

## eAppendix 1: Cannabis policy data collection protocol

### Overview

We used a legal epidemiological approach<sup>1,2</sup> to conduct a comprehensive assessment of local cannabis policies in 12 of California's 58 counties.

### Geographic scope

This study focused on 12 California counties and the cities within them. The 12 counties were: Alameda, Humboldt, Los Angeles, Orange, Riverside, Sacramento, San Bernardino, San Francisco, Santa Barbara, Sonoma, Tulare, Yuba. The 12 counties were selected to capture a range of sizes, sociodemographic compositions, political orientations, and approaches to cannabis regulation.<sup>3</sup> We used the most recent US Census Bureau maps (2010 TIGER/Line shapefiles) to identify all incorporated places (i.e., cities and towns) within the 12 study counties. We identified 228 unique cities and towns. We added an additional 2 cities which became incorporated places after the last US Census Map update (Eastvale and Jurupa Valley). San Francisco is a consolidated city and county with a single unified government, so the final policy data covered 241 jurisdictions.

### Time frame

Policy text were collected and coded from November 1, 2020 to January 31, 2021. Legal text downloaded between these dates reflects the currently applicable laws and regulations for the corresponding city or unincorporated county area, or the applicable laws as of the last update of the local government's online searchable database of currently applicable laws – usually within 1-2 months of the date on which the text were downloaded. When downloading the legal text, we recorded both the date of download and the date through which the code and ordinances were updated.

### Policies of focus

The cannabis policy measures we collected were guided by an established taxonomy of all possible cannabis policies developed by affiliates of the Alcohol Policy Information System.<sup>4</sup> From this comprehensive taxonomy, we measured all those policies that (a) could be regulated at the local level in California given state law, (b) varied meaningfully across jurisdictions within California, and (c) were plausibly related to public health according to prior evidence, recommended public health best practices, and expert opinion.<sup>3-5</sup> Although we expected that the primary distinction would be between jurisdictions permitting versus banning all commercial cannabis businesses, we collected comprehensive data to fully characterize the local policy approaches, and to replicate prior findings.<sup>3</sup>

Unless the legal text is identical across jurisdictions (which does happen on occasion because localities copy each other), there is always some degree of nuance in how local policies are articulated. We followed recommended practice in legal epidemiology<sup>1,2</sup> to identify the policy constructs that are relevant to the given research question (in our case, these were guided by the typology of all possible cannabis policies<sup>4</sup>), and then to convert these constructs into

objective questions with pre-defined response sets. These questions formed the data collection instrument used by the coders.

California state law specifies a minimum set of regulations that apply to medical and adult-use cannabis statewide. However, localities retain considerable discretion. We coded localities as having a policy if they established regulations more restrictive than state law. Table 1 describes the policies we captured, including the bounds of state and local powers. We covered three overarching groups of local regulations:

- (1) Public health-related restrictions on retail sales (this included a detailed assessment of policies that related to the number, density, geographic distribution, and locations of medical and recreational cannabis retail outlets [e.g. does the jurisdiction allow retail sales, do they place a cap on the number of dispensaries], and aspects of the operations of medical and recreational retail outlets that are likely to be related to violence [e.g. operating requirements related to loitering, upkeep, night lighting, security]. These were the highest priority given the scope of the grant and we coded them in detail.);
- (2) types of commercial cannabis businesses permitted (medical and/or recreational cultivation, distribution, manufacture, or testing);
- (3) other major public health regulations (e.g. taxes, limits on product types or potency, server training requirements, limits on advertising or marketing, requirements for product packaging or labeling).

We focused particularly on restrictions related to cannabis retail sales, which occurs through storefront dispensaries or home delivery businesses, because dispensaries are a primary means by which public health may be affected by cannabis legalization<sup>6</sup> and existing evidence suggests that policies regulating dispensaries are the key component of state laws linking legalization to consumption and problems.<sup>7,8</sup> The other major public health regulations are widely recognized public health policies for alcohol control.<sup>9-11</sup>

Given that the COVID-19 was occurring as this study was conducted, we took note of whether any special COVID-related policies have been adopted and what they are (e.g. a moratorium on in-person cannabis sales at dispensaries).

See data collection instrument for details of exact constructs/measures.

### Collection of legal documents:

Goal: Search and find all relevant code and ordinances (legal text) that applies to cannabis in the jurisdiction.

#### Pilot:

- We first piloted our process by having 2 investigators independently identify and download the legal text for the same 15 jurisdictions, then compared whether we uncovered the same citations / legal documents.
- We reviewed this initial pass and any issues that came up with a third investigator/expert and made revisions to our process to ensure comprehensiveness and consistency.
- After establishing consistency and confidence with the process, one investigator applied the same process for the remaining 226 jurisdictions.

#### Process:

1. Start with [Municode Library](#) and determine if the jurisdiction is covered.
  - a. If so, navigate to the page for that jurisdiction. Pay attention to whether the page is for the county or city, if they have the same name (e.g. Alameda county vs. Alameda city). If the jurisdiction is not listed in Municode, proceed to step 2
  - b. In a data collection spreadsheet, record the date of the code version to which the Municode documentation for that city/county refers.
  - c. Search for the search term: “cannabis OR marijuana OR marihuana”
    - “Select all” code hits and download for every page
    - “Select all” ordinance hits and download for every page
    - Save these text files in the folder corresponding to that jurisdiction name
  - d. If the option is provided, we are interested in both administrative code and code of ordinances.
  - e. Municode may also have “adopted ordinances not yet codified”. If so, check these ordinances for the search terms too. If any of these ordinances have any of our search terms, download them too and put them in the relevant folder.
  - f. Record the date the text was downloaded and the applicable date of the code in the data collection and coding tracker.
2. Find the city or county government’s official website
  - a. Find the searchable database that has all the current city/county code and ordinances
    - Often, the easiest way to do this is simply by googling the name of the jurisdiction plus code and ordinances, e.g. “alameda county government code ordinances”
    - If this does not work, try navigating to the city/county government’s webpage, specifically to the page for the city/county clerk of the board of supervisors, or the board of supervisors page. Usually, it is their job to document all the municipal/county codes and ordinances, and there should be a link to the code there.

- Try to find the site that indicates something like “here is all the current city code and ordinances” if it exists. This may very well be a link to Municode. Or, it should be a searchable database.
- We are specifically looking for the official codes and ordinances, not documents that are general guides, information, or application forms
- If it’s not on the city/county clerk page, try to use the website’s search bar for terms like “code ordinances” to try to find the right site.
- If that doesn’t work, try a manual search through the jurisdiction’s relevant departments where the code may be found, such as the planning department, development code, land use code, code compliance, or documents/archive

b. Once the online searchable database of the city/county’s current laws has been identified, use the keyword search to find the codes and ordinances that currently apply to cannabis. Use the same search term as for Municodes.

- Use whatever search mechanism works so that a hit will be identified if any of the relevant terms (cannabis, marijuana, marihuana) are mentioned. You may find that you need to go to the advanced search option to be sure your search is achieving this.
- In advanced search, select yes to ‘stemming’ if it is an option.
- Save the corresponding full text of each hit in a word document in the in the folder corresponding to that jurisdiction name.

c. In addition to keyword searching, also check for any uncodified ordinances or recently adopted ordinances such as those in Code Alerts or lists of New Ordinances

- If any of these ordinances have any of our search terms in them, find the full text, and download them. If you can’t find the full text online, call the county clerk to ask for it.

d. No need to search through the general ordinance lists – these are just records of how the city’s code has changed over time. Everything relevant that is in these should be captured in the current county/city’s code and caught in the keyword search.

e. Ignore statutory references – these are relevant state law.

f. Be sure to record the date you downloaded the text and the applicable date of the code in the data collection and coding tracker

3. Call the city/county clerk

- a. Do this only if no online searchable database of code and ordinances can be found. Explain what we are seeking to do and see if they can search the relevant terms for your and send the relevant text of the code/ordinances.
- b. When calling, also ask about:
  - Documents: Can you send me / do I have the most recent legal code on any alcohol policies?
  - Most recent documents: Have any code or ordinances been updated since [date of most recent document we have]?

- Changes in our study period: Has anything changed in cannabis codes or ordinances between 2017 and 2020? If so, do you have any previous versions of the codes relevant to 2017-2020?
- Are there any city/county-specific practices I should be aware of regarding the type of information posted on the websites and how often it is updated?
- Is there any information or data on enforcement of cannabis-related codes and ordinances that you are aware of and can share?
- Is there anything else I should know about any local cannabis laws with respect to implementation or enforcement? For example, if there are certain laws that are in place but not being enforced? Or if there are state laws that are being differentially implemented or enforced in your city or county versus in other parts of the state?

Document organization – for fully-scaled document collection:

- If it's in Municode, just download the entire relevant text and put it in the corresponding jurisdiction's folder
- If it's not in Municode, copy and paste the list of hits into a word document. Then click on the link to each hit and copy and paste the corresponding text into the word document below the title for that hit.

Other important notes, information, and considerations:

- There are likely to be a few places that have a lot of cannabis policies and a lot of places with few cannabis policies because they ban everything.
- We are primarily interested in cannabis laws that existed pre-COVID-19, but the laws that apply now are all we will be able to get. So, try to evaluate whether any of the current laws are ones that were adopted specifically because of COVID-19 and note these when coding the jurisdiction (e.g. a ban on in-person sales during shelter-in-place).
- Under California Sunshine Laws, jurisdictions are legally required to make their currently applicable laws publicly available. So if it's not on their website or Municode or else posted somewhere, they are legally obligated to provide it.
- During pandemics, sunshine laws are suspended, so the legal codes/ordinances may not be up-to-date.
- Relevant documents are often a single, comprehensive ordinance, but could also be multiple documents or sections of code spread across multiple chapters of the city/county code.
- Relevant policies can appear in multiple sections of the city/county code: land use & transportation, zoning, public safety, fire codes, school codes, etc.
- The hardest thing is to determine the negative -- that a place doesn't have a policy, or any policies, versus being unable to find the code. We grappled with this and did our best. We said that a jurisdiction doesn't have any cannabis-specific laws if:
  - There's nothing in Municode.
  - There's nothing on the jurisdiction website.
  - We've talked to county/city clerk and confirmed there's nothing.

- We were interested in city and county codes and ordinances. The scope of this analysis did not include reviewing case law, executive orders, or other forms of policy.

### Applying the coding scheme

The coding scheme is a structured question-and-answer style data extraction form coded in RedCap. REDCap is an electronic data capture tool for collecting and managing data hosted at the University of California San Francisco.<sup>12,13</sup>

Coding procedures: The data collection instrument was iteratively piloted and refined as new regulatory approaches were uncovered. To ensure accuracy, all jurisdictions were double-coded by two analysts until achieving >95% agreement.<sup>14</sup> In batches of 10 jurisdictions at a time, coders assessed agreement; discussed discrepancies, issues, and clarifications; and refined the data collection instrument. When the data collection instrument was revised, the coders re-coded previous jurisdictions as needed. Interpretations of the legal text were confirmed with a legal expert as needed. Policy data collection and coding was conducted from November 2020 to January 2021.

### Additional notes on coding:

- Most jurisdictions banned all commercial cannabis activity and were straightforward to code.
- Some jurisdictions had hundreds of pages of code regulating cannabis, including on occasion chapters that appeared to directly conflict. When this was the case, we consulted with legal experts and local government officials to confirm the city/county's official policies.
- We did not wade into the details of the zoning code or tables that apply to businesses generally (e.g. mapping out each zone, reviewing its applicable rules, determining which types of cannabis businesses are allowed in that zone, etc). Many laws may apply equally to dispensaries as to other types of businesses. These are laws that do affect cannabis, but they are not what we were interested in capturing with this study. With respect to zoning, we focused exclusively on policies that were specified in the cannabis-specific chapters of the city/county code.
- The first couple jurisdictions take a long time. Coding rapidly gains speed over time.
- It was important to pay attention to the details, but we saw the same code over and over again, or at least similar language, style, structure, because localities copy each other and use model ordinances.
- In general, we were not interested in laws/codes that only apply to certain areas of a city or certain zones (unless it is a question about whether there is a law that says cannabis businesses can only be located in certain zones). These were too detailed to code and less likely to have broad public health effects. We looked for laws that apply to the city generally.

## References

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# Cannabis Policy Data Collection Instrument

Please complete the survey below.

Thank you!

## General

City/County Name:

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Fips code:

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Coder name:

- Ellie
- Catherine
- Cynthia
- Laura
- Serena
- Leyla
- Chloe
- FINAL

Where did the legal text for this city/county come from?

- Municode
- City/County Website
- Through call with city/county clerk
- Other

## Retail Sales

Does the jurisdiction allow any retail sales of medical or recreational cannabis?  
 This can include storefront dispensaries with or without delivery, delivery-only, or microbusinesses.  
 "Not specified" should rarely if ever be the case.

- Yes
- No
- Not specified

What types of retail sales businesses are allowed?  
 Note that ""delivery"" here refers to the jurisdiction allowing delivery businesses to operate within their borders. A delivery that starts from a business located outside the jurisdiction and ends with a customer inside the jurisdiction does not count. By state law, delivery businesses are allowed to deliver anywhere in the state, but this rule was only recently clarified, so some jurisdictions may still have tried to ban delivery to customers within their jurisdiction. You can ignore this.

### What types of retail sales businesses are allowed?

**Note that ""delivery"" here refers to the jurisdiction allowing delivery businesses to operate within their borders. A delivery that starts from a business located outside the jurisdiction and ends with a customer inside the jurisdiction does not count. By state law, delivery businesses are allowed to deliver anywhere in the state, but this rule was only recently clarified, so some jurisdictions may still have tried to ban delivery to customers within their jurisdiction. You can ignore this."**

Yes

No

Not specified

Medical storefront dispensary (allowed)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Medical delivery (allowed)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Medical microbusiness (allowed)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational storefront dispensary (allowed)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational delivery (allowed)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational microbusiness (allowed)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Does the jurisdiction allow any on-site consumption of cannabis at cannabis storefronts?

Per state law, if the jurisdiction doesn't affirmatively allow it, then it is not allowed. So if the jurisdiction doesn't specify, the answer is no.

**Does the jurisdiction allow any on-site consumption of cannabis at cannabis storefronts?**

**Per state law, if the jurisdiction doesn't affirmatively allow it, then it is not allowed. So if the jurisdiction doesn't specify, the answer is no.**

	Yes	No	N/A
Medical (on-site consumption)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational (on-site consumption)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Unspecified (on-site consumption)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

In addition to a state license, does the jurisdiction require a cannabis-specific conditional use permit (not a general CUP) or other type of local cannabis-specific license in order to conduct retail sales?

**In addition to a state license, does the jurisdiction require a cannabis-specific conditional use permit (not a general CUP) or other type of local cannabis-specific license in order to conduct retail sales?**

	Yes	No	N/A
Medical store front dispensary (CUP)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Medical delivery (CUP)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Medical microbusiness (CUP)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational storefront dispensary (CUP)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational delivery (CUP)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational microbusiness (CUP)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**Does the jurisdiction place any cap or limit on the number or density of dispensaries, delivery services, or microbusinesses?**

	Yes	No	N/A
Medical storefront dispensary (density limit)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Medical delivery (density limit)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Medical microbusiness (density limit)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational storefront dispensary (density limit)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational delivery (density limit)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational microbusiness (density limit)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

If yes, what is the limit?

(medical storefront dispensary)

If yes, what is the limit?

(medical delivery)

If yes, what is the limit?

(medical microbusiness)

If yes, what is the limit?

(recreational storefront dispensary)

If yes, what is the limit?

(recreational delivery)

If yes, what is the limit?

(recreational microbusiness)

Does the jurisdiction place any limits about where cannabis businesses can be located (i.e. only in certain zones, districts, streets), beyond what is typically allowed in the zoning code for retail, cultivation, or manufacturing businesses generally? DO NOT wade through all of the city/county's general zoning code to determine this. Only examine the laws that regulate cannabis businesses to see if this is specified.

**Does the jurisdiction place any limits about where cannabis businesses can be located (i.e. only in certain zones, districts, streets), beyond what is typically allowed in the zoning code for retail, cultivation, or manufacturing businesses generally?**

**DO NOT wade through all of the city/county's general zoning code to determine this. Only examine the laws that regulate cannabis businesses to see if this is specified.**

	Yes	No	N/A
Medical storefront dispensary (location limit)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Medical delivery (location limit)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Medical microbusiness (location limit)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational storefront dispensary (location limit)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational delivery (location limit)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational microbusiness (location limit)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Does the jurisdiction make any stipulations about aiming not to disproportionately place retail businesses in or adjacent to low-income communities / areas of high-crime / areas of over-concentration / etc?

**Does the jurisdiction make any stipulations about aiming not to disproportionately place retail businesses in or adjacent to low-income communities / areas of high-crime / areas of over-concentration / etc?**

	Yes - prohibited	Yes - a consideration for license approval	No	N/A
Medical storefront dispensary (over concentration)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Medical delivery (over concentration)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Medical microbusiness (over concentration)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational storefront dispensary (over concentration)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational delivery (over concentration)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational microbusiness (over concentration)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Does the jurisdiction make any stipulations about where cannabis businesses can be located in relation to alcohol outlets?

**Does the jurisdiction make any stipulations about where cannabis businesses can be located in relation to alcohol outlets?**

	Yes - specific restrictions	Yes - a consideration	No	N/A
Medical storefront dispensary (alcohol stipulations)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Medical delivery (alcohol stipulations)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Medical microbusiness (alcohol stipulations)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational storefront dispensary (alcohol stipulations)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational delivery (alcohol stipulations)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational microbusiness (alcohol stipulations)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

If yes, what is the stipulation?

(medical storefront dispensary )

If yes, what is the stipulation?

(medical delivery)

If yes, what is the stipulation?

(medical microbusiness)

If yes, what is the stipulation?

(recreational storefront dispensary)

If yes, what is the stipulation?

(recreational delivery)

If yes, what is the stipulation?

(recreational microbusiness)

Does the jurisdiction place any stipulations on hours or days of retail sales?

**Does the jurisdiction place any stipulations on hours or days of retail sales?**

	Yes - specific requirements	Yes - a consideration for license approval	No	N/A
Medical storefront dispensary (hours stipulations)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Medical delivery (hours stipulations)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Medical microbusiness (hours stipulations)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational storefront dispensary (hours stipulations)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational delivery (hours stipulations)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational microbusiness (hours stipulations)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

If yes to any, what is the earliest time sales can open?

(medical storefront dispensary)

If yes to any, by what time must sales close?

(medical storefront dispensary)

If yes to any, what is the earliest time sales can open?

(medical delivery)

If yes to any, by what time must sales close?

(medical delivery)

If yes to any, what is the earliest time sales can open?

(medical microbusiness)

If yes to any, by what time must sales close?

(medical microbusiness)

If yes to any, what is the earliest time sales can open?

(recreational storefront dispensary)

If yes to any, by what time must sales close?

(recreational storefront dispensary)

If yes to any, what is the earliest time sales can open?

(recreational delivery)

If yes to any, by what time must sales close?

(recreational delivery)

If yes to any, what is the earliest time sales can open?

(recreational microbusiness)

If yes to any, by what time must sales close?

(recreational microbusiness)

Does the jurisdiction place any stipulations on how close retail businesses can be to sensitive locations (e.g. schools, parks, churches, drug treatment facilities)?

**Does the jurisdiction place any stipulations on how close retail businesses can be to sensitive locations (e.g. schools, parks, churches, drug treatment facilities)?**

	Yes - specific requirements	Yes - a consideration for license approval	No	N/A
Medical storefront dispensary (sensitive locations)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Medical delivery (sensitive locations)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Medical microbusiness (sensitive locations)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational storefront dispensary (sensitive locations)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational delivery (sensitive locations)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational microbusiness (sensitive locations)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

If yes, what is the largest distance in feet? (If reported in any other metric or unit besides feet, please convert) If distance depends on the type of retail outlet (e.g. medical storefront vs recreational delivery-only service), list the largest/most stringent distance here and note the varying distances/places in the Additional Comments/Notes section.

Does the jurisdiction place any stipulations on how close retail businesses can be from each other?

**Does the jurisdiction place any stipulations on how close retail businesses can be from each other?**

	Yes - specific requirements	Yes - a consideration for license approval	No	N/A
Medical storefront dispensary (close to each other)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Medical delivery (close to each other)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Medical microbusiness (close to each other)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational storefront dispensary (close to each other)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational delivery (close to each other)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational microbusiness (close to each other)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

If yes, what is the largest distance in feet? (If reported in any other metric or unit besides feet, please convert) If distance depends on the type of retail outlet (e.g. medical storefront vs recreational delivery-only service), list the largest/most stringent distance here and note the varying distances/places in the Additional Comments/Notes section.

Does the jurisdiction have operating stipulations related to loitering, upkeep (litter, graffiti), or noise?

**Does the jurisdiction have operating stipulations related to loitering, upkeep (litter, graffiti), or noise?**

	Yes - specific requirements	Yes - a consideration for license approval	No	N/A
Medical storefront dispensary (upkeep)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Medical delivery (upkeep)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Medical microbusiness (upkeep)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational storefront dispensary (upkeep)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational delivery (upkeep)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational microbusiness (upkeep)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Does the jurisdiction have operating stipulations related to safety such as night lighting, safes, alarms, security personnel, or cash management?

**Does the jurisdiction have operating stipulations related to safety such as night lighting, safes, alarms, security personnel, or cash management?**

	Yes - specific requirements	Yes - a consideration for license approval	No	N/A
Medical storefront dispensary (safety)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Medical delivery (safety)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Medical microbusiness (safety)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational storefront dispensary (safety)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational delivery (safety)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational microbusiness (safety)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Additional Comments/Notes:

---

Relevant ordinance numbers/codes:

(please separate each with semicolon)

---

Does the jurisdiction allow any commercial cultivation of cannabis? (this does not include personal cultivation, or cultivating medical marijuana for yourself or someone you care for)

**Other businesses/ operations**

**Does the jurisdiction allow any commercial cultivation of cannabis? (this does not include personal cultivation, or cultivating medical marijuana for yourself or someone you care for)**

	Yes	No	Not specified
Medical (comm cultivation)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational (comm cultivation)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Does the jurisdiction allow any commercial distribution of cannabis (e.g. businesses that transport cannabis from cultivators to retailers)?

**Does the jurisdiction allow any commercial distribution of cannabis (e.g. businesses that transport cannabis from cultivators to retailers)?**

	Yes	No	Not specified
Medical (comm distribution)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational (comm distribution)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Does the jurisdiction allow any manufacturing of cannabis products (e.g. making edibles, concentrates)?

**Does the jurisdiction allow any manufacturing of cannabis products (e.g. making edibles, concentrates)?**

	Yes	No	Not specified
Medical (manufacturing)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational (manufacturing)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Does the jurisdiction allow any cannabis testing facilities (e.g. testing for purity and/or potency)?

**Does the jurisdiction allow any cannabis testing facilities (e.g. testing for purity and/or potency)?**

	Yes	No	Not specified
Medical (testing)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational (testing)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Does the jurisdiction allow personal cultivation of cannabis outdoors (versus inside the house only)?

**Does the jurisdiction allow personal cultivation of cannabis outdoors (versus inside the house only)?**

	Yes	No	Not specified
Medical (personal cultivation)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recreational (personal cultivation)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Relevant ordinance numbers/codes:

(please separate with semicolons)

Additional Comments/Notes:

\_\_\_\_\_

**Other restrictions**

Does the jurisdiction place any restrictions on cannabis advertising or marketing?

- Yes
- No
- Could not determine easily

If yes, what are the relevant ordinance numbers/codes?

\_\_\_\_\_

Does the jurisdiction have any type of social host law holding people responsible for hosting underage cannabis consumption?

- Yes
- No
- Could not determine easily

If yes, what are the relevant ordinance numbers/codes?

\_\_\_\_\_

Does the jurisdiction have any regulations on special events specifically involving cannabis?

- Yes
- No
- Could not determine easily

---

If yes, what are the relevant ordinance numbers/codes?

---

Does the jurisdiction place any limits on product types or potency (e.g. no edibles, max concentrations of THC, no flavors)?

Yes  
 No  
 N/A  
 Could not determine easily

---

If yes, what are the relevant ordinance numbers/codes?

---

Does the jurisdiction have any requirements for product packaging or labeling, including required health warnings on packaging?

Yes  
 No  
 N/A  
 Could not determine easily

---

If yes, what are the relevant ordinance numbers/codes?

---

Does the jurisdiction place any price controls on cannabis products (e.g. bans on discounts, required price floors)?

Yes  
 No  
 N/A  
 Could not determine easily

---

If yes, what are the relevant ordinance numbers/codes?

---

Does the jurisdiction place any taxes on cannabis retail, cultivation, or distribution?

Yes - retail  
 Yes - cultivation  
 Yes - distribution  
 Yes - manufacturing  
 Yes - testing  
 None of these  
 N/A  
 Could not determine easily

---

If yes, what are the relevant ordinance numbers/codes?

---

If yes to any, specify the details of these taxes here:

---

Does the jurisdiction have requirements regarding responsible cannabis service or server training?

Yes  
 No  
 N/A  
 Could not determine easily

---

If yes, what are the relevant ordinance numbers/codes?

---

Additional Comments/Notes:

---

**Additional**

Did this jurisdiction have any policies that affect cannabis operations specifically during COVID-19 (e.g. a moratorium on cannabis sales during shelter-in-place)?

Yes  
 No  
 N/A  
 Could not determine easily

If yes, describe the policies:

---

Should this record be discussed?

Yes

General comments/notes

---

Person at city/county contacted for verification

---

Date first contacted

---

Number of times contacted

---

Position

---

Phone number

---

Email

---

## eAppendix 3

### Cannabis policy data

We classified local cannabis policies for 12 of California's 58 counties representing 59% of the state population. The 12 counties were selected to capture a range of sizes, sociodemographic compositions, political orientations, and approaches to cannabis regulation,<sup>1</sup> and included 230 cities and 11 unincorporated county areas (San Francisco city and county constitute a single government).

Data collection and coding were conducted from November 1, 2020 to January 31, 2021. Using a legal epidemiological approach,<sup>2,3</sup> we systematically identified and coded the characteristics of cannabis policies in all 241 jurisdictions. For each city or unincorporated county government, we identified the online searchable database of all currently applicable laws. We downloaded all legal text pertaining to cannabis using the search terms "cannabis OR marijuana OR marihuana". Five analysts used a structured data collection instrument created in REDCap, an electronic data capture tools hosted at the University of California San Francisco,<sup>6,7</sup> to capture the presence/absence and content of pre-specified provisions. The instrument was iteratively piloted and refined as new regulations were identified. All jurisdictions were coded separately by two analysts until achieving >95% agreement. Complete protocols and data collection instruments are provided in eAppendices 1-2.

### Cannabis outlet measurement

This study focused on both legal and illegal cannabis outlets in California, as both may affect the availability of cannabis and thus influence cannabis-related health outcomes. Illegal outlets are prevalent in California, making up as much as 60% of all outlets, and their presence reflects the legacy of the medical cannabis era when regulation was undeveloped and many medical outlets operated in a legal grey space.<sup>8,9</sup> It also reflects that following legalization of adult-use or recreational cannabis in California, existing medical dispensary owners were given the opportunity to convert to recreational outlets. Illegal dispensaries and those operating in a legal grey space were also given the opportunity come into compliance with the new laws, and if they did not do so within the designated timeline, they were subject to abatement.

Grandfathered outlets also exist in jurisdictions that previous permitted but now ban outlets.

Data on storefront recreational cannabis outlets (hereafter, "outlets") was webscraped annually between 2018 and 2020 from Weedmaps, a high-traffic online promotional cannabis business finder widely used in cannabis research.<sup>10-13</sup> A recent validation study of all storefront cannabis outlets in California found that compared to official license listings or other finders, Weedmaps was the most up-to-date and comprehensive source for capturing both legal and illegal outlets.<sup>8</sup>

We focused on recreational cannabis outlets, as opposed to medical outlets, because following recreational legalization, few medical-only outlets remained, the applicable state laws are distinct for medical outlets, and Weedmaps measures of medical outlets were less stable over the study period (see further detail on this below). Recreational outlets include both existing retailers that converted from medical to recreational with legalization as well as newly opened retailers. The Weedmaps data did not allow us to distinguish these two types of outlets

and thus to examine “churning” of outlets.<sup>14</sup> The effects of new recreational outlets may differ from those of converted medical outlets,<sup>14</sup> and this should be examined in future research.

We focused on storefront outlets (also known as brick-and-mortar outlets), as opposed to home delivery retailers, because our study builds on conceptual models and analytic approaches based on physical proximity to outlets where purchases can be made in-person,<sup>15</sup> whereas conceptual models and methods for measuring access to delivery remain undeveloped.<sup>16</sup> In Weedmaps, the majority of delivery-only businesses do not report an address, further justifying this study’s focus on storefront outlets. If a outlet offered both a storefront and home delivery, we included it in the count of storefront outlets.

All sources of cannabis outlet data have strengths and limitations.<sup>8,17</sup> Research suggests that online finders like Weedmaps tend to be more up-to-date—better indicating which outlets are newly opened or no longer operating—and are more comprehensive in capturing illegal outlets.<sup>8,9</sup> However, Weedmaps and other online finders are commercial, promotional websites. They are not designed for public health research and are not optimized for generating comprehensive listings of the locations of outlets. The gold standard for generating cannabis outlets listings is direct observation, but this is a time- and cost-intensive endeavor, especially for research that seeks to track changes in outlets over time. California’s state cannabis control agency offers official license listings, but such records exclude most illegal outlets, are not updated as frequently as online finders, and sometimes lack the premise addresses needed to identify outlet locations. Merging Weedmaps data with official license listings for California to determine which outlets may be legal or illegal is also challenging and time-intensive because no clear, clean variables exist on which to merge the two sources. None of the available sources keep historical records of outlet listings and therefore listings must be collected regularly and prospectively to construct panel data on outlets over time. It is also possible to identify illegal outlets is through direct physical observation or using a google street view classification algorithm in comparison with official license listings. Unfortunately, this was not feasible within the timeline or level available through the grant supporting this project.

An important consideration for the Weedmaps data is that illegal outlets may be undercounted in our data in 2020, because legal action in 2019 and 2020 encouraged Weedmaps to purge listings of illegal outlets. Anecdotally, it is clear that some illegal outlets continue to be listed, but the number of illegal outlets is likely fewer. It is unlikely that Weedmaps comprehensively captures illegal outlets. From mid-2019 to mid-2020, the number of medical outlets listed in Weedmaps dropped off dramatically from about 450 to 25. In contrast, the number of outlets offering recreational cannabis continued to increase steadily throughout this period, suggesting that most of the illegal outlets purged from Weedmaps were medical outlets, further justifying this study’s focus on recreational outlets. This pattern is also consistent with the history of cannabis legalization in California: prior to recreational cannabis legalization, many medical outlets were operating in legal grey space or were completely illegal, but the regulatory framework brought about by recreational legalization has facilitated the transition of these outlets to either fully legal outlets or fully illegal outlets subject to abatement. However, it is possible that since 2020, more illegal recreational outlets have emerged, especially as some outlets that were given a grace period to come into compliance have failed to do. News reporting suggests that illegal cannabis outlets remain a consistent challenge in California up to today.<sup>18</sup>

### Covariates

The potential confounders we measured for adjustment included demographic composition (total population, population change, age, and race and ethnicity), socioeconomic factors (educational attainment, poverty, median income, unemployment, home ownership, family households), commercial environment (per capita densities of general retail businesses and payday loan, tobacco, and pawnshop businesses; off-premise, restaurant, and bar/pub alcohol outlet densities), a local alcohol outlet policy stringency score, and the percent of voters favoring recreational cannabis legalization as a proxy for pro-cannabis norms. eTable 1 provides detail on the data sources and procedures for each covariate.

eTable 1: Policy predictor data sources

Measures	Data source	Notes
Sociodemographics covariates: Population count, population change since 2000, median age, % non-Hispanic Black alone, % Hispanic or Latinx, % non-Hispanic Asian alone, % with high school degree, % with some college/Associate's degree, % with Bachelor's degree or higher, % living below 150% of the federal poverty level, median income, % unemployed, % renters, % family households	Geolytics, 2019, Census block group level	Measures are originally derived from the American Community Survey
Density per capita of: general retail businesses; payday loan, tobacco, and pawnshop businesses	Zip code business patterns data, 2017, zip code level	Business counts for each zip code were crosswalked from zip codes to Census block groups using ESRI's 2019 Zip Code Boundaries shapefile overlaid with Census TIGER/Line block group shapefiles in ArcGIS Pro. Per capita denominators were drawn from Geolytics.
Density per square mile of: Alcohol outlets, off-premise alcohol outlets, bars/pubs, and restaurant alcohol outlets	California Alcohol Beverage Control annual license listings, 2017	Addresses of outlets were geocoded and assigned to Census block groups using the ArcGIS World Geocoding Service in ArcGIS Pro and Census TIGER/Line Shapefiles (>99% success rate). Land area denominators were derived from the Shapefiles. Variables were operationalized as the overall alcohol outlet density (summing off-premise outlets, bars/pubs, and restaurants),

		percent of outlets that were bars/pubs, and percent of outlets that were off-premise.
Local alcohol outlet policy stringency score	The study authors	Local alcohol policy data were collected using procedures identical to those described for local cannabis policies. Using the subset of policy measures that directly dictate the number, density, or locations of alcohol outlets, we created a stringency score using the weighting scheme developed by Thomas and colleagues. <sup>5</sup>
Percent voting in favor of recreational cannabis legalization (Proposition 64, November 2016; a proxy for pro-cannabis norms)	<a href="#">The Orange County Register</a>	Jurisdiction-level measures were recorded from the Orange County Register website on December 13, 2019.

#### *Database development*

City policies apply with city borders, but county policies only applied to the unincorporated areas of counties outside cities. We overlaid Census TIGER/Line Shapefiles of block group, city, and county boundaries in ArcGIS Pro and used the “intersect” spatial tool to identify unincorporated county areas. Boundaries of block groups, cities, and counties aligned imperfectly; we assigned block groups to jurisdictions (i.e. cities or unincorporated county areas) based on the jurisdiction in which with the greatest portion of the population resided, according to the geographic centroids of Census block-level population counts. We used the resulting assignments to merge the block group-level outlet density data to the jurisdiction-level policy data. Three small jurisdictions had no residential populations within their boundaries and were excluded from the analyses. We excluded an additional 30 of the 14,009 block groups due to missingness in key covariates. The final analytic dataset was a hierarchical panel of 13,979 block groups nested within city and unincorporated county jurisdictions from 2017 to 2020.

Supplemental results

eTable 2: Observed frequencies of every possible combination of the 6 policies relevant in localities that permitted cannabis outlets (N=56 jurisdictions)

Density limit	Location restriction	Buffers around sensitive locations	Limits on overconcentration	Buffers around alcohol outlets	Buffers between outlets	Frequency
1	1	1	0	0	1	14
0	1	1	0	0	0	10
1	1	1	0	0	0	6
0	0	0	0	0	0	4
1	0	1	0	0	0	4
0	1	1	0	0	1	4
0	1	0	0	0	0	2
1	1	1	1	0	0	2
1	0	0	0	0	0	1
1	1	0	0	0	0	1
0	0	1	0	0	0	1
0	1	1	1	0	0	1
1	1	1	0	1	0	1
0	0	1	0	0	1	1
1	0	1	0	0	1	1
0	0	1	1	0	1	1
0	1	1	1	0	1	1
1	1	1	1	0	1	1
0	0	0	1	0	0	0
1	0	0	1	0	0	0
0	1	0	1	0	0	0
1	1	0	1	0	0	0
0	0	1	1	0	0	0
1	0	1	1	0	0	0
0	0	0	1	0	0	0
1	0	0	0	1	0	0
0	1	0	0	1	0	0
1	0	0	0	1	0	0
0	1	1	0	1	0	0
0	0	0	1	1	0	0
1	0	0	1	1	0	0
1	0	0	1	1	0	0
0	1	1	0	1	0	0
0	0	0	1	1	0	0
1	0	0	1	1	0	0
1	0	0	1	1	0	0

0	1	0	1	1	0	0
1	1	0	1	1	0	0
0	0	1	1	1	0	0
1	0	1	1	1	0	0
0	1	1	1	1	0	0
1	1	1	1	1	0	0
0	0	0	0	0	1	0
1	0	0	0	0	1	0
0	1	0	0	0	1	0
1	1	0	0	0	1	0
0	0	0	1	0	1	0
1	0	0	1	0	1	0
0	1	0	1	0	1	0
1	1	0	1	0	1	0
1	0	1	1	0	1	0
0	0	0	0	1	1	0
1	0	0	0	1	1	0
0	1	0	0	1	1	0
1	1	0	0	1	1	0
0	0	1	0	1	1	0
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0	1	0	0	1	1	0
1	1	1	0	1	1	0
0	0	0	1	1	1	0
1	0	0	1	1	1	0
0	1	0	1	1	1	0
1	1	0	1	1	1	0
0	0	1	1	1	1	0
1	0	1	1	1	1	0
0	1	1	1	1	1	0
1	1	1	1	1	1	0

eTable 3: Characteristics of study jurisdictions adopting density- or location-related policies, among places permitting storefront recreational cannabis outlets, California, 2020

	All jurisdictions permitting outlets	No density- or location-related policies	Density limit	Location limit	Buffers around sensitive locations	Limit on overconcentration in vulnerable neighborhoods	Buffers around alcohol outlets	Buffers between outlets
Jurisdictions (N)	56	4	31	43	48	6	1	23
Block groups (N)	6,291	114	4,546	5,589	6,051	2,807	86	5,066
Total population	10475935	213,074	7,473,439	9,376,147	10,076,086	4,617,292	239,685	8,252,988
Cannabis outlets (N)	369	12	244	315	351	174	3	266
Cannabis outlet density per 10 square miles (mean [min, max])	1.1 (0, 549.9)	1.1 (0, 549.9)	3.5 (0, 380.0)	3.7 (0, 380.0)	3.9 (0, 380.0)	4.5 (0, 380.0)	1.2 (0, 51.1)	4.2 (0, 380.0)

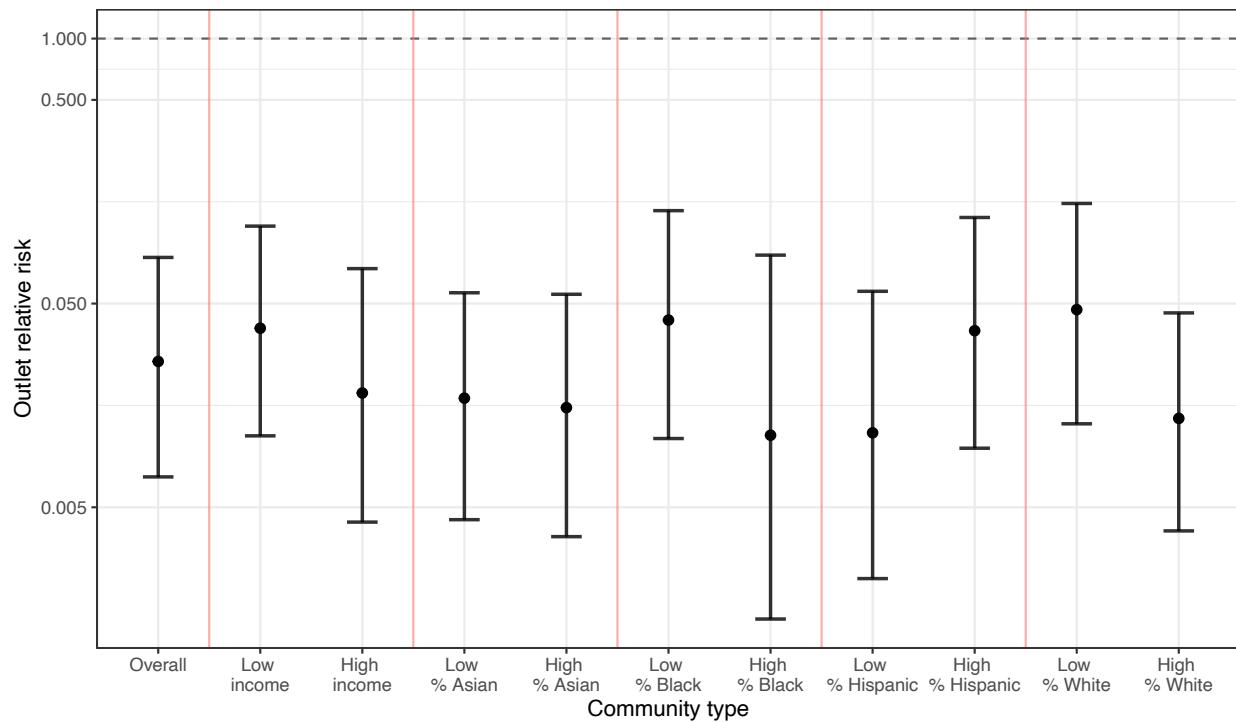
Note: Policy categories are not mutually exclusive. Cannabis outlet density statistics were calculated across block groups.

eTable 4: Estimated hyperparameters in fully adjusted spatiotemporal models evaluating the associations of local cannabis policies with cannabis outlets, California, 2018-2020

Policy model	Effect measure modifiers (if any)	Hyperparameter	Estimate (95% CI)
Outlet bans	None	Marginal precision of BYM2 random effects	120.03 (6.06, 710.24)
		Proportion of marginal variance explained by BYM2 spatial effect (versus i.i.d. effect)	0.09 (0.01, 0.35)
		Marginal precision of block group random slopes	0.34 (0.26, 0.44)
		Marginal precision of jurisdiction random intercepts	0.34 (0.17, 0.62)
	Median income	Marginal precision of BYM2 random effects	3.453171E+56 (2.69, 306.97)
		Proportion of marginal variance explained by BYM2 spatial effect (versus i.i.d. effect)	0.07 (0.02, 0.17)
		Marginal precision of block group random slopes	0.34 (0.27, 0.43)
		Marginal precision of jurisdiction random intercepts	0.33 (0.17, 0.55)
	Percent Asian	Marginal precision of BYM2 random effects	0.12 (0.1, 0.14)
		Proportion of marginal variance explained by BYM2 spatial effect (versus i.i.d. effect)	0.06 (0.02, 0.14)
		Marginal precision of block group random slopes	5112.39 (181.87, 32049.98)
		Marginal precision of jurisdiction random intercepts	0.3 (0.12, 0.53)
	Percent Black	Marginal precision of BYM2 random effects	9259.76 (7.89, 544.63)
		Proportion of marginal variance explained by BYM2 spatial effect (versus i.i.d. effect)	0.02 (0, 0.12)
		Marginal precision of block group random slopes	0.31 (0.28, 0.34)
		Marginal precision of jurisdiction random intercepts	0.35 (0.3, 0.45)
	Percent Hispanic	Marginal precision of BYM2 random effects	46.87 (1.99, 255.47)
		Proportion of marginal variance explained by BYM2 spatial effect (versus i.i.d. effect)	0.53 (0.1, 0.95)
		Marginal precision of block group random slopes	0.36 (0.27, 0.45)
		Marginal precision of jurisdiction random intercepts	0.34 (0.17, 0.73)
	Percent White	Marginal precision of BYM2 random effects	0.12 (0.1, 0.14)
		Proportion of marginal variance explained by BYM2 spatial effect (versus i.i.d. effect)	0.04 (0.01, 0.1)
		Marginal precision of block group random slopes	75 (27.99, 202.13)
		Marginal precision of jurisdiction random intercepts	0.32 (0.18, 0.52)

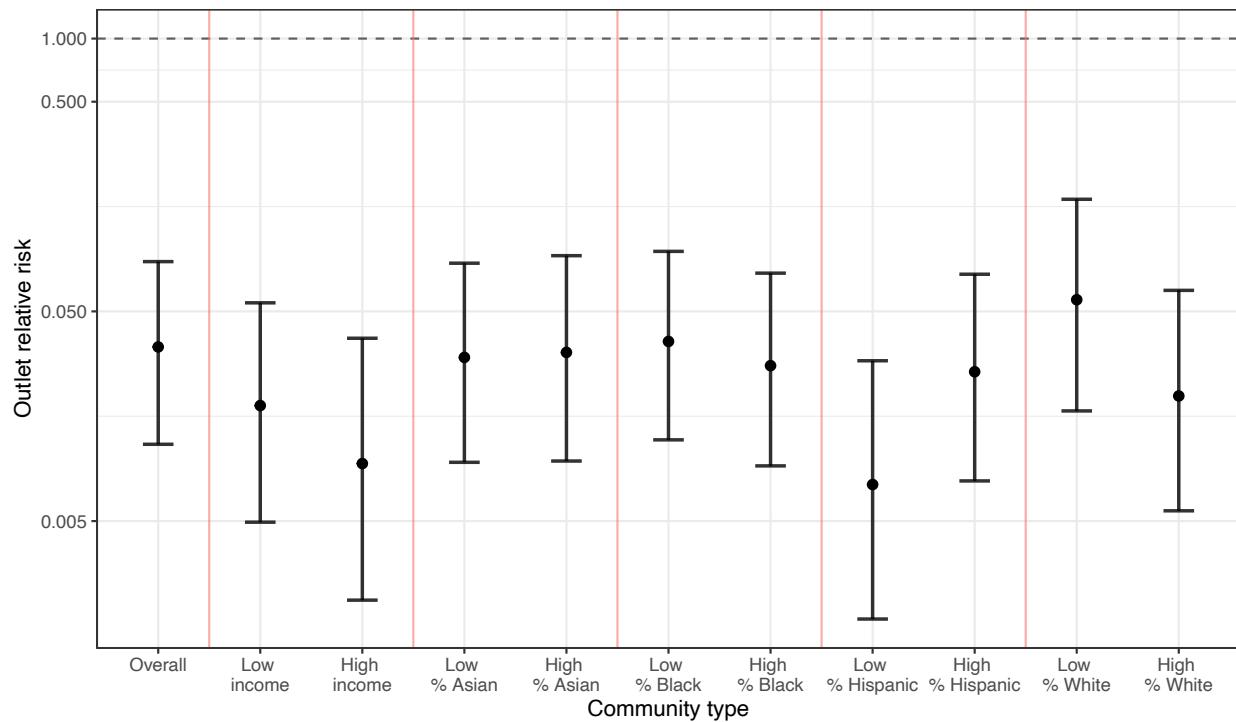
Policies relevant in jurisdictions without outlet bans	None	Marginal precision of BYM2 random effects	1110.86 (5.53, 7567.83)
		Proportion of marginal variance explained by BYM2 spatial effect (versus i.i.d. effect)	0.14 (0.02, 0.43)
		Marginal precision of block group random slopes	0.36 (0.28, 0.45)
		Marginal precision of jurisdiction random intercepts	0.49 (0.21, 0.98)
	Median income	Marginal precision of BYM2 random effects	248.59 (19.38, 1205.76)
		Proportion of marginal variance explained by BYM2 spatial effect (versus i.i.d. effect)	0.5 (0.01, 1)
		Marginal precision of block group random slopes	0.36 (0.27, 0.45)
		Marginal precision of jurisdiction random intercepts	0.47 (0.16, 0.92)
	Percent Asian	Marginal precision of BYM2 random effects	782.72 (7.88, 5248.79)
		Proportion of marginal variance explained by BYM2 spatial effect (versus i.i.d. effect)	0.33 (0, 0.99)
		Marginal precision of block group random slopes	0.35 (0.27, 0.45)
		Marginal precision of jurisdiction random intercepts	0.5 (0.18, 1.24)
	Percent Black	Marginal precision of BYM2 random effects	0.12 (0.1, 0.15)
		Proportion of marginal variance explained by BYM2 spatial effect (versus i.i.d. effect)	0.09 (0.03, 0.17)
		Marginal precision of block group random slopes	2122.95 (124.12, 11915.19)
		Marginal precision of jurisdiction random intercepts	0.91 (0.39, 1.8)
	Percent Hispanic	Marginal precision of BYM2 random effects	0.14 (0.12, 0.16)
		Proportion of marginal variance explained by BYM2 spatial effect (versus i.i.d. effect)	0.05 (0.01, 0.13)
		Marginal precision of block group random slopes	1119.72 (176.79, 4873.36)
		Marginal precision of jurisdiction random intercepts	0.64 (0.21, 1.39)
	Percent White	Marginal precision of BYM2 random effects	235.52 (73.34, 798.37)
		Proportion of marginal variance explained by BYM2 spatial effect (versus i.i.d. effect)	0.33 (0.15, 0.66)
		Marginal precision of block group random slopes	0.37 (0.26, 0.52)
		Marginal precision of jurisdiction random intercepts	0.43 (0.26, 0.7)

eFigure 1: Adjusted associations of banning cannabis outlets with cannabis outlet counts, overall and by median income and racial/ethnic composition, restricted to cities and towns, California, 2018-2020



Reported values are the posterior mean and posterior 95% credible intervals for the model parameters estimated in INLA. Estimates are for the 230 cities and towns and exclude unincorporated county areas in the study regions. Estimates by median income and racial/ethnic composition are for block groups at the 25<sup>th</sup> and 75<sup>th</sup> percentiles of median income and racial/ethnic composition. All models were adjusted for demographic composition (total population, population change, age, and race/ethnicity), socioeconomic factors (educational attainment, poverty, median income, unemployment, home ownership, family households), commercial environment (per capita densities of general retail businesses and payday loan, tobacco, and pawnshop businesses; off-premise, restaurant, and bar/pub alcohol outlet densities), a local alcohol outlet policy stringency score, and the percent of voters favoring recreational cannabis legalization as a proxy for pro-cannabis norms.

eFigure 2: Adjusted associations of banning cannabis outlets with cannabis outlet counts, overall and by median income and racial/ethnic composition, with expected outlet counts proportional to population, California, 2018-2020



Reported values are the posterior mean and posterior 95% credible intervals for the model parameters estimated in INLA. Estimates by median income and racial/ethnic composition are for block groups at the 25<sup>th</sup> and 75<sup>th</sup> percentiles of median income and racial/ethnic composition. All models were adjusted for demographic composition (total population, population change, age, and race/ethnicity), socioeconomic factors (educational attainment, poverty, median income, unemployment, home ownership, family households), commercial environment (per capita densities of general retail businesses and payday loan, tobacco, and pawnshop businesses; off-premise, restaurant, and bar/pub alcohol outlet densities), a local alcohol outlet policy stringency score, and the percent of voters favoring recreational cannabis legalization as a proxy for pro-cannabis norms.

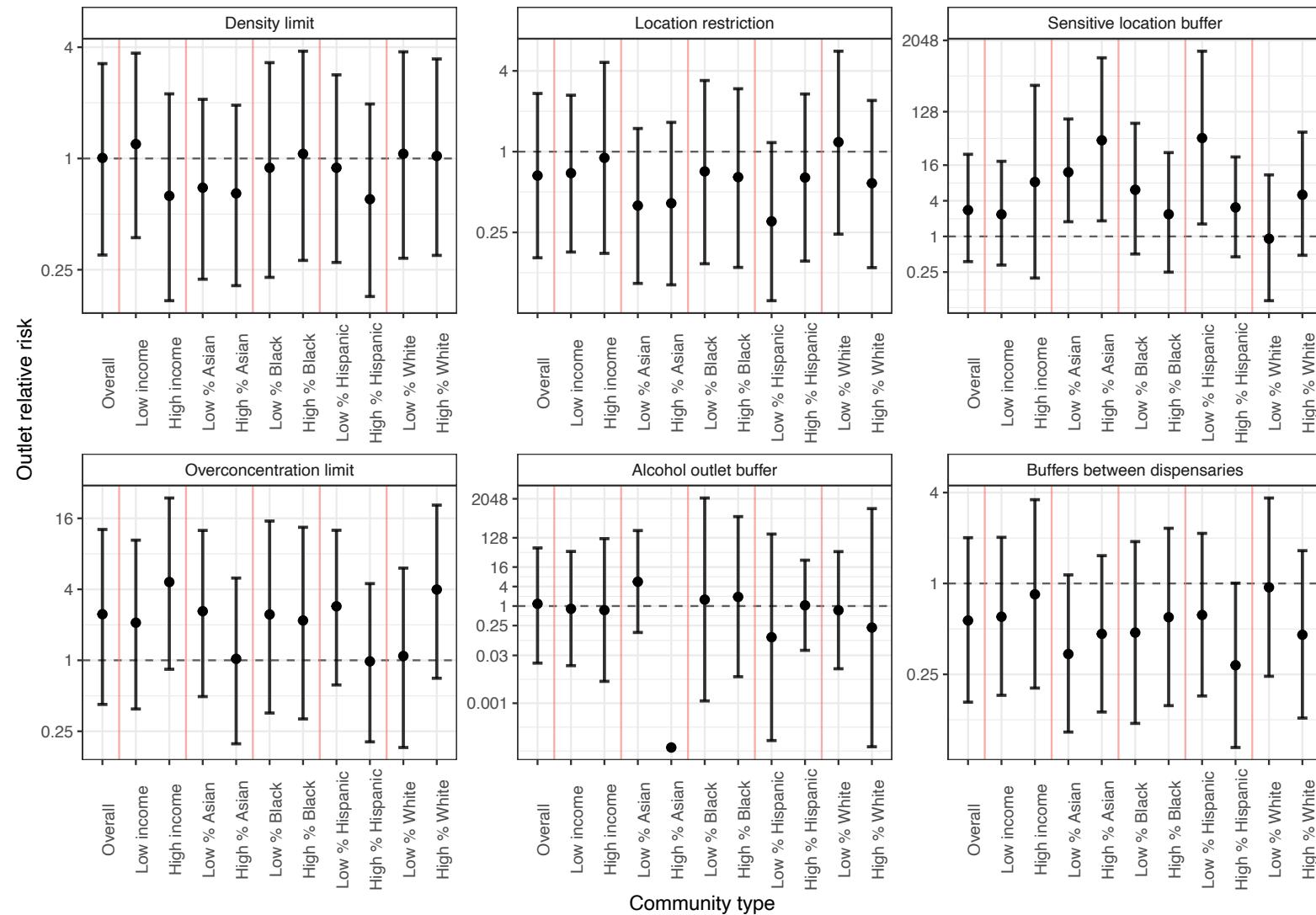
eTable 5: Specification testing of spatiotemporal models including all possible combinations of the three types of random effects

Policy	$\theta(t)_{ji}$ : spatially unstructured block group linear random slopes	BYM2 components: $\omega_{ji}$ (spatially unstructured block group random intercepts) and $\psi_{ji}$ (spatially structured block group random intercepts)	$\phi_j$ : jurisdiction random intercepts	WAIC	RR (95% CI)
Outlet bans	No	No	Yes	1.13e04	0.02 (0.01, 0.07)
	Yes	Yes	No	2.58e08	0.03 (0.01, 0.05)
	No	Yes	Yes	4.07e08	0.02 (0.00, 0.06)
	No	Yes	No	3.91e09	0.03 (0.01, 0.05)
	Yes	Yes	Yes	1.41e24	0.04 (0.01, 0.11)
	Yes	No	Yes	1.12e26	0.04 (0.01, 0.12)
	Yes	No	No	3.98e35	0.04 (0.02, 0.07)
Buffers around alcohol outlets	No	No	Yes	6.10E+03	0.65 (0.01, 40.69)
	No	Yes	Yes	1.40E+07	0.63 (0.02, 21.67)
	No	Yes	No	2.90E+07	1.03 (0.17, 8.59)
	Yes	Yes	No	3.69E+07	1.02 (0.17, 8.72)
	Yes	Yes	Yes	8.51E+21	0.85 (0.02, 57.74)
	Yes	No	Yes	1.32E+24	0.86 (0.02, 56.77)
	Yes	No	No	8.94E+28	2.32 (0.23, 46.20)
Buffers between outlets	No	No	Yes	6.10E+03	1.84 (0.50, 6.64)
	No	Yes	Yes	1.40E+07	2.56 (0.77, 8.29)
	No	Yes	No	2.90E+07	3.04 (1.66, 5.55)
	Yes	Yes	No	3.69E+07	3.06 (1.66, 5.63)
	Yes	Yes	Yes	8.51E+21	1.76 (0.50, 6.12)
	Yes	No	Yes	1.32E+24	1.72 (0.49, 5.89)
	Yes	No	No	8.94E+28	2.22 (1.33, 3.67)
Density limits	No	No	Yes	6.10E+03	1.54 (0.46, 5.41)
	No	Yes	Yes	1.40E+07	1.52 (0.51, 4.90)
	No	Yes	No	2.90E+07	0.75 (0.43, 1.29)
	Yes	Yes	No	3.69E+07	0.75 (0.43, 1.31)
	Yes	Yes	Yes	8.51E+21	0.99 (0.31, 3.33)
	Yes	No	Yes	1.32E+24	0.97 (0.30, 3.27)
	Yes	No	No	8.94E+28	0.51 (0.32, 0.81)
Location restrictions	No	No	Yes	6.10E+03	2.01 (0.47, 8.78)
	No	Yes	Yes	1.40E+07	2.44 (0.65, 9.23)
	No	Yes	No	2.90E+07	2.99 (1.59, 5.53)
	Yes	Yes	No	3.69E+07	2.99 (1.58, 5.61)

	Yes	Yes	Yes	8.51E+21	1.51 (0.37, 6.18)
	Yes	No	Yes	1.32E+24	1.47 (0.37, 6.02)
	Yes	No	No	8.94E+28	1.43 (0.76, 2.58)
Limits on overconcentration in vulnerable neighborhoods	No	No	Yes	6.10E+03	0.87 (0.14, 6.25)
	No	Yes	Yes	1.40E+07	0.63 (0.14, 3.69)
	No	Yes	No	2.90E+07	0.17 (0.09, 0.29)
	Yes	Yes	No	3.69E+07	0.16 (0.09, 0.29)
	Yes	Yes	Yes	8.51E+21	0.41 (0.08, 2.37)
	Yes	No	Yes	1.32E+24	0.39 (0.08, 2.34)
	Yes	No	No	8.94E+28	0.15 (0.09, 0.24)
Buffers around sensitive locations	No	No	Yes	6.10E+03	0.22 (0.03, 1.60)
	No	Yes	Yes	1.40E+07	0.24 (0.03, 1.56)
	No	Yes	No	2.90E+07	0.39 (0.11, 1.21)
	Yes	Yes	No	3.69E+07	0.38 (0.11, 1.22)
	Yes	Yes	Yes	8.51E+21	0.36 (0.04, 2.66)
	Yes	No	Yes	1.32E+24	0.38 (0.04, 2.71)
	Yes	No	No	8.94E+28	0.53 (0.17, 1.52)

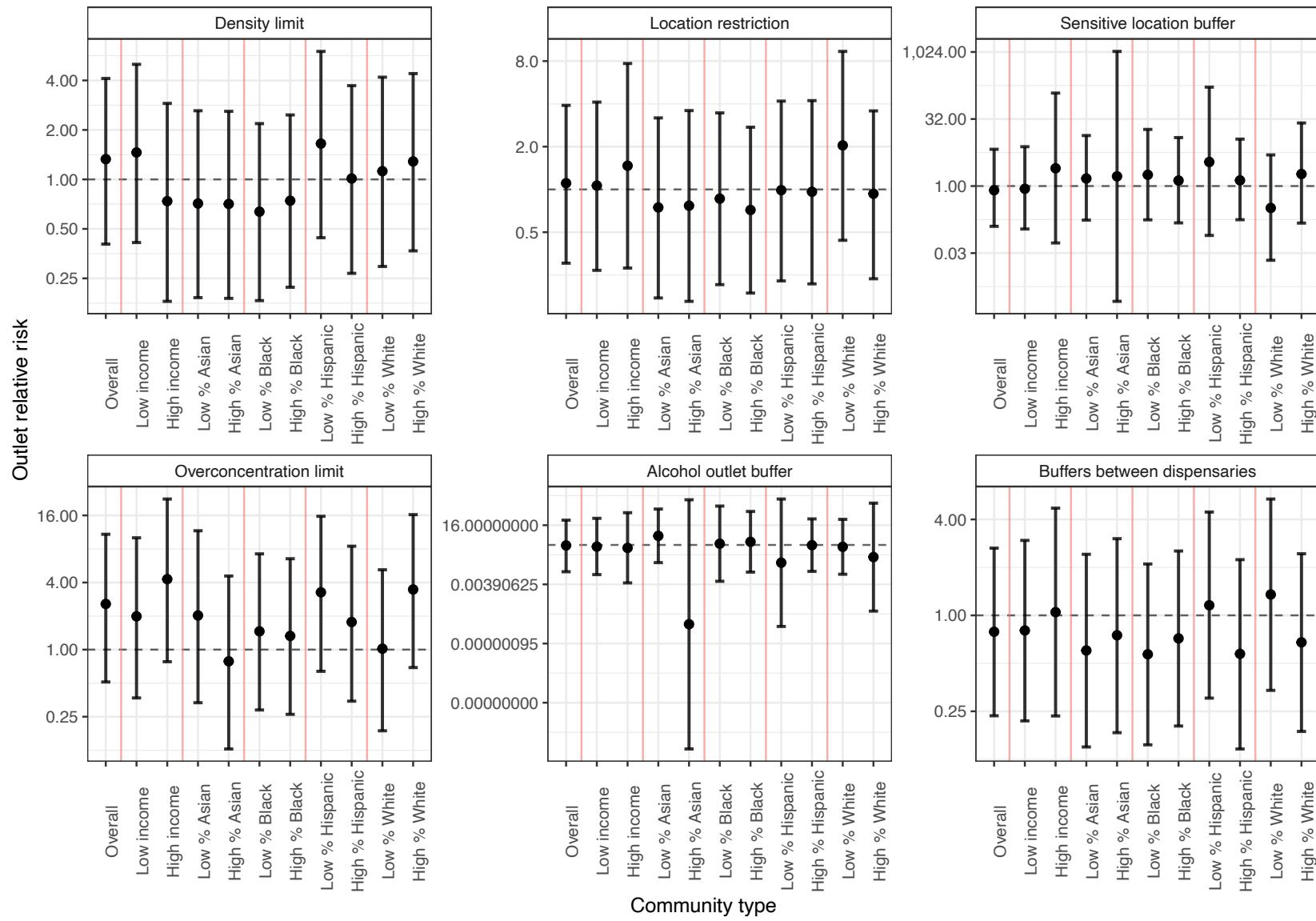
The table reports the WAIC and estimated RR (95% CI) for the main models, with all possible combinations of all three types of random effects:  $\theta(t)_{ji}$  (the spatially unstructured block group random linear random slopes), the BYM2 components ( $\omega_{ji}$ , the spatially unstructured block group random intercepts and  $\psi_{ji}$ , the spatially structured block group random intercepts), and  $\phi_j$  (the jurisdiction random effects intercepts).

eFigure 3: Adjusted associations of density- and location-related policies with cannabis outlet densities, among jurisdictions permitting outlets, estimated from Bayesian spatiotemporal models, overall and by median income and racial/ethnic composition, California, 2018-2020



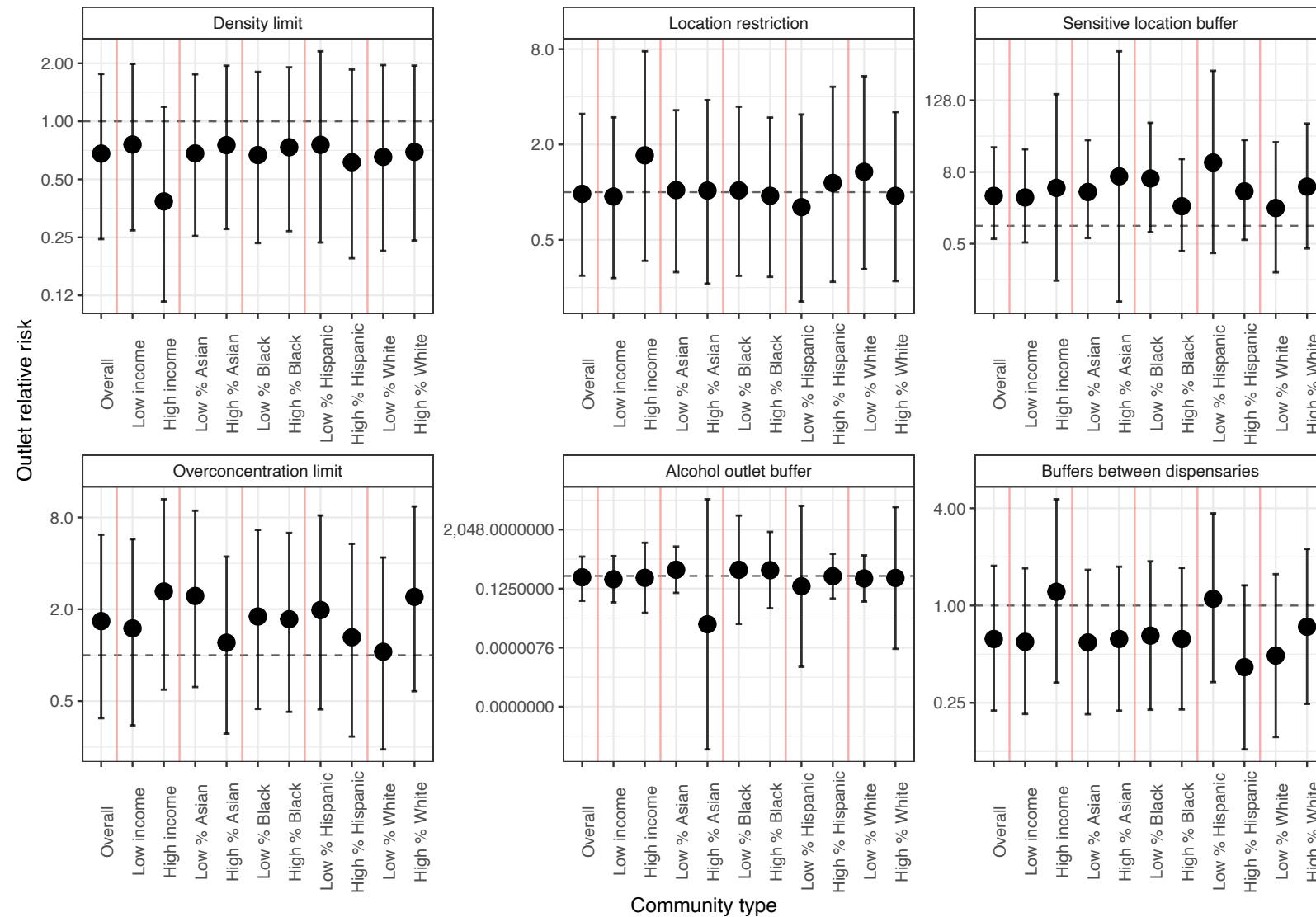
Reported values are the posterior mean and posterior 95% credible intervals for the model parameters estimated in INLA. Estimates by median income and racial/ethnic composition correspond to block groups at the 25<sup>th</sup> and 75<sup>th</sup> percentiles of median income and racial/ethnic composition. All models were adjusted for demographic composition (total population, population change, age, and race/ethnicity), socioeconomic factors (educational attainment, poverty, median income, unemployment, home ownership, family households), commercial environment (per capita densities of general retail businesses and payday loan, tobacco, and pawnshop businesses; off-premise, restaurant, and bar/pub alcohol outlet densities), a local alcohol outlet policy stringency score, and the percent of voters favoring recreational cannabis legalization as a proxy for pro-cannabis norms. The 95% credible interval for the association of alcohol outlet buffers with outlet densities among block groups at the 75<sup>th</sup> percentile of percent Asian residents was suppressed in the figure because it was so wide as to be uninformative (3.58e-12 to 501).

eFigure 4: Adjusted associations of density- and location-related policies with cannabis outlet counts, among jurisdictions permitting cannabis outlets, overall and by median income and racial/ethnic composition, restricted to cities and towns, California, 2018-2020



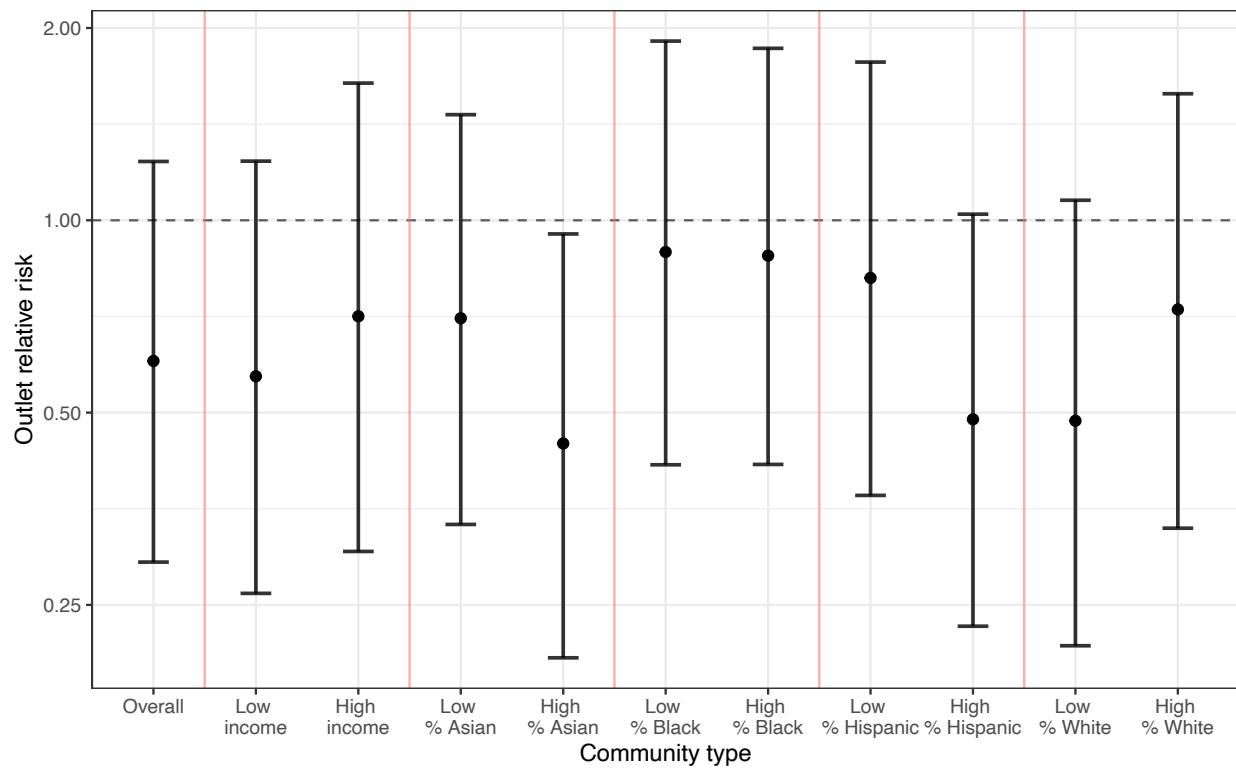
Reported values are the posterior mean and posterior 95% credible intervals for the model parameters estimated in INLA. Estimates are for the 230 cities and towns and exclude unincorporated county areas in the study regions. Estimates by median income and racial/ethnic composition are for block groups at the 25<sup>th</sup> and 75<sup>th</sup> percentiles of median income and racial/ethnic composition. All models were adjusted for demographic composition (total population, population change, age, and race/ethnicity), socioeconomic factors (educational attainment, poverty, median income, unemployment, home ownership, family households), commercial environment (per capita densities of general retail businesses and payday loan, tobacco, and pawnshop businesses; off-premise, restaurant, and bar/pub alcohol outlet densities), a local alcohol outlet policy stringency score, and the percent of voters favoring recreational cannabis legalization as a proxy for pro-cannabis norms.

Figure 5: Adjusted associations of density- and location-related policies with cannabis outlet counts, among jurisdictions permitting cannabis outlets, overall and by median income and racial/ethnic composition, with expected outlet counts proportional to population, California, 2018-2020



Reported values are the posterior mean and posterior 95% credible intervals for the model parameters estimated in INLA. Estimates by median income and racial/ethnic composition are for block groups at the 25<sup>th</sup> and 75<sup>th</sup> percentiles of median income and racial/ethnic composition. All models were adjusted for demographic composition (total population, population change, age, and race/ethnicity), socioeconomic factors (educational attainment, poverty, median income, unemployment, home ownership, family households), commercial environment (per capita densities of general retail businesses and payday loan, tobacco, and pawnshop businesses; off-premise, restaurant, and bar/pub alcohol outlet densities), a local alcohol outlet policy stringency score, and the percent of voters favoring recreational cannabis legalization as a proxy for pro-cannabis norms.

eFigure 6: Adjusted associations of cannabis outlet policy score with cannabis outlet counts, among jurisdictions permitting cannabis outlets, overall and by median income and racial/ethnic composition, California, 2018-2020



Reported values are the posterior mean and posterior 95% credible intervals for the model parameters estimated in INLA. Estimates are for a 1-unit increase in cannabis outlet policy score (range 0-6). This summed policy count score summarizes the combined effects of the six density/location-related policies relevant to jurisdictions that permitted outlets. This measure may reflect the overall restrictiveness of a locality's cannabis outlet regulations and may offer more statistical support since all possible combinations of the 6 policy variables may not be present in the observed data. However, this approach assumes that the policies are interchangeable in effectiveness and that a one-unit change in policy score has the same effect regardless of the baseline score. Estimates by median income and racial/ethnic composition are for block groups at the 25<sup>th</sup> and 75<sup>th</sup> percentiles of median income and racial/ethnic composition. All models were adjusted for demographic composition (total population, population change, age, and race/ethnicity), socioeconomic factors (educational attainment, poverty, median income, unemployment, home ownership, family households), commercial environment (per capita densities of general retail businesses and payday loan, tobacco, and pawnshop businesses; off-premise, restaurant, and bar/pub alcohol outlet densities), a local alcohol outlet policy stringency score, and the percent of voters favoring recreational cannabis legalization as a proxy for pro-cannabis norms.

## R statistical code

```
# Clear workspace
rm(list=ls())

#####
# Load packages
#####

require(INLA)
require(sf) # to read in shapefiles
require(spdep) # to assign the map to spatial dependencies in r inla - poly2nb
require(dplyr)
require(skimr)
require(data.table)
require(stats)

#####
# Initial data setup
# Load data, define spatial relations, subset to places with policy data, define place and time
# identifiers
#####

# Load the data
load(file="analytic_data_annual.rdata") # This file includes both the analytic dataframe (data)
and a shapefile of Census block groups for CA (map)

# Specify the spatial relationships
temp <- poly2nb(map)
nb2INLA("CA.graph", temp) # saves file to working directory
CA.adj <- paste0(getwd(),"/CA.graph") # location of this file
H <- inla.read.graph(filename = "CA.graph") # to import the graph in the R format

# Adjacency matrix
adj <- inla.graph2matrix(H)

# Specify units
Nareas <- length(unique(data$CBG))
Nareas

Ntimes <- length(unique(data$time_num))
Ntimes

# Make a sequential ID for Census block group
data <- data[order(data$time_num,data$CBG),]
data$sequential_ID <- rep(1:Nareas, times = Ntimes)

# Make a sequential time variable
data$time_num_dummy <- rep(1:Ntimes, each=Nareas)

# Main effect for time should be factor
data$time_num <- as.factor(data$time_num)
table(data$time_num, useNA = 'always')

# Make a copy of census block group (CBG) number for CBG-level trend (INLA can't use same ID name
# twice in a model)
data$sequential_ID2 <- data$sequential_ID

# Jurisdiction ID should be a factor
data$jurisdiction <- as.factor(data$jurisdiction)

#####
# Define the outcome and expected outcome, confirm that the average outcome is the same as the
# average expected outcome
#####

# Poisson outcome
# y: data$disp.nomed
# E: data$disp.nomed.E
```

```

data$disp.nomod.E <- NA
rate <- sum(data[, 'disp.nomod']) / sum(data$ALAND) # Calculate the statewide density of outlets
per square mile
data[["disp.nomod.E"]] <- data$ALAND * rate

# Confirm that average of E is same as average of outcome (average disp counts across CBGs/time)
summary(data$disp.nomod)
summary(data$disp.nomod.E)

rm(rate)

#####
# Omit places with missingness in key predictor variables
#####

# Final predictor set
has.miss <- unique(data$sequential_ID[is.na(data$STOTPOP) |
                                         is.na(data$retail2017.pc.trans) |
                                         is.na(data$nimby2017.pc.trans) |
                                         is.na(data$SHMEDINC.trans) |
                                         is.na(data$p_hhs_families_std) |
                                         is.na(data$p_pov150_std) |
                                         is.na(data$edu_hs_std) |
                                         is.na(data$edu_somcoll_std) |
                                         is.na(data$edu_ba_std) |
                                         is.na(data$SMEDAGE.trans) |
                                         is.na(data$p_black_std) |
                                         is.na(data$p_hisp_std) |
                                         is.na(data$p_asian_std) |
                                         is.na(data$renters_std) |
                                         is.na(data$UNEMPRATE_std) |
                                         is.na(data$SPOPCHPCT_std) |
                                         is.na(data$alc2017.dens.trans) |
                                         is.na(data$p_OffPrem2017_std) |
                                         is.na(data$p_BarPub2017_std) |
                                         is.na(data$alc.cup.dao.score.short) |
                                         is.na(data$prop64_std))]

length(has.miss)
dim(data)
data <- data[!data$sequential_ID %in% has.miss, ]
dim(data)

#####
# Calculate quartiles and corresponding transformed values of key vars for making linear
combinations that summarize the associations of the interaction terms
#####

medincq1 <- quantile(data$SHMEDINC.trans, probs=0.25)
medincq3 <- quantile(data$SHMEDINC.trans, probs=0.75)

blackq1 <- quantile(data$p_black_std, probs=0.25)
blackq3 <- quantile(data$p_black_std, probs=0.75)

hispq1 <- quantile(data$p_hisp_std, probs=0.25)
hispq3 <- quantile(data$p_hisp_std, probs=0.75)

asianq1 <- quantile(data$p_asian_std, probs=0.25)
asianq3 <- quantile(data$p_asian_std, probs=0.75)

whiteq1 <- quantile(data$p_white_std, probs=0.25)
whiteq3 <- quantile(data$p_white_std, probs=0.75)

#####
## Models
#####

# Geospatial model of outlets, all control vars one by one, without the policy variables
covs <- c('time_num', 'STOTPOP', 'SMEDAGE', 'p_black_5per',
         'p_hisp_5per', 'p_asian_5per', 'p_white_5per',
         'SHMEDINC', 'p_pov150_5per',

```

```

'edu_hs_5per', 'edu_somcoll_5per', 'edu_ba_5per',
'p_hhs_families_5per', 'renters_5per',
'UNEMPRATE_5per', 'SPOPCHPCT_5per',
'retail2017.pc', 'nimby2017.pc',
'alc2017.dens', 'p_BarPub2017_5per', 'p_OffPrem2017_5per',
'alc.cup.dao.score.short', 'prop64_5per')
for (s in covs) {
  file <-
paste0(ifelse(mac,"","C:"),"Users/ematthay/Dropbox/K/paper_aim1/results/paper2/model_results8/m0
_bivariate/inla_m0_",s,".rdata")
  formula.par <- as.formula(paste0("disp.nomed ~ 1 +
f(sequential_ID, model='bym2', graph=CA.adj,
adjust.for.con.comp=T, scale.model=T) +
f(sequential_ID2, time_num_dummy, model='iid', constr=T) +
f(jurisdiction, model='iid', constr=T) + ",s)) if
(!file.exists(file)) {
  model <- inla(formula.par, family='poisson', data=data, E=disp.nomed.E, verbose=F,
control.predictor=list(compute=T), control.compute=list(dic=T,waic=T, cpo=T))
  save(model, file = file)
} else { load(file) }
summary(model, digits=4)
}

# Effect of allowing recreational storefronts on outlets, over time, all control vars
file <-
paste0(ifelse(mac,"","C:"),"Users/ematthay/Dropbox/K/paper_aim1/results/paper2/model_results8/in
la_m2.rdata")
if (!file.exists(file)) {
  formula.par <- disp.nomed ~ 1 + f(sequential_ID, model='bym2', graph=CA.adj,
adjust.for.con.comp=T, scale.model=T) + # iCAR and unstructured/non-spatial RE on CBG.
  f(sequential_ID2, time_num_dummy, model='iid', constr=T) + # interaction between space and
time (time is linear not dummies)
  f(jurisdiction, model='iid', constr=T) + # Spatially unstructured RE on jurisdiction
  time_num + # time fixed effects
  can.retail.rec.storefront.any +
  STOTPOP +
  SMEDAGE.trans + p_black_std + p_hisp_std + p_asian_std +
  SHMEDINC.trans + p_pov150_std + edu_hs_std + edu_somcoll_std + edu_ba_std +
  p_hhs_families_std + renters_std + UNEMPRATE_std + SPOPCHPCT_std +
  retail2017.pc.trans + nimby2017.pc.trans +
  alc2017.dens.trans + p_BarPub2017_std + p_OffPrem2017_std +
  alc.cup.dao.score.short + prop64_std
  model <- inla(formula.par, family='poisson', data=data, E=disp.nomed.E, verbose=F,
control.predictor=list(compute=T), control.compute=list(dic=T,waic=T, cpo=T))
  save(model, file = file)
} else { load(file) }
summary(model, digits=4)

# Effect of individual cannabis policies, over time, among places allowing retail cannabis, all
control vars
file <-
paste0(ifelse(mac,"","C:"),"Users/ematthay/Dropbox/K/paper_aim1/results/paper2/model_results8/in
la_m4.rdata")
if (!file.exists(file)) {
  temp <- data[data$can.retail.rec.storefront.any==1,]
  formula.par <- disp.nomed ~ 1 + f(sequential_ID, model='bym2', graph=CA.adj,
adjust.for.con.comp=T, scale.model=T) + # iCAR and unstructured/non-spatial RE on CBG.
  f(sequential_ID2, time_num_dummy, model='iid', constr=T) + # interaction between space and
time (time is linear not dummies)
  f(jurisdiction, model='iid', constr=T) + # Spatially unstructured RE on jurisdiction
  time_num + # time fixed effects
  can.retail.rec.storefront.density + can.retail.rec.storefront.loclimit +
  can.retail.rec.storefront.sensloc +
  can.retail.rec.storefront.overconc + can.retail.rec.storefront.alc +
  can.retail.rec.storefront.buffer +
  STOTPOP +
  SMEDAGE.trans + p_black_std + p_hisp_std + p_asian_std +
  SHMEDINC.trans + p_pov150_std + edu_hs_std + edu_somcoll_std + edu_ba_std +
  p_hhs_families_std + renters_std + UNEMPRATE_std + SPOPCHPCT_std +
  retail2017.pc.trans + nimby2017.pc.trans +
  alc2017.dens.trans + p_BarPub2017_std + p_OffPrem2017_std +
  alc.cup.dao.score.short + prop64_std +
  alc.cup.dao.score.short + prop64_std
  model <- inla(formula.par, family='poisson', data=temp, E=disp.nomed.E, verbose=F,
control.predictor=list(compute=T), control.compute=list(dic=T,waic=T, cpo=T))
  save(model, file = file)
} else { load(file) }
summary(model, digits=4)
}

```



```
can.retail.rec.storefront.buffer =c(0,0,0,0,0,0,0,0,0,1,1),
"can.retail.rec.storefront.buffer:SHMEDINC.trans" =c(0,0,0,0,0,0,0,0,0,medincq1,medincq3))
model <- inla(formula.par, family='poisson', data=temp, E=disp.nomod.E,
              lincomb = lc,
              control.predictor=list(compute=T), control.compute=list(dic=T,waic=T, cpo=T) )
save(model, file = file)
} else { load(file) }
summary(model, digits=4)

## END
```

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