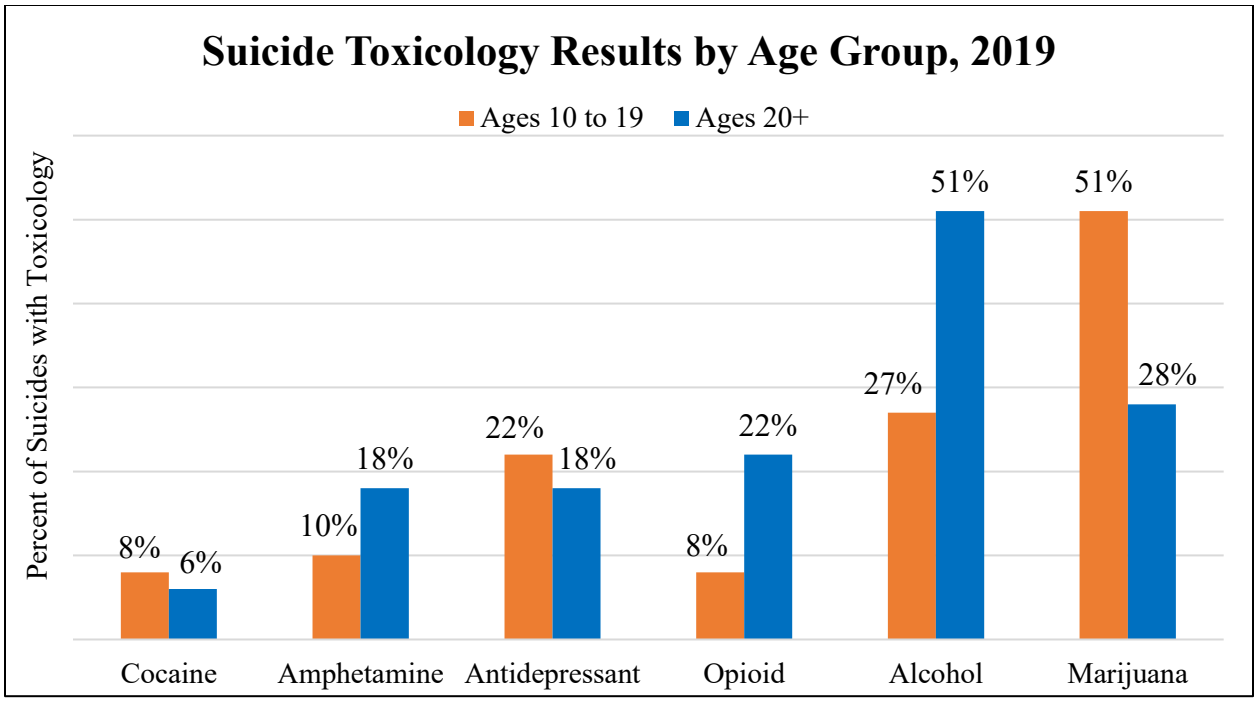
SOURCE: CDPHE, Colorado Violent Death Reporting System



SOURCE: CDPHE, Colorado Violent Death Reporting System

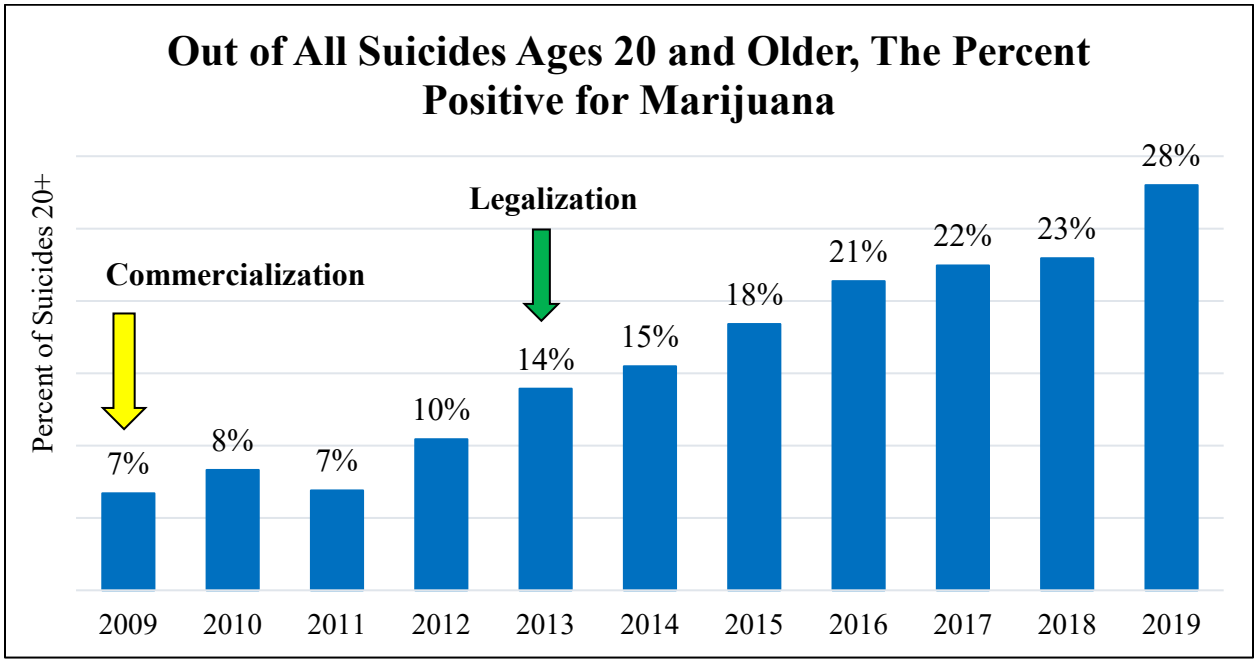
NOTE: Toxicology is not available for every suicide. Only those suicides with toxicology available are represented above. Due to an 18-month lap in detailed suicide circumstances and toxicology information from coroner and law enforcement records, 2019 is the most recent year available.

NOTE: Toxicology results were available for 62% of suicides from 2019. As a result, there may be underrepresentation in the numbers and percentages presented.



SOURCE: CDPHE, Colorado Violent Death Reporting System

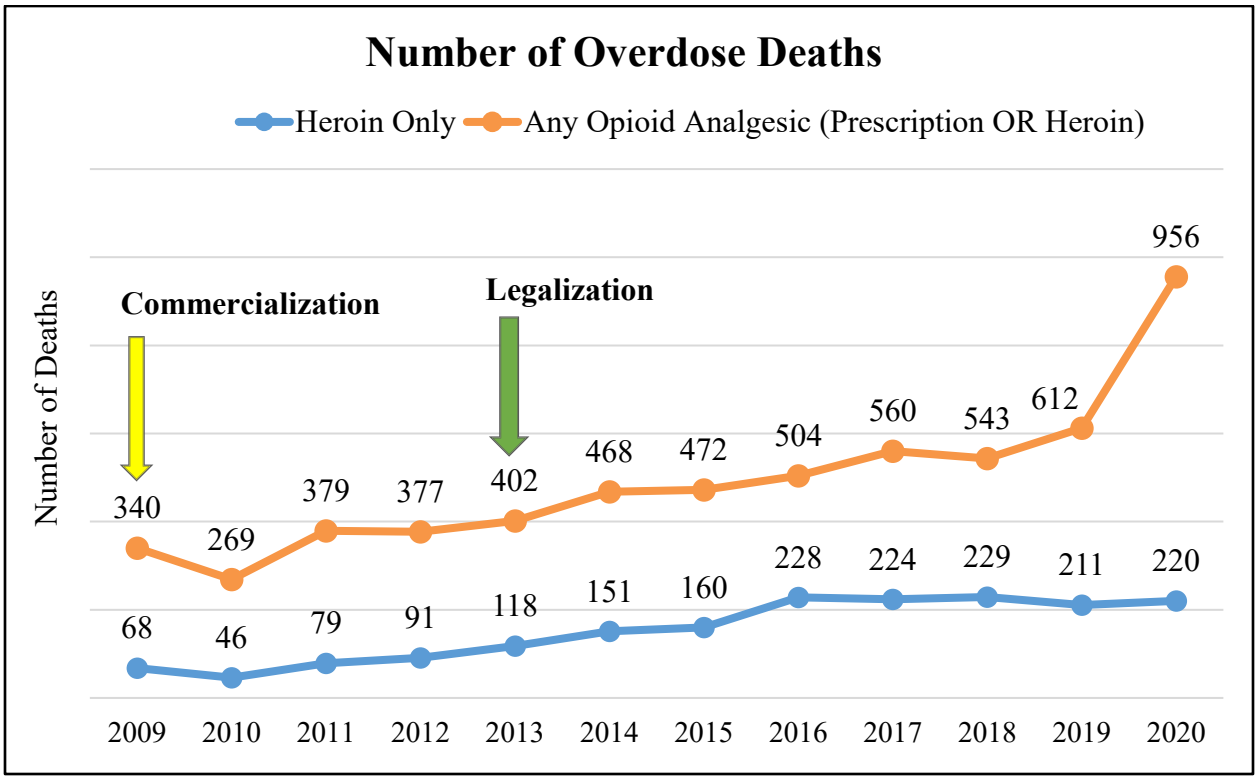
NOTE: Toxicology results were available for 62% of suicides from 2019. As a result, there may be underrepresentation in the numbers and percentages presented.



SOURCE: CDPHE, Colorado Violent Death Reporting System

NOTE: Toxicology results were available for 62% of suicides from 2019. As a result, there may be underrepresentation in the numbers and percentages presented.

Colorado Opioid Overdose Deaths



Source: CDPHE, Vital Statistics Program

This data is included in response to reports of declining opioid overdose deaths post-marijuana legalization.

NOTE: Heroin cause of death codes include T40.1. Any Opioid Analgesic (prescription or heroin) cause of death codes include T40.1-T40.4

Public Health Information

Impact of Licensed and Unlicensed Cannabis Retailers in California

California legalized recreational marijuana in 2016, which resulted in the establishment of unlicensed retailers until the issuance of cannabis retail licenses at the end of 2017. For example, in Los Angeles County, there are 37 licensed retailers compared to 92 unlicensed retailers. This can create problems for regulation as unlicensed locations "have been reported to engage in illegal business practices that can compromise public health and encourage underage use, including selling products that exceed the legal THC limit, selling counterfeit products that contain pesticides, allowing consumption of cannabis in retail stores, not imposing daily limits on purchases, staying open late at night, and selling products that are attractive to youth and lack child-resistant packaging" (Unger et al, 2020).

The results indicated that "neighborhoods with only licensed retailers represented 8% of the California population, neighborhoods with only unlicensed retailers represented 17% of the California population, and neighborhoods with both licensed/unlicensed retailers represented 18% of the California population. Of all neighborhood types, neighborhoods with only unlicensed retailers had the lowest proportion of non-Hispanic whites (25%) and the highest proportion of Hispanics (52%). However, the highest proportions of African Americans (9%), Asian Americans (15%), and individuals living in poverty (19%) were in neighborhoods with both licensed/unlicensed retailers" (Unger et al, 2020). Residents living near unlicensed retailers face greater public health risks due to the lack of regulation of the products and the authors recommend greater enforcement of these dangerous practices.

Source: Unger, J., Vos, R., Wu, J., Hardaway, K., Li Sarain, A., Soto, D., Rogers, C., and Steinberg, J. (2020). *Locations of licensed and unlicensed cannabis retailers in California: A threat to health equity*. Preventive Medicine Reports, 19, 101165-101173.

Mixed Findings for the Public Health Effects of Medical Marijuana Treatment

Researchers sought to examine the public health effects from the use of medical marijuana on various conditions- amyotrophic lateral sclerosis, autism, cancer, chronic noncancer pain, Crohn's disease, epilepsy, glaucoma, human immunodeficiency virus/AIDS, multiple sclerosis (MS), Parkinson's disease, and posttraumatic stress disorder. Across the 33 states in which medical marijuana is legal, there are over 50 medical conditions that have qualified to be treated through the use of medical marijuana. Nationwide, 6.2% of people use medical marijuana and 3.6% use both medical and recreational marijuana. A systematic review was conducted for studies that took place from May 2016 to October 2019.

The results indicated that "there is conclusive or substantial evidence for cannabis in treating chronic noncancer pain, chemotherapy-induced nausea and vomiting (oral cannabinoids), and MS spasticity symptoms (via oral cannabinoids). In addition, limited evidence was reported for the efficacy of cannabis and cannabinoids for the purposes of increasing appetite and decreasing weight loss in patients with HIV/AIDS, improving clinician measures of MS spasticity symptoms (specifically, via oral cannabinoids), and improving symptoms of PTSD (specifically, with

nabilone)" (Jugl et al, 2021). However, there was insufficient evidence to support evidence of medical marijuana improving glaucoma symptoms. In addition, studies showed neither support or opposition for indications such as "cancer (cannabinoids), cancer-associated anorexia-cachexia syndrome and anorexia nervosa (cannabinoids), symptoms of irritable bowel syndrome (dronabinol), epilepsy (cannabinoids), symptoms associated with ALS, or Parkinson's disease-related symptoms or levodopa-induced dyskinesia (cannabinoids)" (Jugl et al, 2021).

Source: Jugl, S., Okpeku, A., Costales, B., Morris, E., Alipour-Haris, G., Hincapie-Castillo, J., Stetten, N., Sajdeya, R., Keshwani, S., Joseph, V., Zhang, Y., Shen, Y., Adkins, L., Winterstein, A., and Goodin, A. (2021). *A mapping literature review of medical cannabis clinical outcomes and quality of evidence in approved conditions in the USA from 2016 to 2019.* Medical Cannabis and Cannabinoids, 4(1), 21-42.

Analysis of Pre-Existing Factors and Experiences to Marijuana Use During Pregnancy

Similar to cigarette use during pregnancy, marijuana can have physical effects on the fetus such as anemia, low birth weight, and more time spent in the neonatal intensive care unit after birth. Although women have used marijuana to assist with nausea in the first trimester, some medical professionals have expressed concerns of this practice. A study was conducted and found 29.6% of women used marijuana prior to their first prenatal visit. Additionally, the participants in the study who used marijuana while pregnant were more likely to be unemployed, have low educational attainment, use tobacco and alcohol, and experience depression. The rate of women using marijuana decreased across pregnancy terms.

The authors of this study recruited 101 pregnant participants in Indiana who used the WIC Food and Nutrition Service. The main measures were childhood adversity, interpersonal violence, cigarette use, and marijuana use. Of the participants, 71% experienced childhood adversity like physical abuse, 28% used at least one cigarette a day, and 7% used marijuana during pregnancy. Results indicated a strong association between marijuana use during pregnancy and sexual interpersonal violence.

The researchers concluded "this study suggests that a comprehensive assessment of women's history of exposure to violence provides insight into which women may have the most difficulty with unassisted substance cessation in the prenatal period—above and beyond already known risk factors, including sociodemographic characteristics and pre-pregnancy smoking behaviors. It could be that women who have experienced recent IPV and past childhood adversity may experience a higher general stress burden, making cessation more difficult. Providing better intervention and support around smoking and marijuana cessation for women exposed to violence is therefore a critical need, even among groups that are at a generally high sociodemographic risk" (Miller-Graff et al, 2021).

Source: Miller-Graff, L., Howell, K., Grein, K., and Keough, K. (2021). *Women's cigarette and marijuana use in pregnancy: identifying the role of past versus recent violence exposure*. Journal of Interpersonal Violence, 36(7-8), NP3983-NP3998.

Section IV: Black-Market

Some Findings

- RMHIDTA Colorado Drug Task Forces (10) conducted **294 investigations** of black-market marijuana in Colorado resulting in:
    - **168** felony arrests
    - **5.54** tons of marijuana seized
    - **86,502** marijuana plants seized
    - **21** different states the marijuana was destined
- Seizures of marijuana reported to the El Paso Intelligence Center (EPIC) in Colorado **increased 48%** from an average of 174 parcels (2009-2012) when marijuana was commercialized to an average of 257 parcels (2013-2020) during the time recreational marijuana become legalized.

Definitions by Rocky Mountain HIDTA

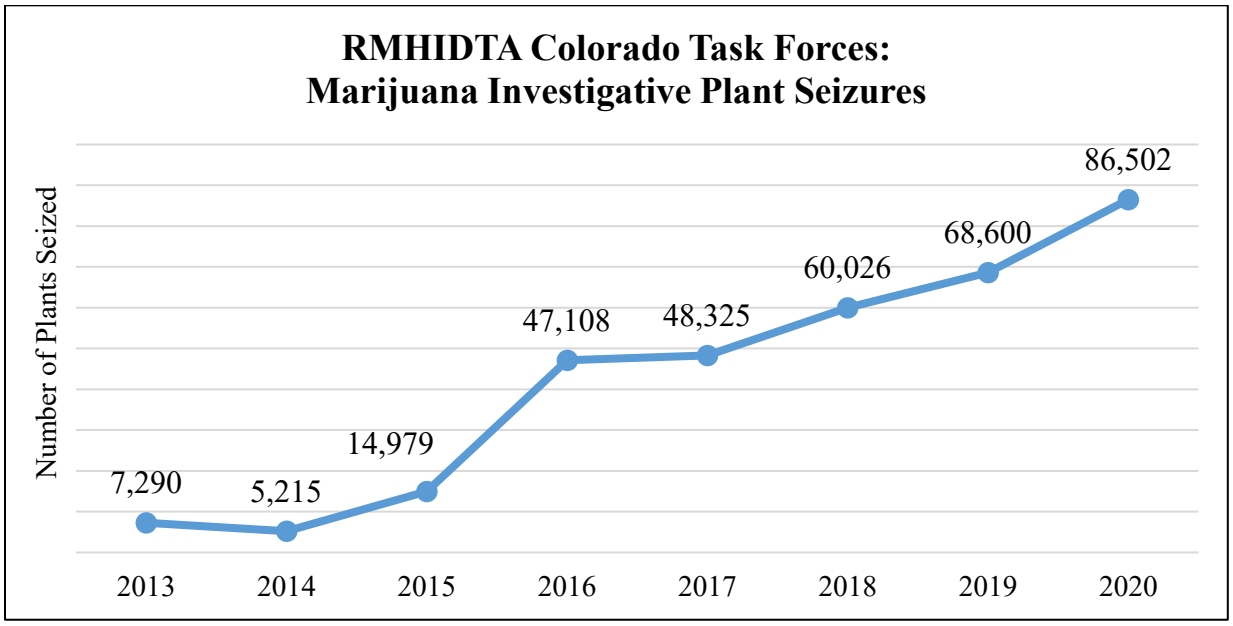
Colorado Marijuana Investigations: RMHIDTA Colorado drug task forces investigating individuals or organizations involved in illegally selling Colorado marijuana, both within and outside of the state. These investigations only include those reported by the ten RMHIDTA drug task forces.

Colorado Marijuana Interdictions: Interdictions include incidents where drugs are being transported, generally by vehicle or parcel, and the shipment is randomly seized by law enforcement. Interdictions are made by Colorado State Patrol.

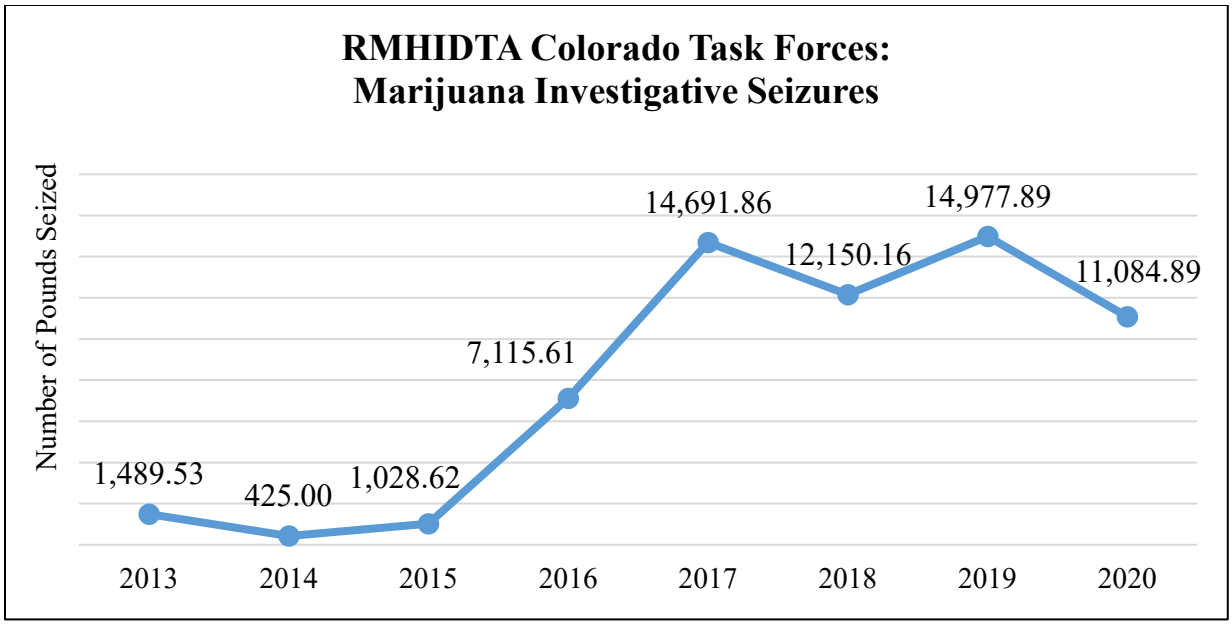
Task Force Investigations

Rocky Mountain HIDTA Colorado Task Forces			
	2018	**2019**	**2020**
Number of Completed Investigations	257	278	294
Number of Felony Arrests	192	237	168
Pounds of Bulk Marijuana Seized	12,150 (6.1 tons)	14,978 (7.5 tons)	11,085 (5.5 tons)
Number of Plants Seized	60,026	68,600	86,502
Number of Edibles Seized	2,894	15,025	4,202
Pounds of Hash/THC Concentrate Seized	319	86	626
Different States to Which Marijuana was Destined	25	29	21

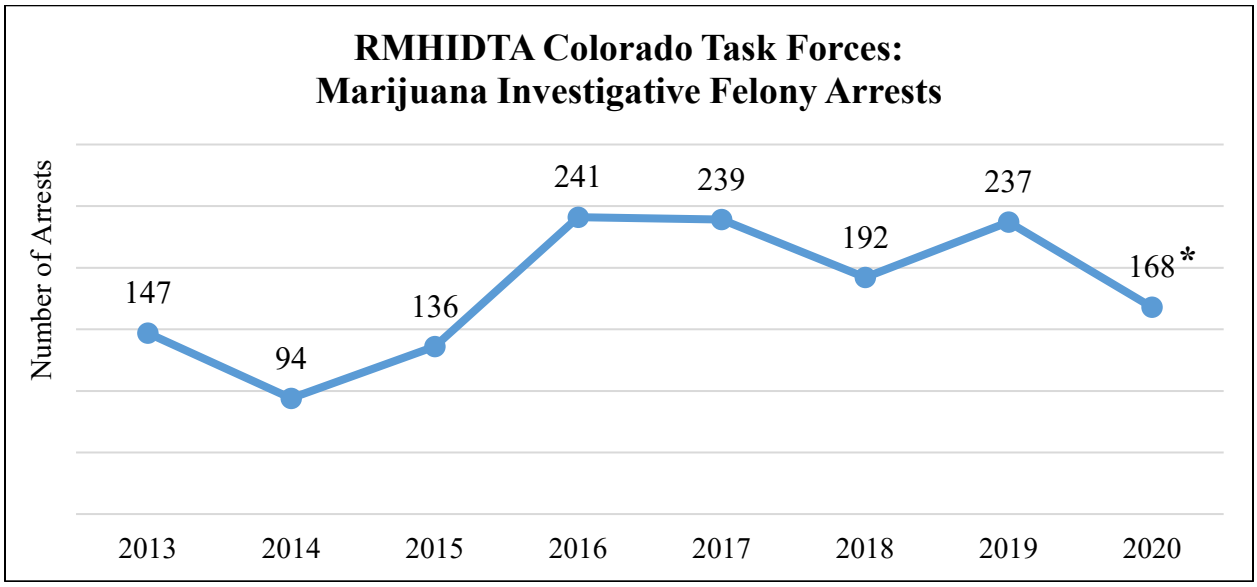
Task force data only includes completed investigations reported by the RMHIDTA Colorado Investigative Drug Task Forces. It is unknown how many of these types of investigations were completed by non-RMHIDTA Colorado drug units or task forces.



SOURCE: Rocky Mountain HIDTA Performance Management Process (PMP) Data



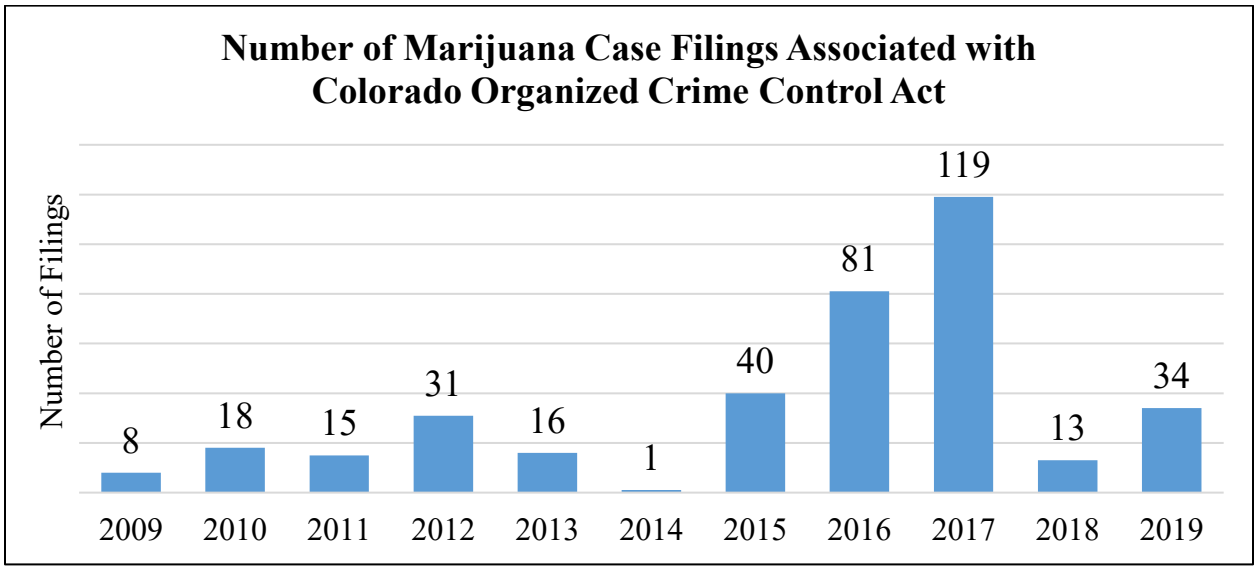
SOURCE: Rocky Mountain HIDTA Performance Management Process (PMP) Data



SOURCE: Rocky Mountain HIDTA Performance Management Process (PMP) Data

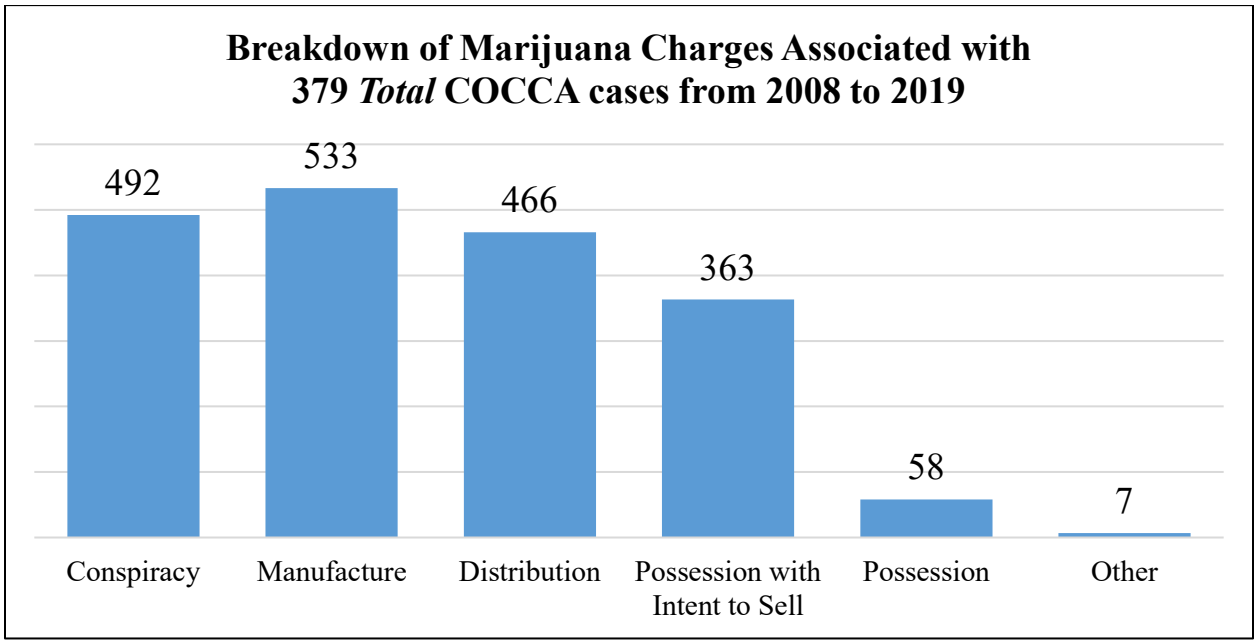
*** NOTE:** In 2020, arrest numbers were impacted by the COVID-19 pandemic's impact of the local, state, and federal judicial systems.

Colorado Organized Crime Control Act Filings



SOURCE: Colorado Department of Public Safety, Division of Criminal Justice, Office of Research and Statistics

Colorado Organized Crime Control Act (COCCA) filings are conspiracy cases in which there is potential for a larger sentence than other types of drug filings.

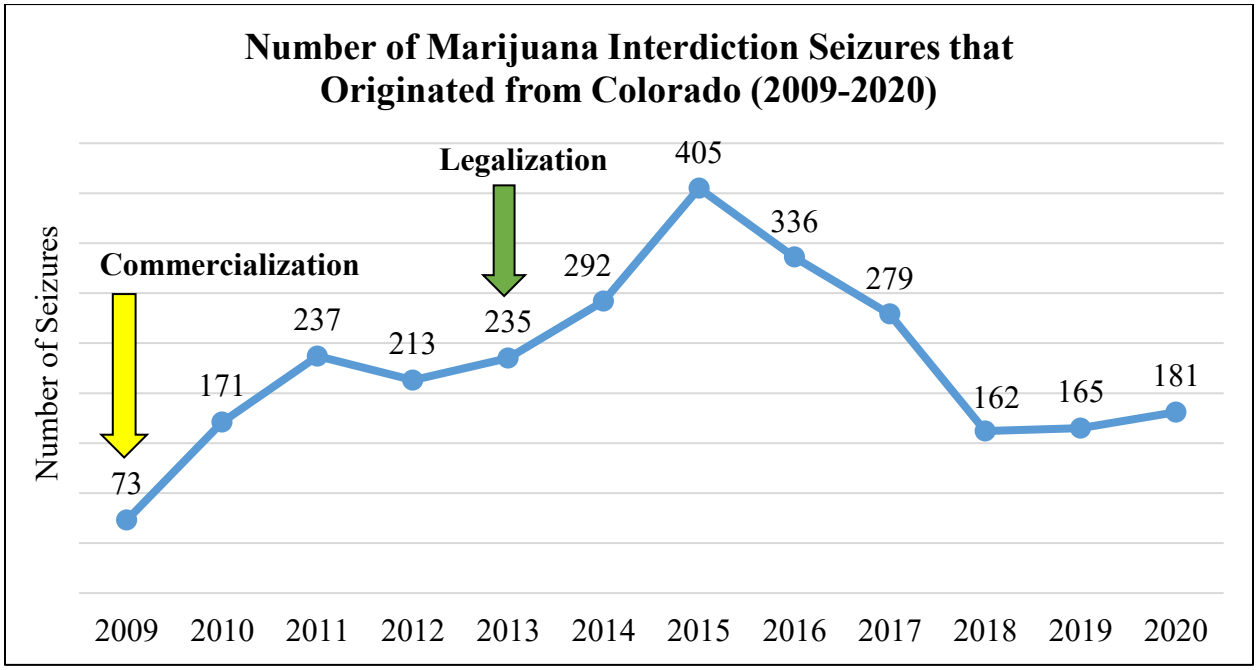


SOURCE: Colorado Department of Public Safety, Division of Criminal Justice, Office of Research and Statistics

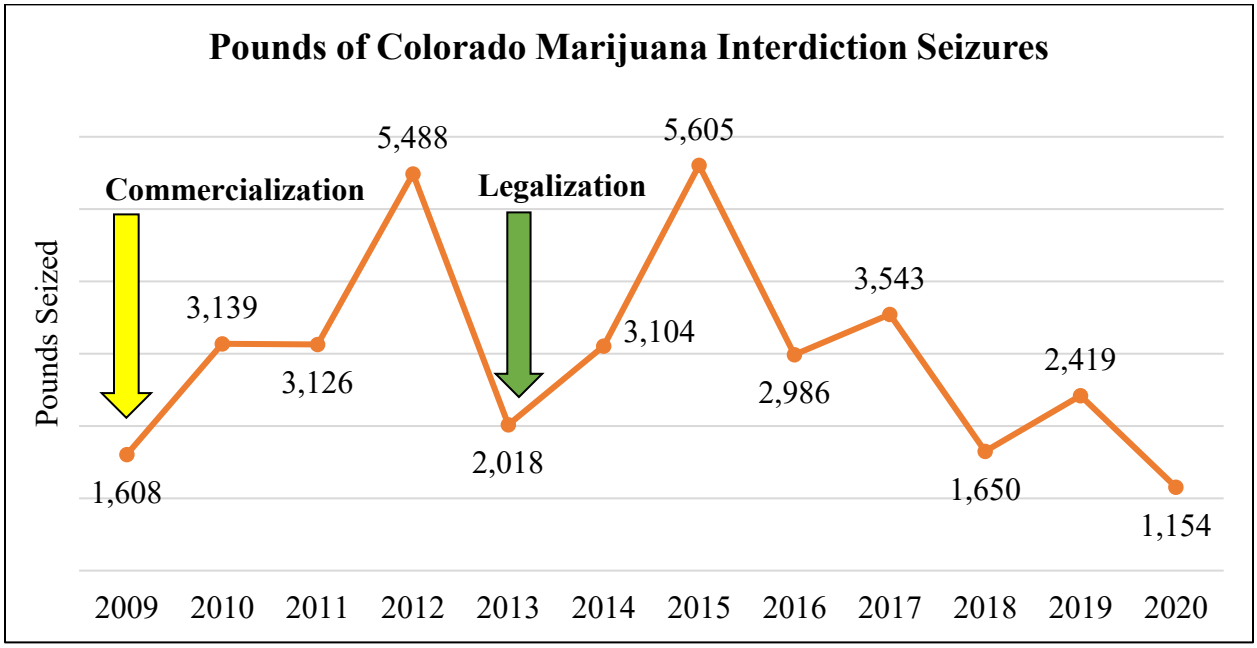
NOTE: The breakdown is more than the 379 total COCCA cases as there can be multiple charges associated with each case.

Highway Interdiction Data

NOTE: The charts below only include cases where Colorado marijuana was actually seized and reported. It is unknown how many Colorado marijuana loads were not detected or, if seized, were not reported. These are roadside interdictions voluntarily reported by state highway patrol to EPIC.



SOURCE: EPIC, National Seizure System, as of July 2021



SOURCE: EPIC, National Seizure System, as of July 2021

Black Market Information

Black-Market Marijuana Continues After Legalization

Despite the legalization of recreational marijuana in Colorado, the black-market marijuana continues to thrive. In 2019, federal and local law enforcement conducted the largest marijuana bust in the history of Colorado- raids across 250 homes and businesses, dozens of arrests, over 80,000 marijuana plants, and nearly $2.2 million in assets. The base of this operation was buying suburban homes in the Denver Metro area with large, unfinished basements for the cultivation of thousands of plants, operating under the radar in plain sight. Then, the money was laundered through family restaurants by multiple Chinese drug trafficking organizations.

There is difficulty, however, in fully assessing the size of the black market as all the efforts are "underground" and not well known. It has been established by the Drug Enforcement Administration that well-established drug trafficking organizations are able to generate millions of dollars through the sale of up 1,800 pounds of marijuana a year based on 100 plants grown. This problem has resulted in the creation of the Illicit Market Marijuana Team within the Colorado Bureau of Investigations. The solution to combating the black market is split between those who believe law enforcement needs more resources with those who feel greater legalization and lower prices in the legal market could have the most impact.

Source: Tabachnik, S. (2021, June 20). *Black market marijuana grows are popping up faster than law enforcement can take them down. But is legalization the cause?* Denver Post. Retrieved from https://www.denverpost.com/2021/06/20/black-market-marijuana-colorado-chinese-crime-rings/

Perceptions from Marijuana Users of "Legal" and "Illegal" Markets

While legalization of recreational marijuana is expected to decrease the black market in these states, this is not always the case. After legalization, the retail price of marijuana decreased by 62% in Colorado from 2014 to 2017. While the prices also dropped in Washington and Oregon, it was a lower decline than Colorado. Some studies have indicated that buyers may be willing to pay a higher price for a legal purchase as well as high quality products. For some buyers though, the pre-existing relationship with their supplier may continue to connect them to the illegal market.

The results of the online survey demonstrated a positive perception of the legal marijuana market in these states by participants. Additionally, researchers found "respondents, including frequent cannabis consumers, perceived legal cannabis to be of equal or greater quality and convenience, and as safer to buy and use than cannabis from illegal sources. The one notable exception was price: legal cannabis products were perceived as more expensive than illegal products, particularly among frequent cannabis users. The prevalence of this belief suggests that price may in fact be a barrier to transitioning to the legal market; however, it is also possible that higher prices may be tolerated given that legal cannabis products may be perceived as higher quality, safer and more convenient to access. However, frequent users may be able to obtain what they perceive as high-quality products at lower prices through established relationships with unauthorized dealers. Price perceptions were generally more favorable in states with a longer time with retail sales: Colorado, Washington, and Oregon" (Fataar et al, 2021).

Source: Fataar, F., Goodman, S., Wadsworth, E., and Hammond, D. (2021). *Consumer perceptions of "legal" and "illegal" cannabis in US states with legal cannabis sales.* Addictive Behaviors, 112, 106563-106569

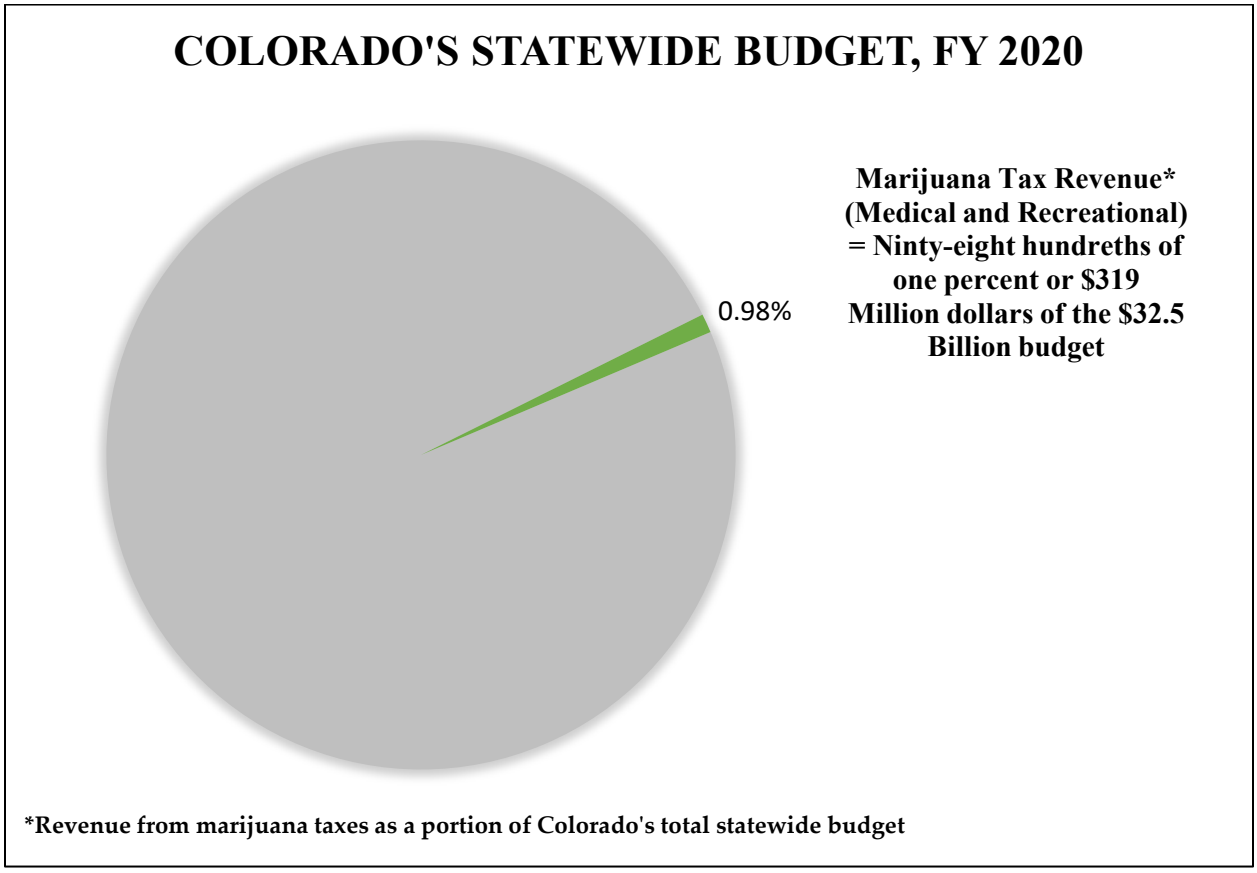
Section V: Societal Impact

Some Findings

- Marijuana tax revenue represent approximately **0.98%** of Colorado's FY 2020 budget.
- **66%** of local jurisdictions in Colorado have banned medical and recreational marijuana businesses.

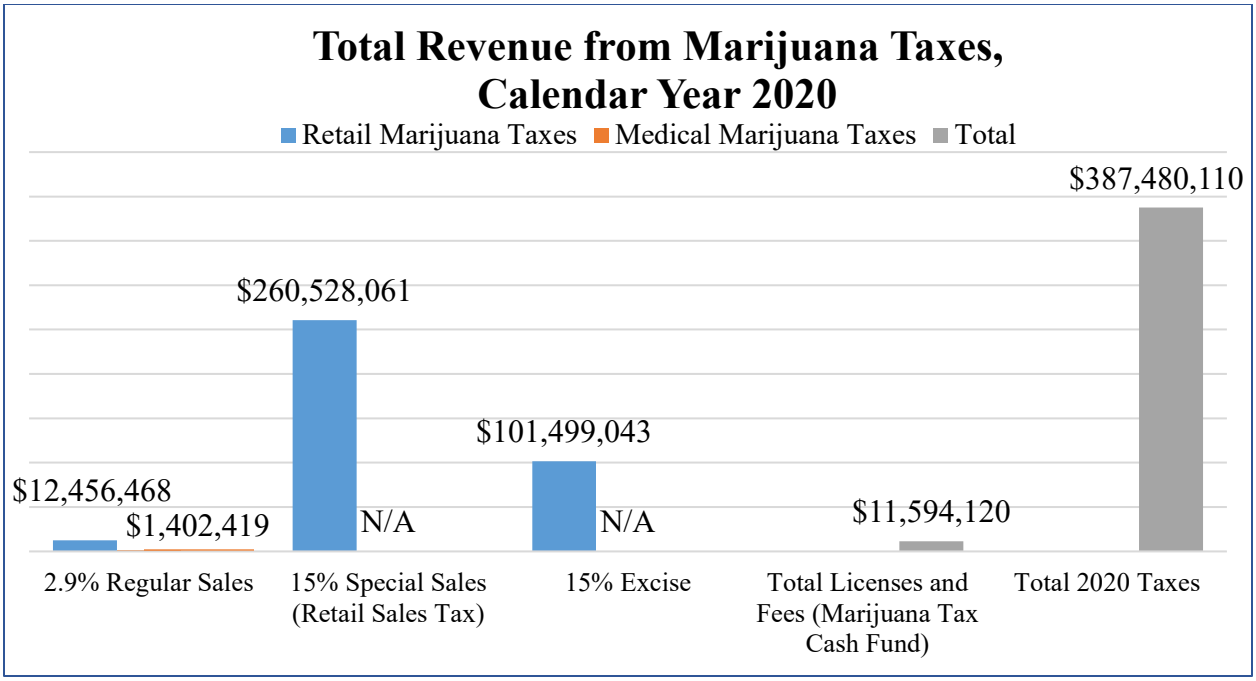
For more detailed marijuana-related crime information, please visit https://cdpsdocs.state.co.us/ors/docs/reports/2021-SB13-283_Rpt.pdf.

Tax Revenue



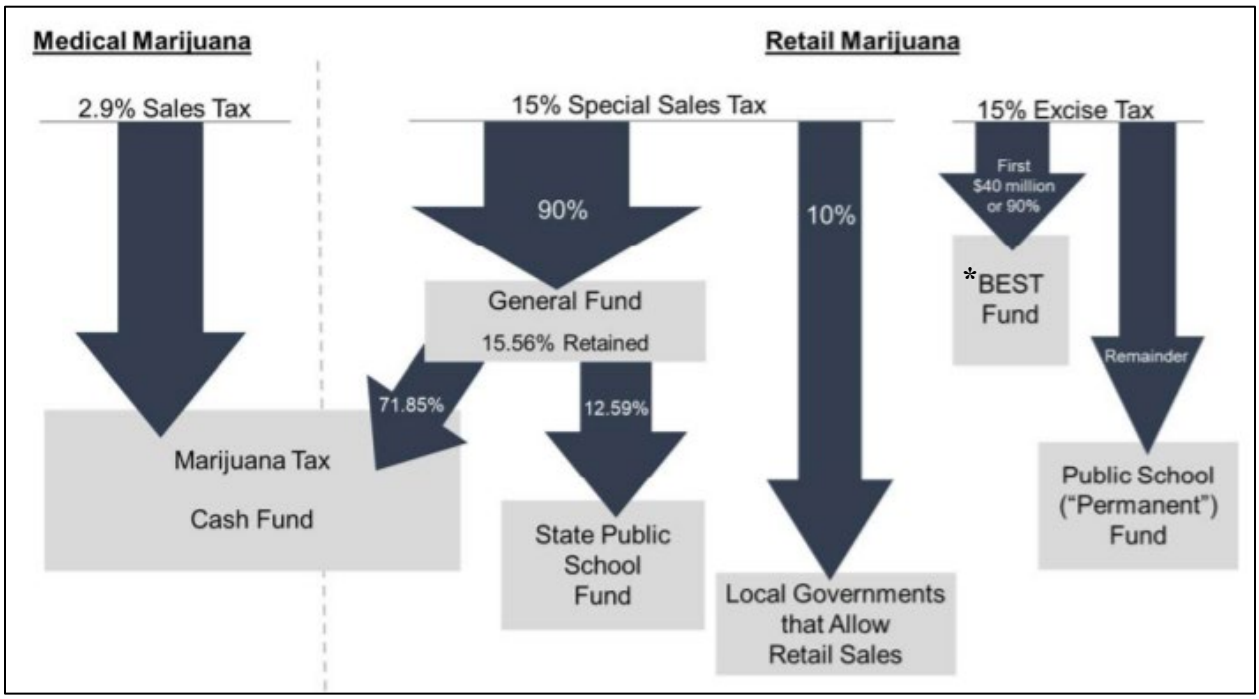
SOURCE: Governor's Office of State Planning and Budgeting

***NOTE:** Revenue from marijuana taxes as a portion of Colorado's total statewide budget.



SOURCE: Colorado Department of Revenue

NOTE: Figures do not include any city taxes; the state does not assess or collect those taxes.
Per §39-26-729, C.R.S., retail marijuana, retail marijuana products, and retail marijuana concentrates are exempt from the 2.9% regular sales tax; however, products that do not contain marijuana (i.e., accessories) are still subject to the 2.9% regular sales tax. Licenses and fees include the following categories: retail marijuana, individual, others, and collections not yet allocated.



SOURCE: Joint Budget Committee Appropriations Report Fiscal Year 2019-2020

*BEST- Building Excellent Schools Today

Crime

Marijuana-Related Arrests in Colorado			
	Crimes Against Person	**Crimes Against Property**	**Crimes Against Society**
2009	187	426	10,388
2010	172	416	10,026
2011	167	450	10,576
2012	192	441	11,365
2013	45	216	5,358
2014	60	273	5,689
2015	55	253	5,560
2016	69	327	5,126
2017	83	297	4,983
2018	74	310	4,641
2019	70	268	3,704
2020	65	188	2,140

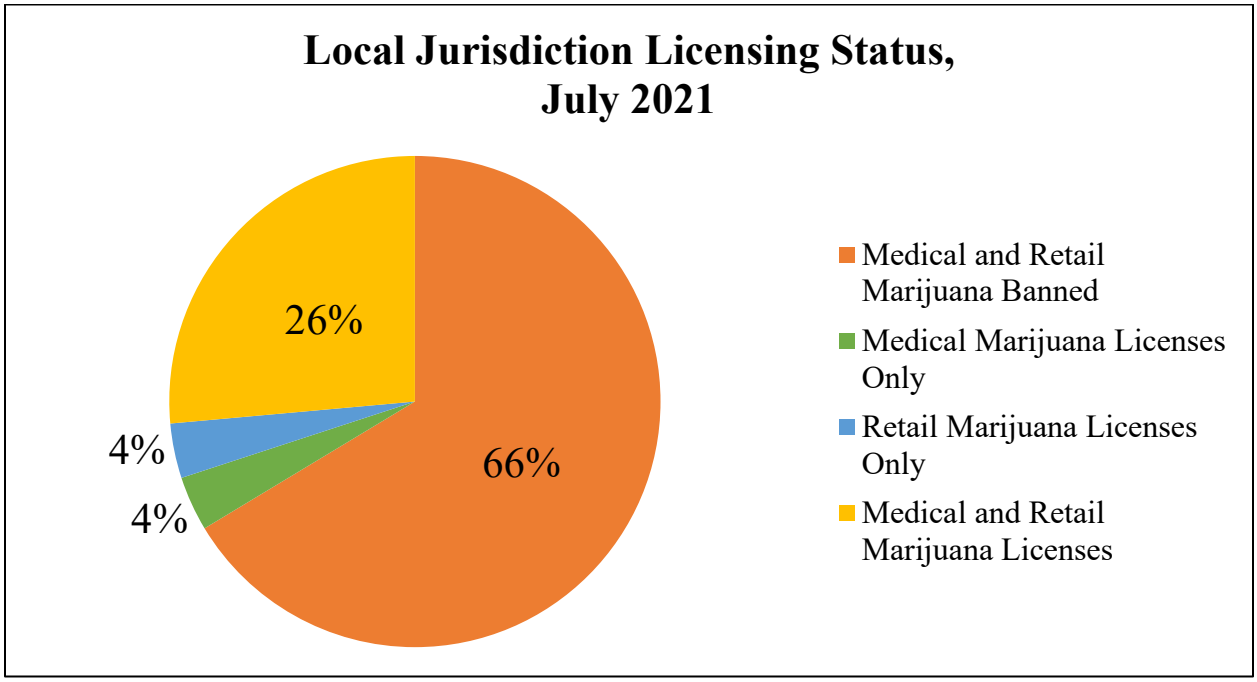
SOURCE: Colorado Bureau of Investigations Crime Statistics

NOTE: In 2020, arrest numbers were impacted by the COVID-19 pandemic's impact of the local, state, and federal judicial systems.

Local Response

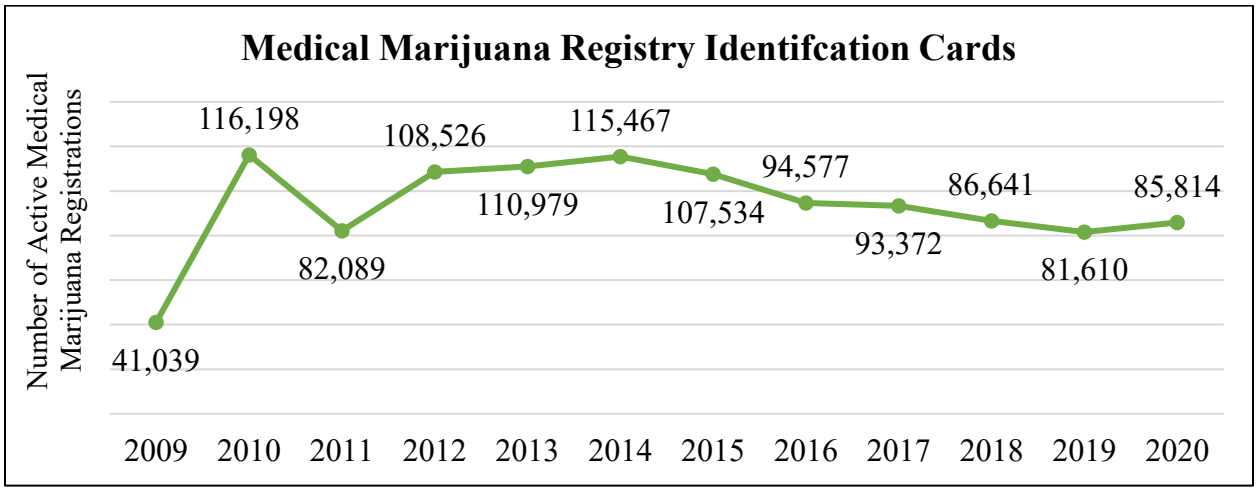
Status of Local Jurisdictions Reporting Marijuana Licensing as of July 12, 2021	
	Number of Jurisdictions
Medical and Retail Marijuana Banned	221
Medical Marijuana Licenses Only	12
Retail Marijuana Licenses Only	12
Medical and Retail Marijuana Licenses	88
Total	333

SOURCE: Colorado Marijuana Enforcement Division



SOURCE: Colorado Marijuana Enforcement Division

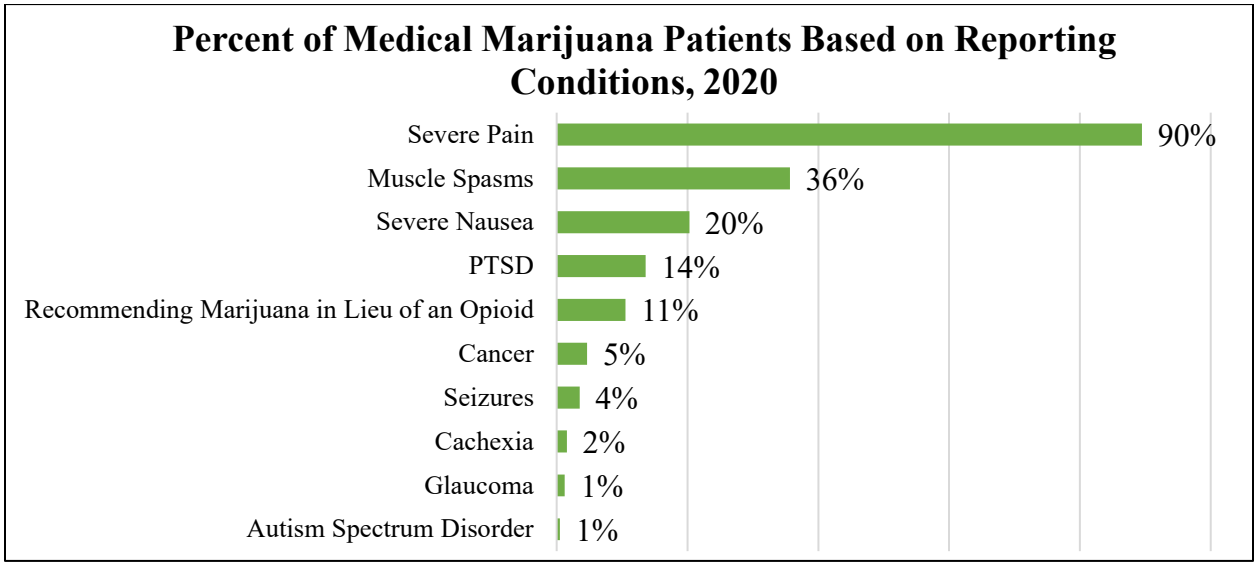
Medical Marijuana Statistics



SOURCE: Colorado Department of Public Health and Environment (CDPHE)

Profile of Colorado Medical Marijuana Cardholders:

- Demographics of cardholder:
  - 61% male with an average age of 41 years
  - 39% female with an average age of 44 years
  - 0.32% between the ages of 0 and 17
  - 4.57% between the ages of 18 and 40 and 22.81% between the ages of 21 and 30
- Top five counties in Colorado- 63.1% of total patients:
  - El Paso County- 28.6%
  - Denver County 13.0%
  - Jefferson County- 9.5%
  - Arapahoe County-7.7%
  - Adams County- 6.3%

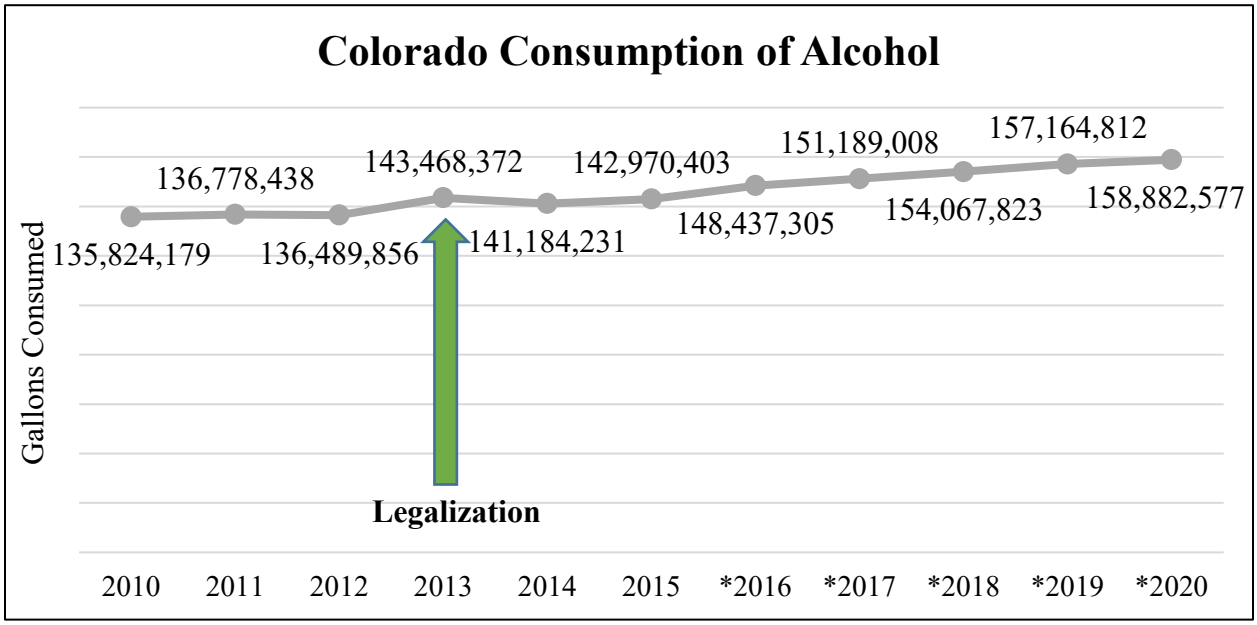


SOURCE: Colorado Department of Public Health and Environment (CDPHE)

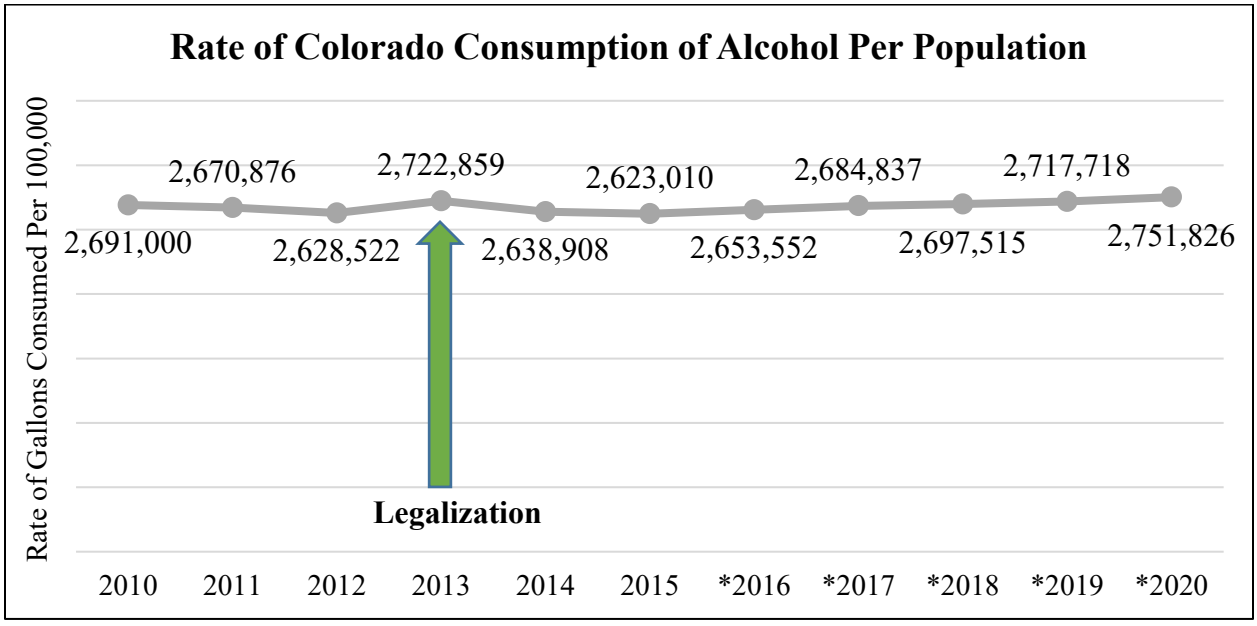
NOTE: Percentages do not add to 100% as some patients report more than one debilitating or disabling medical condition.

Alcohol Consumption

- It has been suggested that legalizing marijuana would reduce alcohol consumption. Thus far that theory is not supported by the data.



SOURCE: Colorado Department of Revenue, Colorado Liquor Excise Tax



SOURCE: Colorado Department of Revenue, Colorado Liquor Excise Tax

***NOTE:** Data from 2009 was not available at this time**.** Calculations of total gallons consumed and the rate of consumption slightly differed from 2010-2015 compared to 2016-2020.

Societal Impact Information

Recreational Marijuana Dispensaries Impact on Property Values in Washington

A study in Washington was completed to assess the impact of marijuana legalization on property values throughout the state. The authors sought to better understand the local level impacts of the expansion of marijuana businesses in neighborhoods throughout Washington. This study utilized data from property sales and retailers statewide to compare the prices in neighborhoods before and after the opening of a recreational marijuana business. One factor that the authors hypothesize may be the source of the decrease in prices is the perception that dispensaries result in more crime in the area. However, existing evidence is unclear of this relationship.

The study resulted in an estimation that while there was not a statistically significant impact on overall crime reports, nuisance crimes around dispensaries increased but drug-related crimes decreased. "Increased nuisance related crime, therefore, may be one contributing factor to depressed home prices in areas near dispensaries" (Thomas and Tian, 2021). When examining the final results, "a marijuana dispensary decreases property values by 3%–4% for homes within 0.36 miles of the retailer, a decline of about $10,000-$15,000 based on the average home values in Washington. These results imply a high willingness to pay to avoid the local negative externalities. […] While we find limited evidence of a general decrease in overall crime and statistically significant evidence of a decrease in drug-related reports, we estimate that nuisance-related crime reports increase by about 4.2 per 10,000 census tract residents. Moreover, we find evidence that violent crime slightly increases in census tracts adjoining those where dispensaries locate. Our findings suggest that crime risk could be a contributing factor to the negative price impacts of dispensaries, but that is likely only a partial explanation" (Thomas and Tian, 2021).

Source: Thomas, D. and Tian, L. (2021). *Hits from the bong: The impact of recreational marijuana dispensaries on property values.* Regional Science and Urban Economics, 87, 103655-103675.

Crime in Colorado and Washington State Post-Legalization

While some believed that crimes, particularly marijuana-related crimes, would decrease after the legalization of recreational marijuana, the preliminary data suggested a significant increase in crime rates. The authors created a study examining the UCR data from 1999 to 2016 in Colorado and Washington at a monthly crime rate compared to control states in which recreational marijuana was not legal. In the results, there was little effect on overall crime rates in Colorado and Washington post-legalization, particularly on violent crimes. However, there was a statistically significant increase in larceny in Colorado immediately after legalization as well as an increase in aggravated assaults, burglary, and overall property crime in Washington. This trend dissipated in recent years and appeared to have been short-lived. Overall, the authors concluded there was "virtually no statistically significant long-term effects of recreational marijuana legalization or retail sales on violent or property crime rates, except for a significant decline of burglary rates in Washington. There were some immediate increases in crime at the point of legalization, but these did not result in long-term effects" (Lu et al, 2021).

Source: Lu, R., Willits, D., Stohr, M., Makin, D., Snyder, J., Lovrich, N., Meize, M., Stanton, D., Wu, G., and Hemmens, C. (2021) *The cannabis effect on crime: time-series analysis of crime in Colorado and Washington state.* Justice Quarterly, 38(4), 565-595.

Impact of Marijuana Legalization on Colorado Clearance Rates

One of the arguments in favor of the legalization of marijuana was police resources would be freed up with less marijuana-related crimes. On the other side of the argument, some believed areas around dispensaries would become a hub for crime, both violent and property, due to the large amount of cash associated with these locations. This study examined violent and property crimes from 2000 to 2017 in Colorado and Washington and compared the crime rates to states where marijuana was not legalized. The results indicated that violent crime clearance rates were not affected by the legalization of marijuana in Colorado. Property crime clearance rates were also not impacted in the long-term in Colorado but instead only for one year after legalization. Similar results were found in Washington when these crimes examined in these two categories compared year-to-year. The authors speculate if the legalization of marijuana has shifted the focus from law enforcement to investigating marijuana-related DUI cases for example rather than clearing crimes.

Source: Jorgensen, C. and Harper, A. (2020). *Examining the effects of legalizing marijuana in Colorado and Washington on clearance rates: a quasi-experimental design.* Journal of Experimental Criminology, 1-22.

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PRACTICE MARIJUANA LAND USE



Regulating Medical and Recreational Marijuana Land Use

By Lynne A. Williams

Twenty-five states and the District of Columbia allow the cultivation, sale, and use of medical marijuana.

In addition, four states—Colorado, Washington, Oregon, and Alaska—have legalized the cultivation, possession, use, and sale of recreational marijuana, and the District of Columbia has legalized cultivation, possession, and use. In 2016, there will likely be at least five, if not more, states that will vote on the legalization of recreational marijuana, including Arizona, California, Massachusetts, Nevada, and Maine. (For information about individual states and the status of marijuana laws, see norml.org/states.)

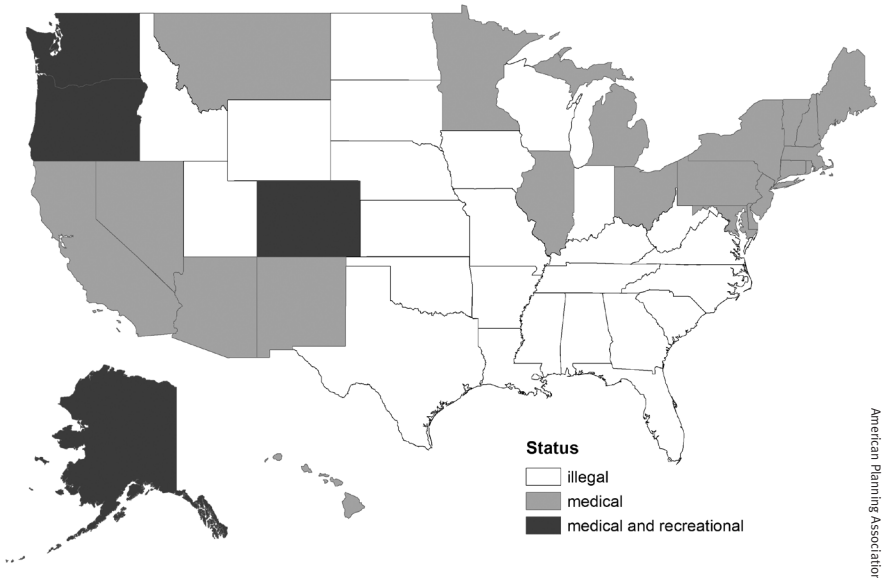
While the legalization of medical marijuana created some land-use issues, for the most part they are simpler and less urgent compared with issues related to the legalization of recreational uses. California failed to even enact a regulatory scheme until late 2015, 19 years after legalizing medical marijuana. During that time, so-called dispensaries proliferated but towns and cities were slow to address potential land-use issues, given the lack of guidance by the state. Maine, which legalized medical marijuana in 1999, did not even allow dispensaries until 2009. So for 10 years Maine's patients got their medicine from a system of individual caregivers, most of whom operated out of their homes or farms and were limited to serving five or fewer patients. However, the legalization of recreational marijuana in a number of states, with more to follow—combined with the possibility of new dispensaries in some states—has spurred towns and cities to begin to discuss land-use issues for marijuana businesses.

Currently, towns, cities, and counties use a wide variety of regulatory tactics to control marijuana businesses and activities, and those tactics break down into two broad groups—business licensing standards and zoning. With respect to medical marijuana uses, most of the focus has been on regulating the siting of dispensaries and cultivation operations through zoning. The types of regulatory schemes established in the newly legalized recreational marijuana states range from localities "opting out" to making a marijuana business a "use by right" in certain districts, with a required permit. Most tactics use both zoning and business licensing regulations, often in combination. For example, a business licensing requirement can be overlaid on a zoning ordinance, so that if a marijuana business use is an allowed use, the business must still obtain a license, and that process would address specific aspects of the business, such as safety issues, noise, odors, parking, traffic, and other impacts.

This article reviews local approaches to regulating medicinal and recreational marijuana. While both medical and recreational marijuana businesses are part of a new economic sector that involves land uses and businesses, heretofore unseen in many communities, there are multiple options that can be implemented. The following sections discuss how these options are being implemented both in jurisdictions that have legalized recreational marijuana as well as in those that have only legalized medical marijuana.

FEDERAL PREEMPTION

Marijuana, whether medical or recreational, continues to be listed on Schedule I of the U.S. Controlled Substances Act (CSA) and is therefore still illegal under federal law. However, the U. S. Department of Justice (DOJ), most recently in 2013, has advised federal prosecutors to refrain from using scarce federal drug enforcement resources to prosecute individuals who are in compliance with state law (Cole 2013).



American Planning Association

As of July 2016, 25 states and the District of Columbia have legalized medical marijuana. Four of those states have also legalized recreational marijuana sale and usage.

This advisory from the DOJ reduced the potential conflict between the federal government and those states that have legalized recreational or medical marijuana. And reducing conflict between the states and the federal government will consequently constrain the ability of a local jurisdiction to successfully ban marijuana businesses based on an argument that such businesses are in violation of the CSA.

Division One of the Arizona Court of Appeals is currently considering a case in which Maricopa County attempted to prevent White Mountain Health Center, a dispensary, from opening (*White Mountain Health Center, Inc. v. Maricopa County et al.,* 1 CA-CV 12-0831). The county argued that denying a dispensary a permit to open is legally permissible since such a business violates the CSA. However, while states can regulate marijuana, they are not required to enforce federal law. In this case, Arizona has legalized medical marijuana and regulates dispensaries, and White Mountain argues that the county's denial of a permit was impermissible in that it conflicted with state law. The *White Mountain* decision will likely be issued soon.

In February 2014, the Michigan Supreme Court declared a city zoning ordinance in Wyoming, Michigan, void because it prohibited uses that were permitted under state law (*Ter Beek v. City of Wyoming,* 846 N.W.2d 531, 495 Mich. 1 (2014)). The plaintiff was a qualifying patient who wished to grow and use marijuana for medical purposes in his home. The town of Wyoming had passed an ordinance prohibiting the activity. The court held that a municipality is precluded from enacting an ordinance if the ordinance directly conflicts with the state's statutory scheme of regulation, in that the ordinance permits what the statute prohibits, or prohibits what the statute permits. In this case, the Michigan Medical Marihuana Act permitted qualified patients to grow their own medicine; therefore, the city could not prohibit such a practice.

MEDICAL MARIJUANA REGULATORY MODELS

The first medical marijuana statute was passed 20 years ago, but in many ways it is only within the last few years that those early statutes have been refined on the local jurisdictional level. Some jurisdictions were required by newly passed state regulations to create local ordinances, such as Humboldt County, California, and the municipalities within the county, while other local jurisdictions, including Detroit, took the initiative following a period of confusion over the definition and regulation of dispensaries.

Humboldt County, California

Earlier this year, California's Humboldt County passed one of the most comprehensive land-use ordinances to date regulating medical marijuana production. The Commercial Medical Marijuana Land Use Ordinance (CMMLUO) passed the Board of Commissioners unanimously, a testament to the many disparate groups coming together to draft the ordinance (Ordinance No. 2544). Much of Humboldt County is unincorporated land, and although there are municipalities in the county, much of the cultivation is done on unincorporated land.

The CMMLUO includes two parts: one regulating the coastal zone and the other regulating inland cultivation. Both zones are regulated according to a list of factors, including whether the applicant is a new or existing grower, the parcel size, the cultivation area size, and whether the proposed grow operation will be outdoors, indoors, or mixed-light, meaning that both natural light and artificial light will be used.

The goal of the CMMLUO is very clear: "to limit and control such cultivation in coordination with the State of California." Although the Compassionate Care Act was passed in 1996—the first medical marijuana law in the country—the state failed to enact medical marijuana regulations until late 2015. Humboldt County was proactive in enacting a countywide ordinance to immediately comply with state law. The ordinance specifically defines exactly what it is regulating. "This section applies to all facilities and activities involved in the Commercial Cultivation, Processing, Manufacture or Distribution of cannabis for medical use, in the County of Humboldt" (CMMLUO §55.4.9). The type of approval necessary for licensing is dependent on the size and current zoning classification of the parcel, as well as the type of state license that the applicant is required to obtain.

The Humboldt municipalities of Arcata and Eureka have also passed ordinances related to cultivation. Arcata essentially permits only small-scale and home cultivation, although those with special needs may request more grow space (Land Use Code §9.42.105). It also enacted a 45 percent tax increase on residences that use more than 600 percent of the energy baseline, with the aim of discouraging indoor growing (Municipal Code §2628.5). Eureka passed a much more restrictive and detailed ordinance, only allowing licensed patients to grow and process medical cannabis within a 50-square-foot area in their residence (§158.010(A)). The ordinance also states that such cultivation will constitute neither a home occupation nor an ancillary use (§158.010(C)). Patient marijuana processing is likewise narrowly regulated (§158.011).

Detroit

Detroit recently passed a medical marijuana ordinance requiring dispensaries, now called

Medical Marijuana Terminology

It is far easier to define recreational marijuana uses by the vocabulary of traditional businesses, such as agricultural, retail, food processing, and the like, than it is to define medical marijuana uses. There is no national consensus on terminology in the medical marijuana arena. In fact, the word "dispensary" has multiple meanings depending on location. In most, but not all, of the medical marijuana states, the term "dispensary" means the entity that distributes medicinal marijuana to qualified patients. This may be a large facility that also cultivates the marijuana (e.g., Maine and Michigan) or a small shop that purchases from independent growers (e.g., California and Arizona). The entity can be a collective, nonprofit, for-profit business, or any other form of entity legal under state law.

In certain states the caregiver system, another form of cultivation and distribution, exists side by side with the dispensary system. Caregivers are state-licensed individuals who grow, process, and distribute medicinal marijuana to a limited number of qualified patients. Caregivers are regulated under state law, but have only recently been subject to land-use regulation. (For a chart detailing the distribution laws under each state that has legalized medicinal marijuana, see tinyurl.com/y2tyn7g.)

Caregiver Centers, to apply to the city for a license (Ordinance 30-15). A subsequent zoning amendment added Caregiver Centers as permissible uses in specific zones and explicitly prohibits them in the Traditional Main Street Overlay and the Gateway Radial Thoroughfare Districts (Ordinance 31-15). Detroit seeks to distribute the Caregiver Centers rather than cluster them in a few areas, since they cannot be less than 1,000 feet from each other nor closer than 1,000 feet from a park, religious institution, or business identified as a controlled use, such as topless clubs and liquor stores. If a business is within 1,000 feet of any of these land uses, the board of zoning appeals allows for a variance process that could still allow the facility to establish or continue to operate. The city's Buildings, Safety, Engineering, and Environmental Department can also approve variances.

If, however, the parcel in question is less than 1,000 feet from the city-defined Drug Free Zones, that option is not available. No variance is allowed for parcels falling into these buffer zones, and there are many such buffers zones. The federal Drug Free School Zone applies just to libraries and K–12 schools. However, the Detroit version includes arcades, child care centers, youth activity centers, public housing, outdoor recreation areas, and all educational institutions, including all of their properties. In the industrial districts, the centers can be less than 1,000 feet from each other to allow for some clustering, and the buffer zone from residential areas is waived.

An individual who cultivates marijuana in a residence in Detroit is required to register as a home-based occupation. The city's licensing standards state: "Except for home occupations . . . no person shall dispense, cultivate or provide medical marijuana under the Act except at a medical marihuana caregiver center" (§24-13-4). That registration process involves inspection and approval by numerous city agencies.

Maine

Maine passed its medical marijuana law in 1999, but it was not until 2009 that dispensaries were allowed there. Up until that time, patients received their medicine from a caregiver, individuals licensed to grow and distribute medicinal marijuana to no more than five patients. That system remains operational, with over 2,000 caregivers, and is greatly favored by many patients in the state. There has been little impact of land-use regulation on caregivers, for a number of reasons. The fact that an individual is a caregiver is kept confidential by the state, so a town doesn't really know who the caregivers are. Until a year or two ago, caregivers mainly grew their plants and serviced their patients out of their homes, and many towns essentially allow home occupations with few, if any, restrictions.

In the last two years, however, there has been an increase in the number of caregivers leasing commercial space, primarily in light industrial zones. Thus the towns where this is occurring will need to decide whether they wish to develop special regulations for buildings housing multiple caregivers in industrial zones. There is no state law prohibiting this practice, even though under state law each caregiver must have his or her own locked space within the building, and that space must be inaccessible to anyone else except their one employee. Some towns maintain that any growing of plants by a caregiver, whether indoors or outdoors, is an agricultural use, thereby preventing multiple caregivers from leasing grow spaces in an industrial space. Conversely, those towns that classify caregiving as a light industrial use will have to contend with outdoor cultivation and grow operations in homes and on farms in residential districts.

Maine towns that have chosen to refine their land-use ordinances to address medical marijuana caregiving share some common goals: updating existing site plan review requirements, if needed; defining the caregiver land-use category; considering a "safe zone" as an overlay zone, thereby requiring greater setback distances than other uses in the zone; instituting fencing and setback requirements on outdoor cultivation; and considering standards for multiple caregiver facilities.

In 2009, the Maine Medical Use of Marijuana Act was amended to allow eight dispensaries in the state, one in each of eight regions. Even though the cap on dispensaries has been reached, some towns with land-use ordinances are struggling to find ways to regulate dispensary locations if the cap is lifted. State law is clear that a town cannot ban dispensaries but can limit the number to one. In general, what a number of towns are attempting to do is bring dispensary siting under site plan review and define what zone or zones are appropriate for a dispensary. Often the dispensaries are relegated to one, or a few, locations, a form of cluster zoning rather than keeping dispensaries and other marijuana businesses a distance away from each other. A few towns are looking at an



Joshuasandoval, Wikimedia (CCby-SA3.0)

A former fast food restaurant in California was converted into a medical marijuana dispensary.

overlay district, which would impose additional controls and an additional form of review, over dispensary siting.

RECREATIONAL MARIJUANA REGULATORY MODELS

Towns, cities, and counties within states that have legalized recreational marijuana have taken very different regulatory tacks. For example, the state of Washington has practically subsumed the Washington medical marijuana program into the recreational legalization scheme, in a bill passed in April 2015 that will be implemented in 2016. And Oregon, while keeping the medical program separate from the regulation of recreational marijuana businesses, has imposed strict new rules on the medical growers and patients.

A key issue for states that have legalized recreational marijuana is where marijuana may be smoked or vaped. None of the legalization statutes permit smoking marijuana in public, so, particularly in communities with a large number of tourists, the issue of consumption location is a critical one. Although a tourist can purchase marijuana, smoking might not be allowed in a hotel or motel room. To address this issue, some jurisdictions are looking at permitting so-called "social clubs," similar to cigar bars, where visitors could smoke or consume marijuana. None of the four states that have legalized recreational marijuana included social clubs in their statutes. However, a pending rule change in Alaska would allow existing marijuana retail stores to purchase a separate license for a "consumption area." And in November, Denver voters will consider a measure that would allow the consumption of marijuana—but not sales—at private social clubs and during private events if the organizers obtain a permit.

Below is a discussion of local prohibition in Pueblo, Colorado, and use by right in Pueblo County; traditional zoning and business permitting in Seattle; a focus on farmland preservation and opt-in/opt-out in Oregon; and a focus on business licensing, as opposed to zoning-based controls, in Denver.

Pueblo County, Colorado

In 2012, Colorado Amendment 64 gave local governments the power to decide whether and how to permit recreational marijuana within their community. A 2014 annual report stated that as of that time 228 Colorado local jurisdictions had voted to ban medical and retail marijuana operations. The city of Pueblo banned recreational marijuana retail stores within city limits and had formerly placed a moratorium on medical marijuana dispensaries.

However, Pueblo County, which governs all unincorporated land in the county, acted differently, making marijuana businesses a by-right use in commercial and industrial districts, thereby allowing such businesses to avoid lengthy governmental reviews (§§17.120.190–240). In addition, the county also made marijuana cultivation a by-right use, apparently the first Colorado county to do so. The county also passed rules mandating a five-mile distance between hemp growing areas and existing marijuana growing areas so as to avoid cross-contamination (§17.120.280). In addition to land-use regulation, the Pueblo Board of Water Works passed its own resolution to address the fact that the Federal Bureau of Reclamation prohibits the use of federal water for marijuana cultivation (Resolution No. 2014-04). The water board subsequently concluded that they could lease up to 800 acre-feet of water to marijuana cultivators each year (Resolution No. 2014-05).

Seattle

Washington voters approved Initiative 502, legalizing recreational marijuana, in 2012. The year before, Seattle had passed Ordinance 123661, clarifying that all marijuana businesses, including manufacture, processing, possession, transportation, dispensing and the like, must be in compliance with all city laws, as well as applicable state laws. In 2013, the city amended its zoning ordinance to specify where larger-scale marijuana business activities could locate (§23.42.058). The specific activities include processing, selling, delivery, and the creation of marijuana-infused products and usable marijuana. While these activities are prohibited in residential, neighborhood commercial, certain downtown, and several historic preservation and other special-purpose districts, the zoning ordinance does not require a land-use permit to specifically conduct marijuana-related activities in industrial, most commercial, and a few downtown districts.

For example, an applicant who wishes to open a marijuana retail store or an agricultural application is required to get the applicable permit, but is not required to disclose that the use is marijuana related. The ordinance does, however, impose a size limit on indoor agricultural operations in industrial areas, but this applies to all agricultural uses in industrial areas, not just marijuana production (§23.50.012, Table A, Note 14).

Meanwhile, state law further restricts permissible locations for marijuana businesses. The state will not grant a license to any marijuana business within 1,000 feet of an elementary or secondary school, playground, recreation center, child care center, park, public transportation center, library, or game arcade that allows minors to enter.

Oregon

The voters of Oregon passed Measure 91 in 2014, legalizing recreational marijuana and related businesses, and the legislature enacted HB 340 in July 2015, thereby establishing a regulatory framework for such businesses.

Farmland preservation is one of the major objectives of land-use regulation in Oregon. Following the passage of Measure 91, a "local option" was created, whereby a local government in a county where at least 55 percent of the voters opposed Measure 91 could opt out of permitting marijuana businesses. The local government had 180 days from the passage of HB 340 to choose to opt out. Local governments in counties where more than 45 percent of the voters supported Measure 91 could refer an opt-out measure to the local electorate for a vote.

Many local governments have chosen to opt out, including a number of rural towns and larger municipalities such as Grant's Pass and Klamath Falls (Oregon Liquor Control Commission 2016). Medford has banned retail marijuana businesses but permits producers and processors. However, some of the towns and cities still need to hold a general referendum on the issue in November 2016.

Portland has chosen to take a two-pronged approach to the regulation of marijuana businesses. The city's zoning authority has not adopted rules governing the zoning of marijuana businesses, but is applying the city's general development rules to them. Those rules include such standards as setbacks, conditional uses, parking height limitations, lot coverage, and the like that are specific to each zone. Therefore, if a marijuana retail business wishes to locate in a retail district, it would be allowed to do so provided the proposed business complies with the relevant general development rules in that district. However, the city does require that such businesses get a special license, and the licensing provisions stipulate a 1,000-foot buffer between retail marijuana

businesses (Chapter 14B.130). As another example, Bend's development code allows retail marijuana businesses in commercial zones and production and processing in industrial zones with certain restrictions, including visual screening, security, and lighting requirements (Development Code §3.6.300.P).

Oregon state law requires non-opt-out rural counties to treat cultivation businesses as a permitted farm use in the farm use zone, but these counties have discretion about how they treat production in other zones. Clackamas County, for example, treats marijuana cultivation as a farm use in other natural resource zones, including forest zones and mixed farm-forest zones (§12.841).

Denver

Denver licenses four types of retail recreational marijuana-related businesses: retail stores, optional premises cultivation, infused products manufacturing, and marijuana testing facilities (§§6-200–220). The city made a conscious decision not to regulate marijuana businesses as distinct land-use categories, but its licensing standards do cross-reference the zoning code. Denver also grandfathered business locations that existed before the licensing regulations were implemented. This mainly benefitted medical marijuana dispensaries that had been in place before Denver adopted a new zoning code in 2010.

The city regulates medical marijuana establishments under a separate set of provisions in the Health and Sanitation section of its code (§§24-501–515).

Denver currently prohibits medical and recreational retail stores in any residential zone, any "embedded retail" district (small retail district embedded in a residential district), any location prohibiting retail sales, and within 1,000 feet of any school or child care center, any alcohol or drug treatment facility, and any other medical marijuana center or dispensary or retail marijuana store. However, the distance requirements are computed differently for medical marijuana centers versus retail stores. The medical marijuana center regulations use a measurement called a "route of direct pedestrian access," and the retail stores regulations use a computation "by direct measurement in a straight line."

Denver's retail and medical marijuana regulations allow cultivation in any location where plant husbandry is a permitted use, and grandfathering is allowed in these zones. The regulations also allow licensing for marijuana-infused products on a lot in any zone where food preparation and sales or manufacturing, fabrication, and assembly are permitted.

PLANNING TO PLAN

Over my years as an attorney in the land-use arena, I have seen numerous towns and cities start down the path of amending their land-use ordinance without answering certain basic questions. Often this is based on a failure to identify what sorts of as yet unheard-of businesses or other operations might, one day, file for site plan review—or, more troubling, *not* file for site plan review because the use is not covered by the land-use ordinance. However, it is at just this time that the local government must act thoughtfully and not overreact. Rather, the locality should answer certain questions.

First, should marijuana businesses be subject to special regulatory controls? If not, what category of use does a specific marijuana business fall into? Without special regulatory controls it will be governed just as any similar use is governed.

For example, California passed the first medical marijuana law in 1996, but since then there has been a problem defining a medical marijuana business. Is a dispensary retail or light industrial? Is a caregiver agricultural, home occupation, or light industrial? Is an outdoor cultivation operation agricultural and an indoor cultivation operation a home occupation or light industrial? Additionally, will the regulation of marijuana businesses include only land-use controls, only licensing requirements, or a combination of both? There are no clear answers to these questions, but in order to regulate successfully, each town must find its own answers.



Jeffrey Beall, Wikimedia (CC-by-3.0)

A combination gas station and recreational marijuana store in Colorado.

Additionally, since all operative medical and recreational marijuana laws are based on statewide statutes, a locality must also address whether a proposed ordinance is in compliance with state law. In most, if not all, statewide marijuana laws, there is either a statement, or an unstated inference that the state has occupied the field of marijuana regulation, and that local ordinances cannot conflict with, or frustrate the intent of, state laws.

Many courts throughout the country have expressed the following sentiment: "A municipality may prescribe the business uses which are permitted in particular districts but to prohibit the sale of all intoxicating beverages or other activities where such sale has been licensed by the state is to infringe upon the power of the state" (*Town of Onondaga v. Hubbell,* 8 N.Y.2d 1039 (1960)). Even home rule, in home-rule states, has its limitations.

Even using zoning in combination with business licensing can create problems. A case currently making its way through the Maine court system is a challenge to a local ordinance that requires medical marijuana caregivers to come to a public meeting in order to request a business permit.

The plaintiffs argue that the ordinance is a violation of state law, which clearly states that the identity of all caregivers must remain confidential, and makes disclosure of such information a civil violation with a fine imposed (*John Does 1–10 v. Town of York*, ALFSC-CV-2015-87). However, as caregivers begin to move away from home cultivation into leased industrial space, a town could conceivably require a non-caregiver landlord, who rents to caregivers, to obtain a business permit.

Conversely, under adult recreational statues in those states that have legalized recreational marijuana—as well as under the initiatives to be voted on in November 2016—the identity of the businesses seeking state licensure is not confidential. Municipalities and counties will therefore be able to determine the proposed business use, its suitability in a zone or district, and whether or not a business license is required, thereby moving marijuana land-use away from the often vague regulatory system of medical marijuana to the well-known structure of land-use regulation and business licensure.

Medical marijuana regulatory systems will still exist in most states that have legalized it, but it is likely that the majority of businesses in the marijuana sector will be recreational, rather than medical, and therefore more easily regulated by municipalities and counties.

CONCLUSION

The public is overwhelmingly in support of legalization of recreational marijuana. A recent Associated Press/University of Chicago poll indicated that 63 percent of those polled support legalization, although when broken down into medical and recreational, a smaller number, yet still a majority, supported recreational. That said, however, 89 percent of millennials, now the country's largest generation, support complete legalization (Bentley 2016). As with medical marijuana legalization, as more states legalize, even more states will likely follow suit.

It is, therefore, incumbent on towns, cities, and counties to become educated on their state's statutes and the local regulations that have been passed or will likely be passed in the future, and to draft land-use ordinances that address, in the ways most appropriate to the locality, the proliferation of medical marijuana and recreational marijuana uses.

Since most states have not yet legalized recreational marijuana, now is definitely the time to study and address the land-use issues that legalization may raise.

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