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America Addresses Two Epidemics – Cannabis and Coronavirus and their Interactions: An Ecological Geospatial Study

Short Title:

Cannabis – Coronavirus Geospatial Interactions

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3 Key Points

Question: Since cannabis is immunosuppressive and is frequently variously contaminated, is its use associated epidemiologically with coronavirus infection rates?

Findings: Geospatial analytical techniques were used to combine coronavirus incidence, drug and cannabinoid use, population, ethnicity, international flight and income data. Cannabis use and daily cannabis use were associated with coronavirus incidence on both bivariate regression and after multivariable spatial regression with high levels of statistical significance. Cannabis use quintiles and cannabis legal status were also highly significant.

Meaning: Significant geospatial statistical associations were shown between cannabis use and coronavirus infection rates consistent with immunomodulatory mechanistic reports and environmental exposure concerns.

Abstract

Importance. Covid-19 infection has major international health and economic impacts and risk factors for infection are not completely understood. Cannabis smoking is linked with poor respiratory health, immunosuppression and multiple contaminants. Potential synergism between the two epidemics would represent a major public health convergence. Cigarettes were implicated with disease severity in Wuhan, China.

Objective. Is cannabis use epidemiologically associated with coronavirus incidence rate (CVIR)?

Design. Cross-sectional state-based multivariable study.

Setting. USA.

Primary and Secondary Outcome Measures. CVIR. Multivariable-adjusted geospatially-weighted regression models. As the American cannabis epidemic is characterized by a recent doubling of daily cannabis use it was considered important to characterize the contribution of high intensity use.

Results. Significant associations of daily cannabis use quintile with CVIR were identified with the highest quintile having a prevalence ratio 5.11 (95%C.I. 4.90-5.33), an attributable fraction in the exposed (AFE) 80.45% (79.61-81.25%) and an attributable fraction in the population of 77.80% (76.88-78.68%) with Chi-squared-for-trend (14,782, df=4) significant at $P<10^{-500}$. Similarly when cannabis legalization was considered decriminalization was associated with an elevated CVIR prevalence ratio 4.51 (95%C.I. 4.45-4.58), AFE 77.84% (77.50-78.17%) and Chi-squared-for-trend (56,679, df=2) significant at $P<10^{-500}$. Monthly and daily use were linked with CVIR in bivariate geospatial regression models (P=0.0027, P=0.0059). In multivariable additive models number of flight origins and population density were significant. In interactive geospatial models adjusted for international travel, ethnicity, income, population, population density and drug use, terms including last month cannabis were significant from $P=7.3\times10^{-15}$, daily cannabis use from $P=7.3\times10^{-11}$ and last month cannabis was independently associated (P=0.0365).

Conclusions and Relevance. Data indicate CVIR demonstrates significant trends across cannabis use intensity quintiles and with relaxed cannabis legislation. Recent cannabis use is independently predictive of CVIR in bivariate and multivariable adjusted models and intensity of use is interactively significant. Cannabis thus joins tobacco as a SARS2-CoV-2 risk factor.

Article Summary

Strengths and Limitations of this Study

- Population level was used for the large datasets employed relating to international travel, Covid-19 rates and drug exposure.
- Nationally representative datasets were employed for drug use and exposure
- A Broad range of covariates was considered including socioeconomic, demographic, drug use, Covid-19 incidence and international travel.
- Advanced geospatial modelling techniques were used to analyze data.
- Higher resolution geospatial data was not available to this study.

Introduction

The coronavirus pandemic of January-March 2020 has gathered great attention worldwide and is accelerating globally at the time of writing. With a mortality originally posted by WHO at 3-4% [1] rising to over 10% in some nations [2], and ventilator shortages reported in Italy [3] and USA [4,5] there is considerable cause for concern. Importantly whilst senior NIH authorities have since revised mortality estimates in the general population downward to below one percent [6] mortality rates in the elderly and patients with chronic disease are likely to remain appreciable [6-9]. Coronavirus data on March 27th 2020 showed that there had been 94,014 cases and 1,431 deaths attributed to the virus in USA to that time (1.52% mortality) [10].

When risk factors for severe infection with coronavirus were recently been studied in Hubei province on China in three tertiary hospitals in Wuhan, tobacco smoking was identified in 27.3% of patients with progressive disease v 3% of non-progressive disease (N= 11 progressors and 67 non-progressors, P=0.018) [7].

Importantly the cannabis industry is known to have recently increased its activity significantly in USA following widespread relaxation of regulations pertaining to its use, and a 2018 study indicated that legalization was associated with an increase of more than 1,000,000 cannabis users and 500,000 cannabis-dependent people [11]. A large literature describes the immunosuppressive properties of several cannabinoids including Δ9-tetrahydrocannabinol (THC), cannabidiol and cannabinol [12-20]. Cannabis users frequently inhale with deep breaths which are held for long period so that smoke can penetrate deeply into the lung [12,21]. Moreover cannabis has been shown to be contaminated with foreign chemicals, viruses and fungal spores [22-25] so that concern has been expressed that patients can be relatively immunocompromised and at heightened risk of exposure to microorganisms placing them at increased risk of infection [26].

Moreover the recent World Drug Report 2019 released from the Office of Drugs and Crime of United Nations emphasized that whilst the US revival of cannabis is including more users, it is primarily about an increase in the number of daily or near daily users with that rate having doubled 2008-2018 [27]. It is important to consider then that we can expected to see more patients presenting with the effects of high level cannabis use. This important datum suggests that the immunosuppressive effects of cannabis are likely to be magnified in habitual users by the higher potency of modern strains, increased exposure and deep inhalation smoking habits in this context.

There are therefore a number of theoretical reasons for being concerned that cannabis use may exacerbate infectious risks such as that posed by coronavirus as was recently suggested [26].

The present study is an ecological exploration designed to test the hypothesis that there may be epidemiological evidence for a geospatial association between high rates of cannabis use with increased coronavirus infection rates (CVIR). The study was performed based on USA data as that nation has the best publicly available datasets available which allow formal analysis. The hypothesis was formulated prior to study commencement.

Methods

Data. U.S. state-based Corona virus data was taken from the worldometer website on March 27th 2020 [10]. The most recently available data on 49,320 international flights into USA (from October 2018-September 2019) was taken from the Department of Transport [24]. Drug use by state data was taken from the 2017-2018 Restricted Use Data Analysis System (RDAS) held by the Substance abuse and Mental Health Services Administration (SAMHSA) [28]. Eight drug codes were employed namely: IRABUPOSPNR for prescription pain reliever abuse in past year, PNRNMYR for Recoded – pain relievers past year misuse, MRJMDAYS for percent using cannabis on all or most days (defined as ≤20 days per month), MJRMON for past month cannabis use, COCYR for past year cocaine use, CIGMON for past month cigarette use, BNGALC for binge alcohol use in past month and AMPHETAPYU for any amphetamine past year use. State recreational cannabis legal status was taken from an internet search [29]. State population, ethnicity and median household income was derived from the US Census Bureau five year American Community Survey (ACS) for 2018 via the tidycensus package in R. State area is included in the albersusa R package and was used to derive population density.

Data Sharing Statement

Study data is made available with this paper in the online supplementary material.

Statistics. Data was processed in RStudio version 1.2.1335 based on R version 3.6.1 on 1st April 2020. Parameters were log transformed depending on the results of the Shapiro test. The packages dplyr, sf, albersusa, spdep, splm were used for data import, manipulation, analysis and drawing of maps and graphs. Non-parametric analysis was performed using the Wilcoxson test. Chi squared test for trend was done in R. Prevalence ratios and associated measures were calculated using the epiR::epi9.2by2 function. Geospatial interstate queen-based (edge and corner) links were derived with spdep::poly2nb and edited manually as indicated. Geospatial analysis was performed in the package splm using spatial panel maximum likelihood (spml) and spatial panel generalized method of moments (spgm) by Millo and Piras [30] and spatial panel random effects maximum likelihood (spreml) analysis was performed using splm::spreml [31]. The spatial error structure used for spml models was that of Kapoor, Kelejian and Prucha (KKP) [32]. Further details are given in the Tables. spml models were compared using the spatial Hausman test (sphtest) with directionality informed by the Log Likelihood Ratio (logLik). The spatial error structure used in spreml models was the full error structure (spatial error after Kapoor Kelejian and Prucha with serially correlated remainder errors and random effects (sem2srre) without lagging). The appropriateness of this error structure was formally tested by substituting various alternative forms and comparing results including the logLik. $P<0.05$ was considered significant.

Patient and Public Involvement Statement

Patients were involved in this research at several points. Patients worldwide are very concerned about the Covid-19 epidemic and the implications for their health, their lifespan, their quality of life, their risk of unemployment and many serious matters related to this. Patients are also concerned about the things they can do to stay healthy. Patients are concerned about possible risk factors for health and well being. For this reason they are interested in the subject of the present investigation. Patients have also been most interested in the results. They are interested in how they can apply this result to their own lives and to that of friends and family who might be close to them.

Hence the research questions and outcome measures were developed and informed by patients priorities, experiences and preferences. Our patients were involved in the design of this study in that they unanimously agreed that such matters should be investigated from extant publicly accessible databases. Patients were not involved in patient recruitment as that was not applicable to a study of this methodology. Hence their time was not consumed with the actual conduct and performance of this research.

Patients have been widely consulted about the best way to disseminate the results of this research. The agreed that publication in reputable professional medical journals is advisable and preferable. They also feel that such efforts should be supported on social media and on mainstream media to the extent that commercial radio personalities might be interested in such subjects for indeed at the time of writing the coronavirus pandemic is receiving very extensive media coverage indeed.

Ethics. This study was approved by the Human Research Ethics Committee of the University of Western Australia on 31st March 2020 (No. RA/4/20/4724).

Results

Figure 1 shows the rates of coronavirus infection (A) and death (B) by state across USA as of March 27th 2020.

It is known that air travel is one of the primary vectors of spread of the virus. For this reason it was of interest to quantitate this. The most recent data on international flights to USA from the US Department of Transport was sourced and is also shown map-graphically in Figure 1 showing the number of flights (Figure 1C), numbers of flight origins (Figure 1D), and the product of these two parameters (Figure 1E).

Other state-based socioeconomic data including population, area, population density and median household income were also sourced from the US Census Bureau (USCB) and shown in Supplementary Figure 1. Ethnicity data sourced from USCB is shown in Supplementary Figure 2.

State-based drug use data was sourced from the RDAS maintained by SAMHSA relating to the use of cigarettes, binge alcohol, amphetamines, opioids and cocaine. Two metrics of cannabis use were obtained related to any use the past month (MRJMON) and percent smoking cannabis daily or near daily (≥20 days/month, MRJMDAYS; denoted hereafter "daily cannabis use"). This data is shown map-graphically in Figure 2.

Supplementary Table 1 provides a tabulation of the states by their daily cannabis use quintile and the legal status of cannabis in 2020. Figure 3A shows a boxplot of the CVIR by quintile of daily cannabis use with Quintile 5 being the lowest daily use and Quintile 1 being the highest daily use. Whilst the trend appears to be positively skewed the notches of the boxes overlap indicating lack of statistical difference. Supplementary Table 2 shows the Prevalence ratio (PR, like odds ratio for cross-sectional data), the attributable fraction in the exposed (AFE) and the attributable fraction in the population (AFP) calculated numerically directly from the case numbers. As can be seen the PR's rise monotonically with Quintile number from 1.22 (95%C.I. 1.14-1.31) to 5.11 (4.90-5.33). The AFE's rise from 18.15% (12.49-23.44%) to 80.45 (79.61-81.25%) and the AFP's rise from 6.9% (4.51-9.24%) to 77.80% (76.88-78.68%). These are very significant fractions indeed. (Chi-squared for trend = 14,782, df=4, P<2.2×10^{-500} ; for comparison X^2 =1,478, df=4, P=8.43×10^{-319}).

Figure 3B shows the coronavirus infection rate as a function of the legal status of recreational cannabis. At this time cannabis is legal in 11 states, illegal in 25 states and decriminalized in 14 states. This Figure is calculated from the CVIR. Again a positive increment is noted with relaxation of cannabis regulations. This time however the notches do not overlap. Supplementary Table 2 shows the case rates calculated from the raw case numbers. Rising PR's, AFE's and AFP's are noted. Cannabis decriminalization is noted in this analysis to be associated with a PR of 4.51 (4.45-4.58), an AFE of 77.84% (77.50-78.17%) and an AFP of 51.22% (50.74-51.70%). (Chi-squared for trend = 56,679, df=2, $P<2.2x10^{-500}$; for comparison X^2 =567, df=2, $P=7.54x10^{-124}$). These data look different from those in Figure 3B due to the skewing effect of outliers. When non-parametric analysis was used on these CVIR the illegal-legal difference was significant (W=72, P=0.0239) but the illegal–decriminalized difference was not (W=180, P = 0.8965).

It was therefore of interest to consider these data from a geospatial analytical perspective. Supplementary Figure 3A shows the links derived from the spdep::poly2nb function and how these were edited to allow Alaska to conceptually relate to Washington state and Oregon and Hawaii to California. The final neighbour link network used is shown in Supplementary Figure 3B.

Table 1 presents a geospatial bivariate spreml analysis of the relationship of the CVIR to last month cannabis use, daily cannabis use, their interaction, cannabis quintiles and cannabis legal status. In each case these parameters are associated with (exponentiated) effect sizes of 1.2851, 1.2611, 0.9734, 2.2318 (Quintile 1 v 5) and 1.6063 (legal v illegal) respectively.

It was of interest to consider also the effect of the other variables each in their domain. Supplementary Table 3 presents the geospatial analysis of the data in the five domains of Flights, Median Household Income, Ethnicity, Population, and Drug Use. All three parameters in the flights domain are significant as might be expected. In this domain the Number of Flight Origins has the highest log likelihood ratio (logLik) so this is the parameter entered into full spatial models. Median household income is not significant. Two ethnicities are significant as noted. In the Population domain both total population and population density are significant.

The lower section of Supplementary Table 3 presents the Drug use domain. Three spreml models are presented each incorporating slightly different interaction structures between their terms as shown. Given that the final model has the highest log likelihood value (-32.4261) that is the model structure which is progressed to the full comprehensive models used subsequently. In this model the most significant term predictive of the CVIR is cannabis use ($P=8.7x10^{-7}$). Cannabis use is included in 8 of the 11 terms remaining in the final model. The interaction between cannabis use last month and daily cannabis use is included in three terms and is also highly significant in its own right.

Given that many terms in the five domains of Supplementary Table 3 were significant it was of considerable interest to investigate how they compared when they were all combined together in a single comprehensive model. The results of additive models in all terms are shown in Supplementary Table 4. The number of flight origins and the population density are the remaining significant covariates after spgm model reduction. When the number of flights is used as the index of travel this term does not appear in the final model, but cannabis use persists as the most significant term (P=0.0079).

Table 2 presents final interactive spatial models after reduction via the spml, spgm and spreml algorithms. Interestingly travel, cannabis and opioid pain relievers are found to be significant in all final models. Terms including cannabis are most significant in the spml model, from $P=7.3x10^{-15}$. Cannabis alone is significant (P=0.0365) in the spgm model, a technique which is sensitive to short panel datasets of this type. Cannabis is included in seven of nine terms, eight of twelve terms and seven of nine terms in the three models respectively. Interactions between last month cannabis use and daily cannabis use are included in three terms in each model. Tobacco, binge alcohol, cocaine and amphetamines did not appear in any final spatial models. Study of spreml model error structure confirmed that the full error structure (sem2srre without lagging) was indeed appropriate.

Discussion

Our study set out to explore the possible ecological and geospatial associations of cannabis use and coronavirus infection with the concern that cannabis-associated immunosuppression and cannabis contamination might exacerbate the global pandemic at a time when cannabis use and particularly the intensity of cannabis use is rising dramatically in many parts of USA and abroad. Bivariate evidence supported this hypothesis by demonstrating significant associations of daily cannabis use quintile with CVIR with the highest quintile having a prevalence ratio (PR, like odds ratio) of 5.11 (95%C.I. 4.90-5.33), an attributable fraction in the exposed of 80.45% (79.61-81.25%), and an attributable fraction in the population of 77.80% (76.88-78.68%) with a trend significant at $P<10^{-500}$. Similarly when cannabis legalization was considered decriminalization was associated with an elevated CVIR prevalence ratio of 4.51 (95%C.I. 4.45-4.58), an attributable fraction in the exposed of 77.84% (77.50-78.17%) and an attributable fraction in the population of 51.22% (50.74-51.70%) and a trend significant at $P<10^{-500}$. When the effect was studied in a multivariable geospatial model after controlling for international travel, ethnicity, income, population, population density and drug use interactive terms in last month cannabis were significant from $7.3x10^{-15}$ and daily cannabis use from $7.3x10^{-11}$. Cannabis use was independently predictive of CVIR in the final spgm model. These results strongly support the hypothesis of an ecological geospatial link between cannabis use and coronavirus infection rate.

Cannabinoids are known to interact with the immune system at multiple points including CB1 and CB2 receptors, six vanilloid channels, peroxisome proliferator-activated receptors (PPAR's), serotonin, adenosine, histamine, glycine, sphingosine, dopamine and opioid receptors, three class A orphan G-protein coupled receptors (GPCR's), toll-like receptors, T-cells, B-cells, macrophages and regulatory cells, effects on sodium channels and several types of potassium and calcium channels, modulation of GABA signalling and inhibition of cyclooxygenase and lipoxygenase enzymes, bind directly to mitochondria and cannabinoid receptors also form heterodimers with opioid, adenosine, dopamine, GABA and other GPCR's and have myriad and major epigenetic effects [13-20,33-38].

The highly potent mammalian toxin carbofuran has also been described as being used on cannabis plants to prevent them being eaten by herbivores such as deer and has been found in cannabis plantations in large quantities [24]. This extremely potent toxin is an acetylcholinesterase inhibitor banned in USA in 1991 in granular form and in liquid form in 2009 by the Environmental Protection Agency (EPA) after it was implicated in the death of over 1,000,000 birds including eagles in USA and many lions in Africa [39,40]. Concerns relating to carbofuran contamination of groundwater and fresh drinking water supplies have been expressed by the US EPA and WHO [41-43].

To our knowledge this investigation is the first report of a positive association between CVIR and cannabis. Nevertheless given that cannabis is known to have significant immunosuppressive effects by many biological mechanisms, and that reports of contamination of cannabis with diverse chemical, microbial and fungal organisms are not uncommon [22-25], and given the very high levels of statistical significance demonstrated in the present analysis by several techniques, we are concerned that this effect is likely robust and generalizable. In the context of rapidly accelerating pandemics of both cannabis and coronavirus this suggests a biological and mechanistic synergism which is of considerable concern. An interesting issue raised by this data is that cannabis-related -immunosuppression and -contamination is likely reversible upon cessation of exposure. This is an important issue requiring further research.

This report has several strengths and limitations. Our study is timely, and uses a current dataset for CVIR. The study uses a well validated nationally representative drug use dataset, which is widely studied and extensively quoted. Importantly we use two metrics of cannabis use including one which provides a measure of daily (or near daily) cannabis use, which has been shown to be the major parameter of American cannabis consumption [27]. We use a very large dataset of international flight arrivals into USA which captures the whole population of these events over a 12 month period. US Census Bureau data is used to source state population, income and ethnicity data from the well validated American Community Survey. Our analysis reaches similar conclusions by several different pathways in both bivariate and multivariable analyses. There is good concordance between models utilizing the spml, spgm and spreml geospatial algorithms. All our major results are at very high levels of statistical significance. The limitations of our study relate to its uncontrolled design. Case control studies cannot be considered in such situations since it is unethical to expose patients to a real risk of mortality in the absence of definitive treatment or vaccination (at the time of writing). Moreover our results are spatially restricted to state level data. For example upstate New York is very rural, but Manhattan is one of the most densely populated places on the planet.

The broader geospatial level of our study was not able to capture such important details which are likely of particular importance to socially transmissible agents such as coronavirus. Further studies at higher geospatial levels of resolution are strongly and urgently indicated.

In summary we found strong bivariate and multivariable confirmatory evidence for the hypothesis that cannabis use is associated with coronavirus infection. A strong quintile effect was noted along with a prominent effect of cannabis decriminalization. After adjustment cannabis use emerged as a persistent, independent and robust correlate of CVIR at high levels of significance. This finding is of concern and suggests a powerful negative feedforward interaction between two major public health challenges faced by USA and the international community. Given the immediate salience and potent imminence of the coronavirus epidemic this association is well worth further immediate epidemiological research. The present report indicates stricter cannabis controls as one public health measure by which to address an infectious challenge and support cellular and soluble immunity for the whole community.

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All authors had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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Authorship Contributions

ASR assembled the data, designed and conducted the analyses, and wrote the first manuscript draft. GKH provided technical and logistic support, co-wrote the paper, assisted with gaining ethical approval, provided advice on manuscript preparation and general guidance to study conduct.

Competing Interests Statement

Neither author has conflicts of interest to declare.

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TABLES

Table 1.: Bivariate Geospatial Regression Models of Cannabis Use

General	Parameters					Model					
Technique	Parameter	Estimate	Std. Error	t value	P-Value	LogLik	Parameters	Value	P-Value		
spreml	Cannabis Use										
spatial	spreml(Case_Rate ~ Cannabis_Use_Last_Month)						phi	2.27E-02	0.9985		
errors =	mrjmon	0.2508	0.0836	3.0005	0.0027	-46.9835	psi	-4.15E-05	0.9998	**	
sem2srre							rho	5.95E-01	1.35E-05		***
method=											
BFGS	spreml(Case_Rate ~ Cannabis_Use_Most_Days_Last_Month)						phi	0.0200	NA		
initval=	mrjmdays	0.2320	0.0843	2.7520	0.0059	-47.5603	psi	0.0000	0.9998	**	
zeros							rho	0.5742	4.1E-05		***
lag=											
false	spreml(Case_Rate ~ Cannabis_Use_Last_Month : Cannabis_Use_Most_Days)						phi	0.0062	0.9991		
	mrjmon: mrjmdays	-0.0265	0.0096	-2.7511	0.0059	-47.5711	psi	3.3E-05	0.9998	**	
							rho	0.5774	2.8E-05		***
spreml	Cannabis Quintile										
spatial	spreml(Case_Rate ~ Cannabis_Daily_Use_Quntile)										
errors =	Quintile 1	0.8028	0.2199	3.6499	0.0003	-44.8044	phi	0.0197	NA	***	
sem2srre	Quintile 2	0.4763	0.2287	2.0821	0.0373		psi	-1.4E-05	0.9999	*	
method=	Quintile 3	0.4184	0.2095	1.9978	0.0457		rho	0.6175	2.4E-06	*	***
BFGS	Quintile 4	0.1716	0.3482	0.4929	0.6221						
initval=											
zeros	Legal Status										

lag=	*spreml(Case_Rate ~ Legal_Status)*						phi	0.0601	< 2e-16	***
false	Legal v Illegal	0.4740	0.2321	2.0422	0.0411	-48.6220	psi	-2.1E-06	0.9041	*
							rho	0.5887	0.0411	*

Abbreviations:

mrjmon - Percent using cannabis within the previous month
mrjmdays - Percent using cannabis on all or most days of the month defined as ≥20 days per month.

Table 2.: Final Geospatial Regression Models

General	Parameters					Model			
Technique	**Parameter**	**Estimate**	**Std. Error**	**t value**	**P-Value**	**LogLik**	**Parameters**	**Value**	**P-Value**
	SPML								
spml	***spml(Case_Rate ~ No._Flight_Origins * mrjmon * mrjmdays * PainRelyr + Cigmon + BingAlc + Cocyr + AmphetYr + AnalYr + MHY + 6_Races + Population + Population_Density)***								
model=	No._Fl_Origins: mrjmon	2.1939	0.2820	7.7787	7.3E-15		phi	7.1E-07	0.9752
random	No._Fl_Origins: PainRelyr	-2.7334	0.3836	-7.1262	1.0E-12	-22.8796	rho	0.8188	<2E-16
effect=	No._Fl_Origins: mrjmon: mrjmdays	0.3430	0.0527	6.5150	7.3E-11				
individual	No._Fl_Origins: mrjmdays: PainRelyr	-1.1782	0.2148	-5.4847	4.1E-08				
spatial.	No._Fl_Origins: mrjmdays	-1.6307	0.3370	-4.8383	1.3E-06				
error=	Pop	-1.6895	0.3594	-4.7002	2.6E-06				
KKP	No._Fl_Origins: mrjmon: mrjmdays: PainRelyr	-0.0820	0.0199	-4.1124	3.9E-05				
lag=	mrjmon: mrjmdays: PainRelyr	0.1450	0.0433	3.3483	0.0008				
false	mrjmdays: PainRelyr	0.9729	0.3155	3.0836	0.0020				
	SPGM								
spgm	***spgm(Case_Rate ~ No._Flight_Origins * mrjmon * mrjmdays * PainRelyr + Cigmon + BingAlc + Cocyr + AmphetYr + AnalYr + MHY + 6_Races + Population + Population_Density)***								
lag=	No._Fl_Origins: mrjmon	2.5296	0.3463	7.3039	2.8E-13				
false	No._Fl_Origins: PainRelyr	-2.9788	0.4401	-6.7680	1.3E-11				
model=	No._Fl_Origins: mrjmdays: PainRelyr	-1.3538	0.2448	-5.5298	3.2E-08				

random	No._Fl_Origins: mrjmdays	-2.4585	0.4575	-5.3739	7.7E-08				
method=	Pop	-2.1324	0.4046	-5.2709	1.4E-07				
g2sls	No._Fl_Origins: mrjmon: mrjmdays: PainRelyr	-0.1113	0.0235	-4.7372	2.2E-06				
moments=	mrjmon: mrjmdays: PainRelyr	0.1757	0.0504	3.4873	0.0005				
initial	PopDens	0.2085	0.0609	3.4237	0.0006				
spatial.	NHPIpc	-0.1924	0.0636	-3.0264	0.0025				
error=	No._Fl_Origins: mrjmon: mrjmdays	0.2239	0.0764	2.9319	0.0034				
true	mrjmdays: PainRelyr	1.0096	0.3795	2.6606	0.0078				
	mrjmon	-1.7411	0.8326	-2.0911	0.0365				
	SPREML								
spreml	***spreml(Case_Rate ~ No._Flight_Origins * mrjmon * mrjmdays * PainRelyr + Cigmon + BingAlc + Cocyr + AmphetYr + AnalYr + MHY + 6_Races + Population + Population_Density)***								
spatial	No._Fl_Origins: mrjmon	2.1478	0.2918	7.3605	1.8E-13	-27.46423	phi	0.0980	NA
errors =	No._Fl_Origins: PainRelyr	-2.6492	0.3964	-6.6834	2.3E-11		psi	6.7E-05	0.9996
sem2srre	No._Fl_Origins: mrjmon: mrjmdays	0.3330	0.0545	6.1163	9.6E-10		rho	0.8105	<2E-16
method=	No._Fl_Origins: mrjmdays: PainRelyr	-1.1340	0.2209	-5.1340	2.8E-07				
BFGS	No._Fl_Origins: mrjmdays	-1.5898	0.3442	-4.6186	3.9E-06				
initval=	Pop	-1.6925	0.3720	-4.5496	5.4E-06				
zeros	No._Fl_Origins: mrjmon: mrjmdays: PainRelyr	-0.0781	0.0206	-3.7995	0.0001				
lag=	mrjmon: mrjmdays: PainRelyr	0.1352	0.0448	3.0179	0.0025				
false	mrjmdays: PainRelyr	0.9045	0.3278	2.7588	0.0058				

Abbreviations:

No._Fl_Origins	- Number of Flight Origins arriving at airport
mrjmon	- Percent using cannabis within the previous month
mrjmdays	- Percent using cannabis on all or most days of the month defined as ≥20 days per month
PainRelyr	- Pain Reliever Misuse Use – Recoded
6_Races	- White + African_American + Asian + Hispanic + American_Indian_/_Alaskan_Native + Native_Hawaiian_/_Pacific_Islander

Technical Notes:

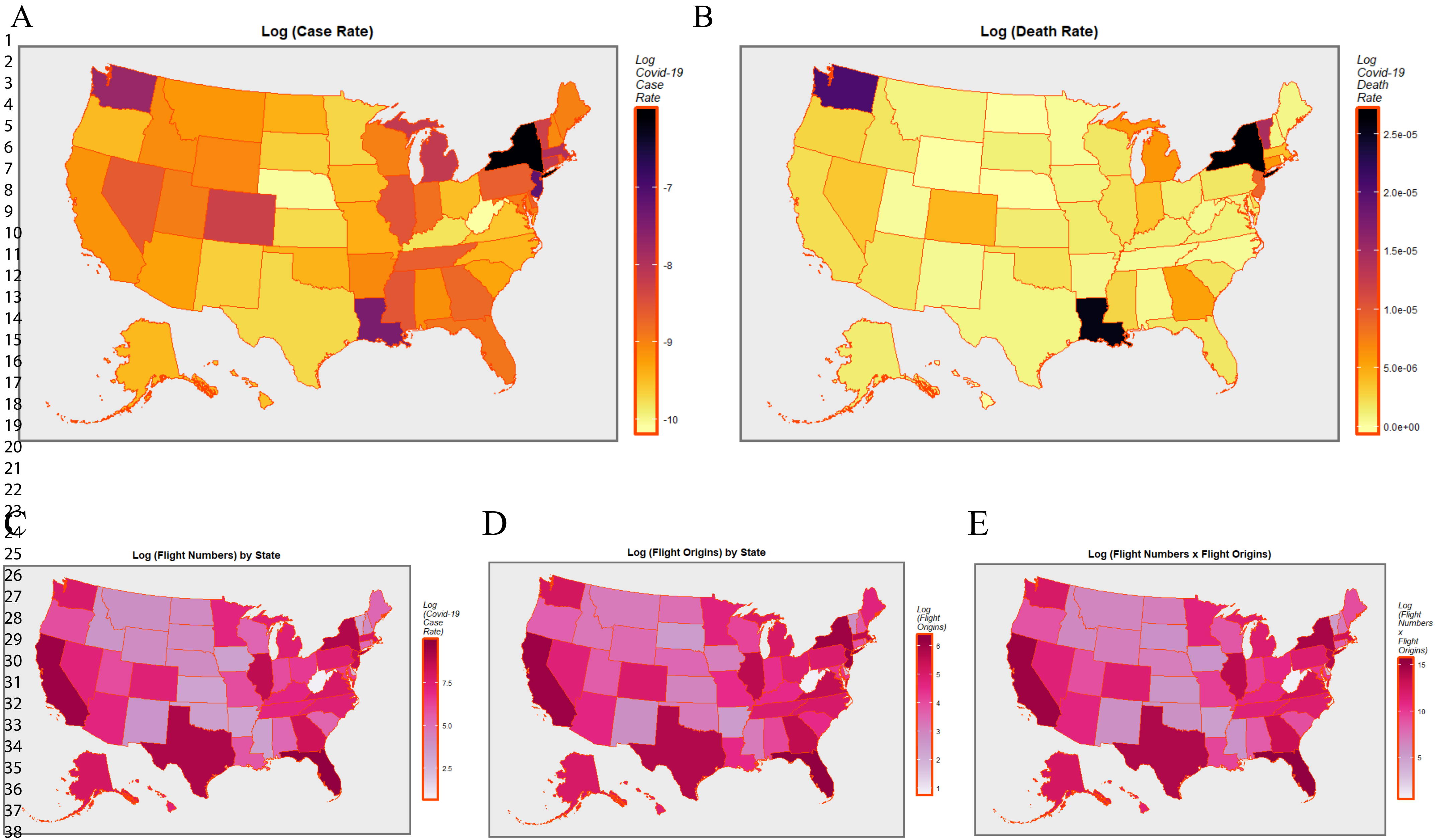
phi:	- idiosyncratic component of the spatial error term
psi:	- individual time-invariant component of the spatial error term
rho:	- spatial autoregressive parameter
lambda:	- spatial autocorrelation coefficient
g2sls	- generalized 2-step spatial least squares error estimation
sem2srre	- spatial error model with errors estimated by Kapoor, Kalejian, and Prucha, serially correlated remainder errors and random effects
KKP	- Kapoor, Kalejian, and Prucha [32]
BFGS	- Errors estimated by the method of Baltagi, Pfaffermayr, Le Gallo and Song [30,31,44]
logLik	- Log of Maximum likelihood ratio
initval	- Initial value
spml	- Spatial panel maximum likelihood estimation
spgm	- Spatial Panel Generalized Method of Moments Estimation
spreml	- Spatial Panel Random Effects Maximum Likelihood Estimation

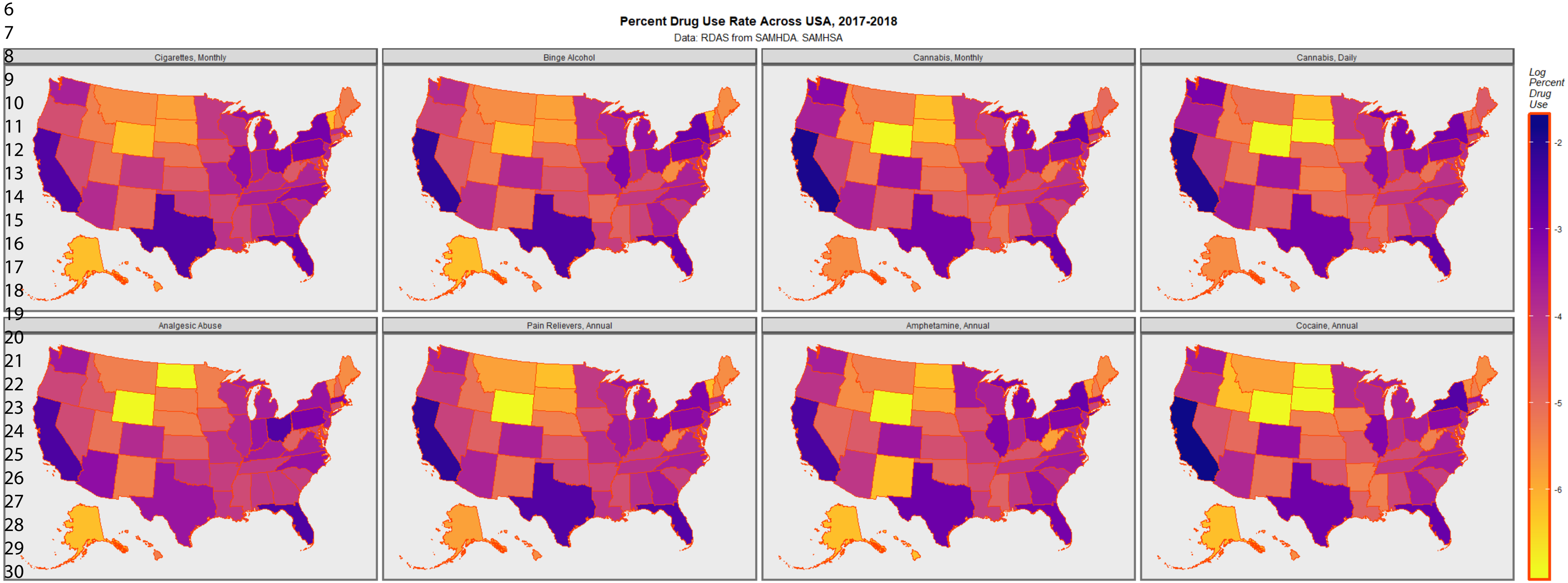
Figure Legends

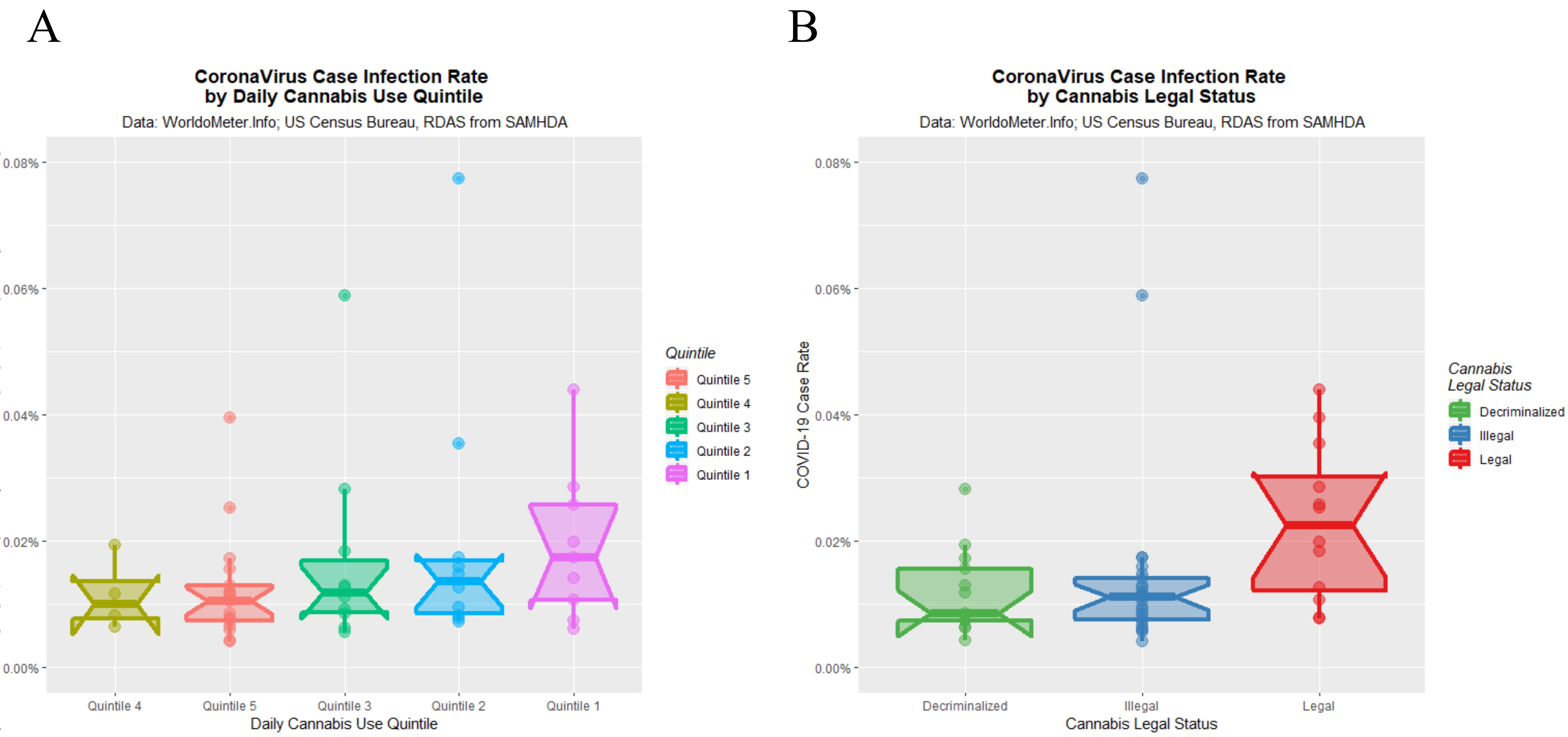
Figure 1.: Covid-19 Rates and Flight Data. (A) Choropleth map of log (Case Rate) by US State. (B) Choropleth map of log (Mortality Rate) by US State. (C) Choropleth map of log (Flight Numbers) by US State. (D) Choropleth map of log (Numbers of Flight Origins) by US State. (E) Choropleth map of log (Product of Flight Numbers x Numbers of Flight Origins) by US State.

Figure 2.: Choropleth maps of log(Drug Use Rates) by US State. Data, Restricted Use Data Analysis System (RDAS) from Substance Abuse and Mental Health Services Data Archive (SAMHDA) from SAMHSA [28].

Figure 3.: Impact of Cannabis Daily Use Quintiles and Legal Status on Coronavirus Infection Rates. (A) Coronavirus infection rate by daily cannabis use quintiles. (B) Coronavirus infection rate by recreational cannabis use legal status.


A
Log (Case Rate)
Log Covid-19 Case Rate
-7
-8
-9
-10
B
Log (Death Rate)
Log Covid-19 Death Rate
2.5e-05
2.0e-05
1.5e-05
1.0e-05
5.0e-06
0.0e+00
C
Log (Flight Numbers) by State
Log (Covid-19 Case Rate)
7.5
5.0
2.5
D
Log (Flight Origins) by State
Log (Flight Origins)
6
5
4
3
2
1
E
Log (Flight Numbers x Flight Origins)
Log (Flight Numbers x Flight Origins)
15
10
5


Percent Drug Use Rate Across USA, 2017-2018
Data: RDAS from SAMHDA. SAMHSA
Cigarettes, Monthly
Binge Alcohol
Cannabis, Monthly
Cannabis, Daily
Analgesic Abuse
Pain Relievers, Annual
Amphetamine, Annual
Cocaine, Annual
Log Percent Drug Use
-2
-3
-4
-5
-6


A
CoronaVirus Case Infection Rate
by Daily Cannabis Use Quintile
Data: WorldoMeter.Info; US Census Bureau, RDAS from SAMHDA
0.08%
0.06%
0.04%
0.02%
0.00%
Quintile
Quintile 5
Quintile 4
Quintile 3
Quintile 2
Quintile 1
Quintile 4
Quintile 5
Quintile 3
Quintile 2
Quintile 1
Daily Cannabis Use Quintile
B
CoronaVirus Case Infection Rate
by Cannabis Legal Status
Data: WorldoMeter.Info; US Census Bureau, RDAS from SAMHDA
COVID-19 Case Rate
0.08%
0.06%
0.04%
0.02%
0.00%
Cannabis
Legal Status
Decriminalized
Illegal
Legal
Decriminalized
Illegal
Legal
Cannabis Legal Status

Supplementary Table 1.: Cannabis Quintiles & Legal Status Designations

State	Quintile Daily Cannabis Use	Legal Status 2020
Alabama	Quintile 3	Illegal
Alaska	Quintile 5	Legal
Arizona	Quintile 2	Illegal
Arkansas	Quintile 4	Illegal
California	Quintile 1	Legal
Colorado	Quintile 1	Legal
Connecticut	Quintile 3	Decriminalized
Delaware	Quintile 5	Decriminalized
Florida	Quintile 1	Illegal
Georgia	Quintile 2	Illegal
Hawaii	Quintile 5	Decriminalized
Idaho	Quintile 5	Illegal
Illinois	Quintile 1	Legal
Indiana	Quintile 2	Illegal
Iowa	Quintile 5	Illegal
Kansas	Quintile 5	Illegal
Kentucky	Quintile 3	Illegal
Louisiana	Quintile 3	Illegal
Maine	Quintile 3	Legal
Maryland	Quintile 3	Decriminalized
Massachusetts	Quintile 2	Legal
Michigan	Quintile 1	Legal

Minnesota	Quintile 3	Decriminalized
Mississippi	Quintile 4	Decriminalized
Missouri	Quintile 3	Illegal
Montana	Quintile 5	Illegal
Nebraska	Quintile 5	Decriminalized
Nevada	Quintile 3	Legal
New Hampshire	Quintile 5	Decriminalized
New Jersey	Quintile 2	Illegal
New Mexico	Quintile 4	Decriminalized
New York	Quintile 1	Decriminalized
North Carolina	Quintile 2	Decriminalized
North Dakota	Quintile 5	Decriminalized
Ohio	Quintile 1	Decriminalized
Oklahoma	Quintile 4	Illegal
Oregon	Quintile 2	Legal
Pennsylvania	Quintile 1	Illegal
Rhode Island	Quintile 5	Decriminalized
South Carolina	Quintile 3	Illegal
South Dakota	Quintile 5	Illegal
Tennessee	Quintile 2	Illegal
Texas	Quintile 1	Illegal
Utah	Quintile 5	Illegal
Vermont	Quintile 5	Legal
Virginia	Quintile 2	Illegal
Washington	Quintile 1	Legal
West Virginia	Quintile 5	Illegal
Wisconsin	Quintile 2	Illegal
Wyoming	Quintile 5	Illegal

Supplementary Table 2.: Quintile & Legal Status Analysis

Group	Cases	Controls	Case_Rate / 10,000	Prevalence Ratio	Attributable Fraction in Exposed (%)	Attributable Fraction in Population (%)
Quintile						
Quintile 5	2,263	23,881,293	9.5	-	-	-
Quintile 4	1,388	11,988,616	11.6	1.22 (1.14-1.31)	18.15 (12.49-23.44)	6.90 (4.51-9.24)
Quintile 3	7,342	44,375,104	16.5	1.75 (1.67-1.83)	42.72 (39.96-45.36)	32.66 (30.19-35.04)
Quintile 2	16,219	74,658,238	21.7	2.29 (2.19-2.40)	56.38 (54.41-58.25)	47.48 (47.48-51.39)
Quintile 1	66,531	167,221,538	39.8	5.11 (4.90-5.33)	80.45 (79.61-81.25)	77.80 (76.88-78.68)
Legal Status						
Illegal	25,943	161,869,909	1.60	-	-	-
Legal	17,878	91,266,635	1.96	1.22 (1.20-1.25)	18.18 (16.61-19.72)	7.42 (6.69-8.13)
Decriminalized	49,922	68,988,245	7.24	4.51 (4.45-4.58)	77.84 (77.50-78.17)	51.22 (50.74-51.70)

Supplementary Table 3.: Geospatial Spreml Regression on Single Group Variables

General	Parameters					Model			
Technique	Parameter	Estimate	Std. Error	t value	P-Value	LogLik	Parameters	Value	P-Value
spatial	***Flights***								
errors =	***spreml(Case_Rate ~ Flight_Number)***						phi	0.0094	NA
sem2srre	Flight_Number	0.1155	0.0392	2.9420	0.0033	-47.1017	psi	1.2E-05	0.9999
method=							rho	0.5794	<2E-16
BFGS									
initval=	***spreml(Case_Rate ~ Number_Flight_Origins)***						phi	0.0216	0.9979
zeros	No._Flight_Origins	0.2202	0.0669	3.2937	0.0009	-46.1750	psi	-3.7E-05	0.9998
							rho	0.5724	4.1E-05
	spreml(Case_Rate ~ Flight_Number x Number_Flight_Origins)						phi	0.0062	0.9991
	Flight_Number x No._Flight_Origins	0.0771	0.0249	3.0976	0.0019	-46.7015	psi	3.3E-05	0.9998
							rho	0.5774	2.8E-05
spatial									
errors =	***Median Household Income (MHY)***								
sem2srre	***spreml(Case_Rate ~ MHY)***						phi	0.0132	0.9991
method=	MHY	0.8713	0.6455	1.3498	0.1771	-50.1873	psi	1.6E-05	0.9999
BFGS							rho	0.5303	0.0005
initval=									
zeros									
spatial	***Race***								
errors =	***spreml(Case_Rate ~ White + Black + Hispanic + Asian + AIAN + NHPI)***								
sem2srre	Asian	0.4132	0.1432	2.8865	0.0039	-46.9494	phi	0.2250	NA
method=	Native Hawaiian / Pacific Islander	-0.2238	0.1008	-2.2208	0.0264		psi	1.3E-05	0.9999

BFGS							rho	0.4691	0.0063
initval=									
zeros									
spatial	***Population***								
errors =	***spreml(Case_Rate ~ Population)***						phi	0.0169	0.9975
sem2srre	Population	0.2242	0.0865	2.5906	0.0096		psi	-2.40E-05	0.9999
method=							rho	0.5938	1.0E-05
BFGS									
initval=									
zeros	***spreml(Case_Rate ~ Population_Density)***								
	Population_Density	0.2278	0.0807	2.8233	0.0048		phi	0.1134	0.9975
							psi	3.1E-06	0.9999
							rho	0.5086	1.0E-05
spatial	***Drugs***								
errors =	***spreml(Case_Rate ~ cigmon * mrjmon * PainRelyr *Analyr + BngAlc + Cocyr + AmphetYr)***								
sem2srre	PainRelyr	-25.2873	5.4440	-4.6450	3.4E-06	-33.0965	phi	0.1099	NA
method=	cigmon: PainRelyr	-5.3952	1.2469	-4.3270	1.5E-05		psi	7.0E-06	1
BFGS	cigmon: mrjmon	5.6747	1.3297	4.2676	2.0E-05		rho	0.6898	2.56E-07
initval=	mrjmon: PainRelyr	-2.0573	0.5150	-3.9947	6.5E-05				
zeros	mrjmon	18.1706	4.6906	3.8738	0.0001				
	cigmon: mrjmon: anlyr	1.0786	0.2798	3.8550	0.0001				
	cigmon: PainRelyr: anlyr	-0.8933	0.2474	-3.6107	0.0003				
	mrjmon: anlyr	3.8312	1.2411	3.0870	0.0020				
	PainRelyr: anlyr	-3.7812	1.2458	-3.0351	0.0024				
	cigmon: mrjmon: PainRelyr	-0.1486	0.0523	-2.8445	0.0044				
	mrjmon: PainRelyr: anlyr	-0.1652	0.0587	-2.8151	0.0049				

spatial	***spreml(Case_Rate ~ mrjmon * mrjmdays * PainRelyr *Analyr + Cigmon + BngAlc + Cocyr + AmphetYr)***								
errors =	mrjmon	2.9736	0.7168	4.1486	3.3E-05	-39.9885	phi	0.5934	0.9607
sem2srre	mrjmdays	-4.2851	1.1334	-3.7807	0.0002		psi	-1.1E-05	1
method=	PainRelyr	-4.3181	1.1493	-3.7572	0.0002		rho	0.6638	7.6E-07
BFGS	mrjmdays: PainRelyr	-1.3727	0.3956	-3.4702	0.0005				
initval=	mrjmon: mrjmdays: PainRelyr	-0.1028	0.0297	-3.4561	0.0005				
zeros									
spatial	***spreml(Case_Rate ~ Cigmon * mrjmon * mrjmdays * PainRelyr + Analyr + Cigmon + BngAlc + Cocyr + AmphetYr)***								
errors =	mrjmon	10.9208	2.2199	4.9196	8.7E-07	- 32.4261	phi	0.1992	0.9374
sem2srre	PainRelyr	-19.1743	4.7785	-4.0126	6.0E-05		psi	4.4E-07	1
method=	mrjmdays: PainRelyr	-4.2636	1.1674	-3.6522	0.0003		rho	0.7477	5.4E-08
BFGS	cigmon: mrjmon: PainRelyr	-0.3949	0.1224	-3.2260	0.0013				
initval=	mrjmon: mrjmdays	2.7491	0.9117	3.0152	0.0026				
zeros	cigmon: PainRelyr	-4.3450	1.6255	-2.6730	0.0075				
	cigmon	-7.8301	3.0909	-2.5333	0.0113				
	cigmon: mrjmon: mrjmdays	0.3557	0.1427	2.4919	0.0127				
	cigmon: mrjmdays: PainRelyr	-0.6716	0.2884	-2.3290	0.0199				
	mrjmdays	-3.3133	1.4962	-2.2144	0.0268				
	cigmon: mrjmon: mrjmdays: PainRelyr	-0.0287	0.0144	-1.9896	0.0466				

Abbreviations:

No._Fl_Origins - Number of Flight Origins arriving at airport
mrjmon - Percent using cannabis within the previous month
mrjmdays - Percent using cannabis on all or most days of the month defined as ≥20 days per month
PainRelyr - Pain Reliever Misuse Use – Recoded
6_Races - White + African_American + Asian + Hispanic + American_Indian_/_Alaskan_Native +

		Native_Hawaiian_/_Pacific_Islander
g2sls	-	generalized 2-step spatial least squares error estimation
sem2srre	-	spatial error model with errors estimated by Kapoor, Kalejian, and Prucha, serially correlated remainder errors and random effects
KKP	-	Kapoor, Kalejian, and Prucha [32]
BFGS	-	Errors estimated by the method of Baltagi, Pfaffermayr, Le Gallo and Song [30,31,44]
logLik	-	Log of Maximum likelihood ratio
initval	-	Initial value
spml	-	Spatial panel maximum likelihood estimation
spgm	-	Spatial Panel Generalized Method of Moments Estimation
spreml	-	Spatial Panel Random Effects Maximum Likelihood Estimation

Supplementary Table 4.: Additive Geospatial Regressions

General	Parameters					Model			
Technique	**Parameter**	**Estimate**	**Std. Error**	**t value**	**P-Value**	**LogLik**	**Parameters**	**Value**	**P-Value**
	spreml(Case_Rate ~ No._Flight_Origins + mrjmon + mrjmdays + PainRelyr + BingAlc + Cocyr + AmphetYr + AnalYr + MHY + 6_Races + Population + Population_Density)								
spreml	No._Flight_Origins	0.2202	0.0669	3.2937	0.0010	-46.17505	phi	0.0216	0.9979
spatial							psi	-3.7E-05	0.9998
errors =							rho	0.5724	4.10E-05
sem2srre									
method=									
BFGS									
initval=									
zeros									
lag=									
false									
	spml(Case_Rate ~ No._Flight_Origins + mrjmon + mrjmdays + PainRelyr + BingAlc + Cocyr + AmphetYr + AnalYr + MHY + 6_Races + Population + Population_Density)								
spml	No._Flight_Origins	0.178156	0.070553	2.5251	0.01157	-44.4226	phi	4.9E-08	0.984294
model=	Population_Density	0.152799	0.084397	1.8105	0.07022		rho	0.5366	0.00028
random									
effect=									
individual									

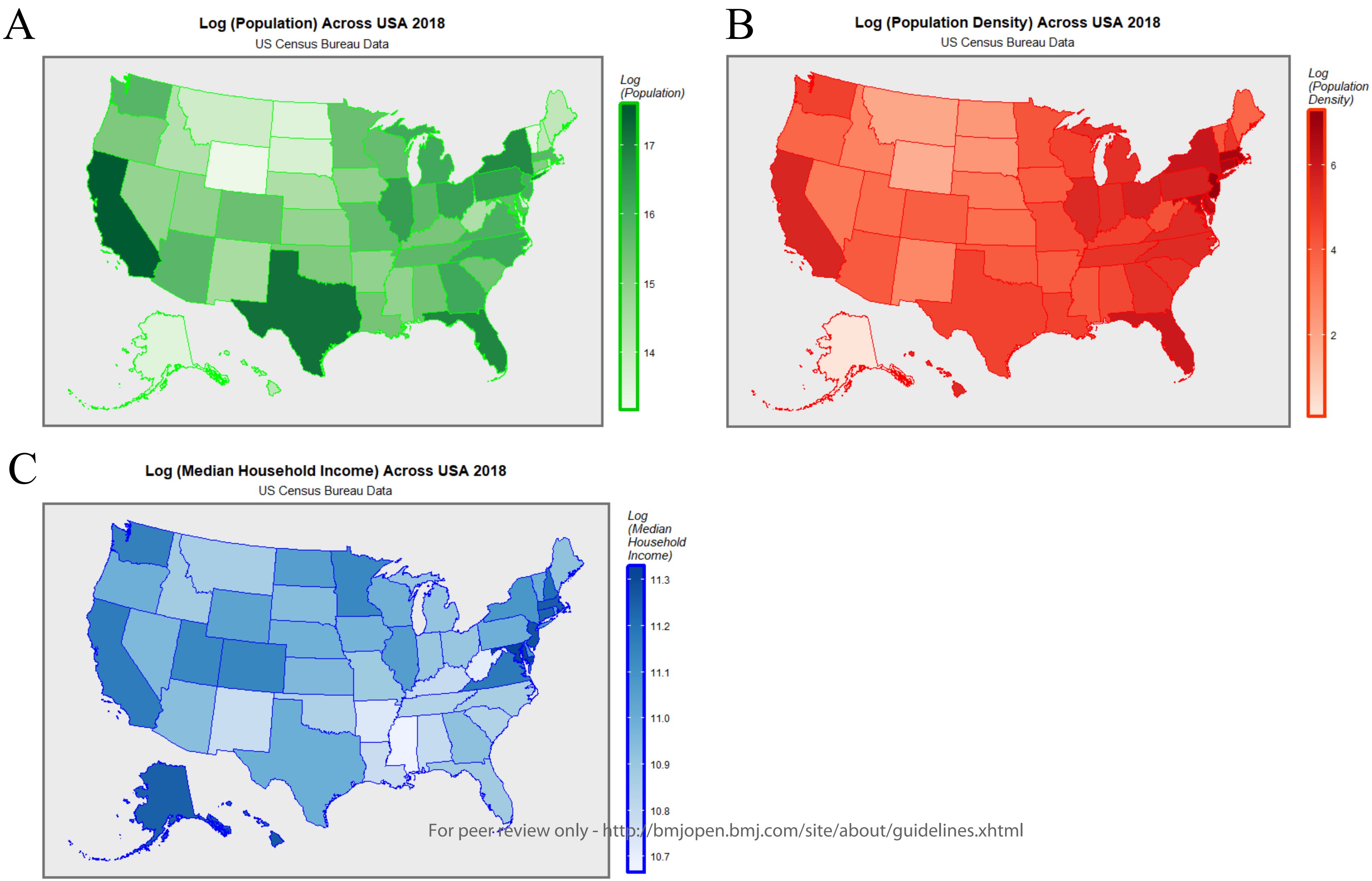
spatial.									
error=									
KKP									
lag=									
false									
	spgm(Case_Rate ~ No._Flight_Origins + mrjmon + mrjmdays + PainRelyr + BingAlc + Cocyr + AmphetYr + AnalYr + MHY + 6_Races + Population + Population_Density)								
spgm	No._Flight_Origins	0.1768	0.0757	2.3357	0.0195				
lag=	Population_Density	0.1616	0.0786	2.0550	0.0399				
false									
model=									
random									
method=									
g2sls									
moments=									
initial									
spatial.									
error=									
true									
	spgm(Case_Rate ~ No._Flights + mrjmon + mrjmdays + PainRelyr + BingAlc + Cocyr + AmphetYr + AnalYr + MHY + 6_Races + Population + Population_Density)								
spgm	mrjmon	0.7618	0.2869	2.6549	0.0079				
lag=	PainRelyr	-0.5935	0.2922	-2.0308	0.0423				
false	White	-1.3307	0.5586	-2.3820	0.0172				
model=	Native_Hawaiian_/_ Pacific _Islanders	-0.2375	0.1104	-2.1510	0.0315				
random									

method=									
g2sls									
moments=									
initial									
spatial.									
error=									
true									

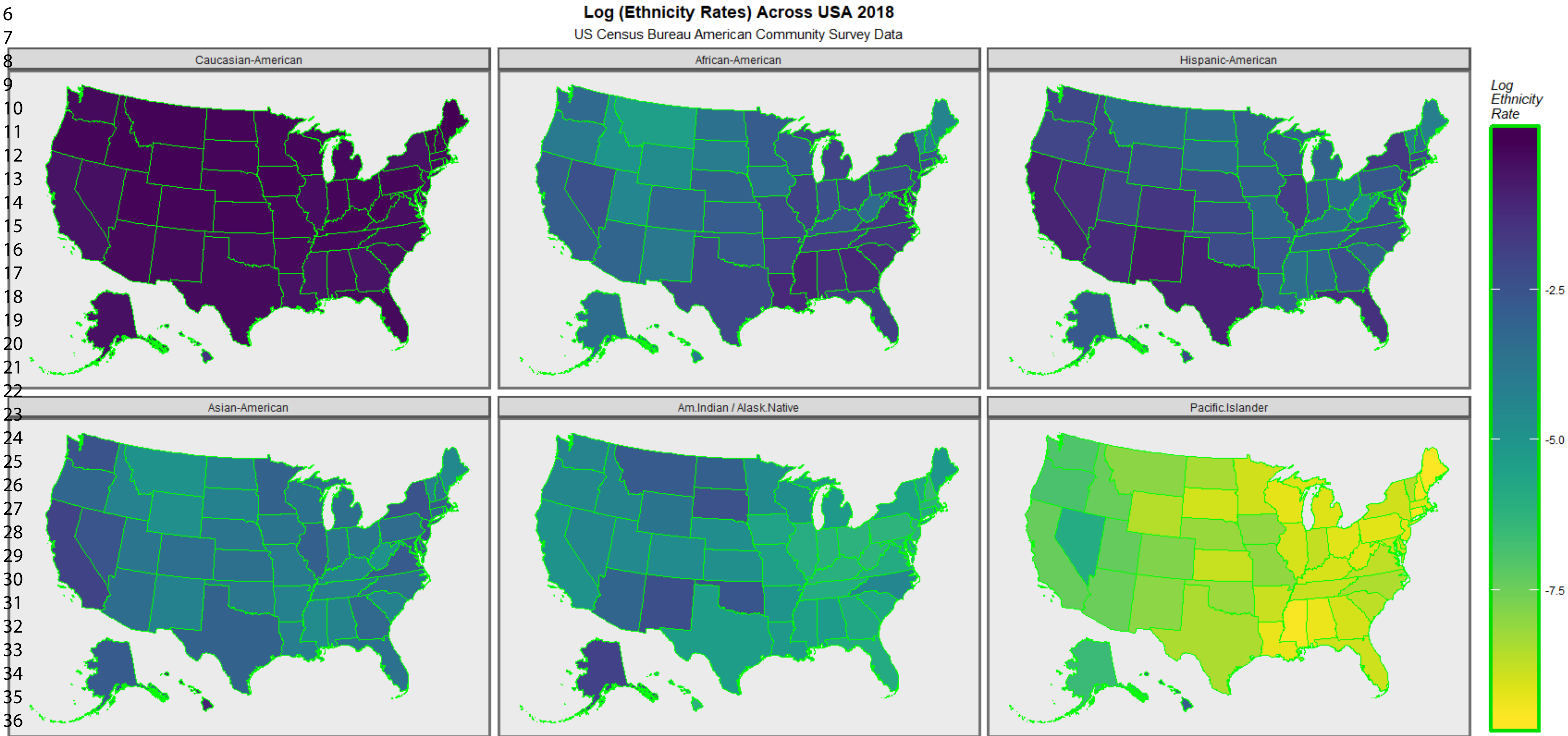
Abbreviations:

No._Fl_Origins - Number of Flight Origins arriving at airport
mrjmon - Percent using cannabis within the previous month
mrjmdays - Percent using cannabis on all or most days of the month defined as ≥20 days per month
PainRelyr - Pain Reliever Misuse Use – Recoded
6_Races - White + African_American + Asian + Hispanic + American_Indian_/_Alaskan_Native + Native_Hawaiian_/_Pacific_Islander
g2sls - generalized 2-step spatial least squares error estimation
sem2srre - spatial error model with errors estimated by Kapoor, Kalejian, and Prucha, serially correlated remainder errors and random effects
KKP - Kapoor, Kalejian, and Prucha [32]
BFGS - Errors estimated by the method of Baltagi, Pfaffermayr, Le Gallo and Song [30,31,44]
logLik - Log of Maximum likelihood ratio
initval - Initial value
spml - Spatial panel maximum likelihood estimation
spgm - Spatial Panel Generalized Method of Moments Estimation
spreml - Spatial Panel Random Effects Maximum Likelihood Estimation

SF1 - MHY, Pop, PopDens

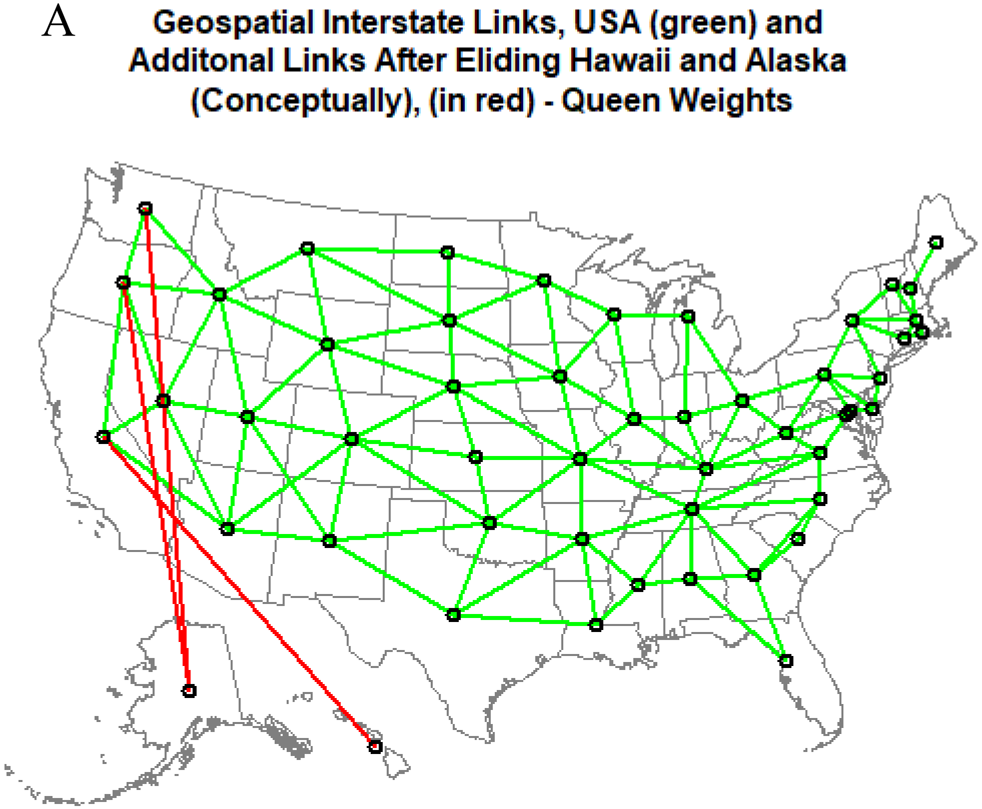


SF2 - Ethnicity

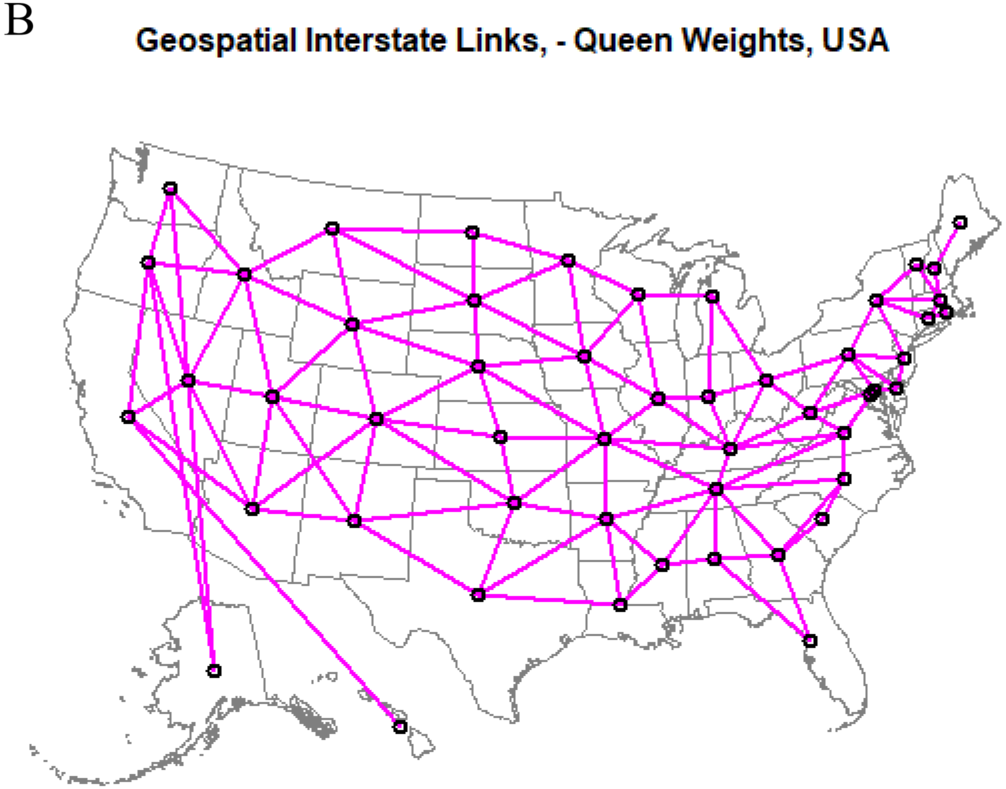


SF3 – Geospatial Links

A



B



State	Cases	Deaths	cigmon	bngalc	mrjmon	mrjmdays	anlyr	PainRelyr	amphyr
New York	44635	519	0.05	0.059	0.061	0.052	0.032	0.044	0.061
New Jersey	6876	81	0.025	0.029	0.022	0.021	0.027	0.022	0.025
Louisiana	2744	119	0.018	0.015	0.011	0.01	0.017	0.018	0.015
Washington	3207	150	0.025	0.02	0.04	0.048	0.029	0.024	0.026
District of Columbia	271	3	0.002	0.003	0.004	0.002	0.004	0.002	0.004
Massachusetts	2417	25	0.02	0.028	0.029	0.028	0.043	0.019	0.038
Michigan	2844	61	0.034	0.033	0.04	0.044	0.026	0.031	0.045
Connecticut	1012	21	0.01	0.014	0.013	0.012	0.011	0.011	0.014
Colorado	1430	24	0.016	0.022	0.031	0.03	0.021	0.025	0.03
Vermont	158	9	0.002	0.002	0.004	0.005	0.004	0.002	0.003
Illinois	2540	26	0.036	0.045	0.038	0.036	0.022	0.027	0.046
Mississippi	579	8	0.013	0.008	0.006	0.007	0.012	0.011	0.008
Nevada	536	10	0.012	0.009	0.014	0.015	0.012	0.014	0.007
Pennsylvania	2218	22	0.044	0.043	0.034	0.038	0.048	0.038	0.041
Tennessee	1153	3	0.025	0.016	0.017	0.017	0.016	0.019	0.018
Delaware	163	2	0.003	0.003	0.003	0.003	0.004	0.003	0.003
Georgia	1642	56	0.031	0.028	0.027	0.021	0.016	0.029	0.034
Rhode Island	165	0	0.003	0.004	0.005	0.006	0.002	0.003	0.006
Indiana	979	24	0.025	0.02	0.021	0.017	0.032	0.027	0.023
Florida	2900	35	0.063	0.062	0.063	0.069	0.084	0.079	0.051
Utah	396	1	0.006	0.005	0.005	0.006	0.006	0.008	0.009
Maryland	775	5	0.016	0.019	0.019	0.016	0.013	0.017	0.018
Wisconsin	732	10	0.019	0.023	0.015	0.018	0.02	0.02	0.025
Maine	168	1	0.005	0.004	0.007	0.009	0.004	0.004	0.004
Wyoming	70	0	0.002	0.002	0.001	0.001	0.001	0.001	0.001
New Hampshire	158	1	0.004	0.005	0.006	0.006	0.007	0.004	0.005
Arkansas	351	2	0.013	0.007	0.008	0.008	0.015	0.013	0.012
Idaho	192	3	0.005	0.005	0.004	0.005	0.009	0.006	0.004
Alabama	540	3	0.021	0.014	0.012	0.013	0.016	0.02	0.017
California	4203	85	0.082	0.12	0.148	0.141	0.086	0.122	0.088
Montana	109	1	0.004	0.004	0.005	0.006	0.005	0.003	0.005
Arizona	665	13	0.021	0.019	0.025	0.029	0.036	0.024	0.017
South Carolina	456	9	0.02	0.017	0.013	0.014	0.015	0.015	0.019
Missouri	520	9	0.023	0.019	0.017	0.013	0.018	0.02	0.016
North Dakota	64	0	0.003	0.003	0.002	0.002	0.001	0.002	0.002
Oklahoma	322	8	0.015	0.011	0.009	0.007	0.017	0.012	0.008
North Carolina	832	4	0.036	0.027	0.024	0.026	0.033	0.026	0.029
Alaska	58	1	0.002	0.002	0.004	0.004	0.002	0.003	0.002
Oregon	317	11	0.011	0.013	0.025	0.027	0.013	0.017	0.018
Iowa	235	3	0.011	0.011	0.007	0.006	0.009	0.01	0.011
Ohio	871	15	0.045	0.036	0.031	0.034	0.081	0.041	0.042
Hawaii	106	0	0.003	0.004	0.004	0.004	0.005	0.004	0.002
Virginia	606	10	0.023	0.024	0.019	0.018	0.027	0.023	0.025
South Dakota	57	1	0.003	0.003	0.002	0.001	0.005	0.003	0.003
New Mexico	136	1	0.007	0.006	0.009	0.008	0.005	0.006	0.002
Minnesota	344	2	0.016	0.019	0.017	0.016	0.005	0.016	0.029
Texas	1683	24	0.082	0.083	0.052	0.053	0.031	0.08	0.058
Kansas	174	4	0.009	0.01	0.006	0.005	0.008	0.009	0.011
Kentucky	247	5	0.021	0.011	0.012	0.011	0.027	0.015	0.01
Nebraska	82	0	0.006	0.007	0.005	0.006	0.005	0.005	0.007

West Virginia	76	1	0.009	0.004	0.005	0.006	0.008	0.005	0.003

cocvr	WhPc	BlPc	HisPc	AsPc	AIANPc	NHPIpc	Pop
0.079	0.637917	0.156388	0.188883	0.083102	0.004060	1.34E-04	19618453
0.02	0.679110	0.134743	0.199060	0.093720	0.002100	9.91E-05	8881845
0.008	0.622072	0.322264	0.050373	0.017127	0.005633	9.35E-05	4663616
0.027	0.760316	0.036995	0.124970	0.083274	0.013030	9.33E-04	7294336
0.006	0.409744	0.469420	0.109242	0.039033	0.002912	1.59E-04	684498
0.032	0.784752	0.074750	0.115535	0.064797	0.002122	1.06E-04	6830193
0.026	0.785197	0.138130	0.050002	0.030570	0.005346	1.09E-04	9957488
0.011	0.763612	0.105615	0.156859	0.044344	0.002708	6.84E-05	3581504
0.035	0.841704	0.041210	0.214204	0.031222	0.009850	4.04E-04	5531141
0.004	0.943308	0.012893	0.018684	0.016927	0.003370	1.82E-04	624977
0.043	0.716701	0.142271	0.169625	0.053880	0.002485	1.23E-04	12821497
0.005	0.585926	0.376689	0.030278	0.009473	0.004580	7.16E-05	2988762
0.01	0.662061	0.089339	0.284516	0.080296	0.012264	0.002658023	2922849
0.039	0.808482	0.111273	0.070764	0.033452	0.001943	1.03E-04	12791181
0.017	0.776750	0.168016	0.052984	0.016977	0.002683	1.51E-04	6651089
0.003	0.689740	0.221056	0.090906	0.038676	0.003639	1.47E-04	949495
0.028	0.590433	0.314572	0.094049	0.039087	0.003252	1.24E-04	10297484
0.005	0.808720	0.065544	0.150347	0.033752	0.005190	2.08E-04	1056611
0.019	0.835908	0.093330	0.067838	0.021844	0.002249	1.60E-04	6637426
0.061	0.753908	0.161004	0.251708	0.027147	0.002822	1.40E-04	20598139
0.007	0.864287	0.011776	0.138612	0.022923	0.010724	6.35E-04	3045350
0.016	0.561875	0.297844	0.098096	0.062344	0.002606	1.37E-04	6003435
0.021	0.855941	0.063814	0.066762	0.027578	0.008726	9.74E-05	5778394
0.004	0.944781	0.013416	0.016072	0.011192	0.006229	6.98E-05	1332813
0.001	0.914361	0.009522	0.097907	0.008174	0.024153	1.94E-04	581836
0.005	0.930332	0.015269	0.035989	0.026886	0.001555	7.59E-05	1343622
0.005	0.770019	0.154136	0.073245	0.014708	0.006700	1.47E-04	2990671
0.002	0.904878	0.006835	0.123872	0.014076	0.013503	6.01E-04	1687809
0.013	0.681947	0.265832	0.041759	0.013281	0.005257	8.86E-05	4864680
0.164	0.601017	0.057930	0.388814	0.143155	0.007573	6.26E-04	39148760
0.003	0.888561	0.004445	0.037456	0.007629	0.064593	3.51E-04	1041732
0.022	0.772187	0.043943	0.311416	0.032949	0.044565	5.87E-04	6946685
0.015	0.672526	0.270254	0.055627	0.015150	0.003367	1.73E-04	4955925
0.009	0.822379	0.115745	0.040904	0.019166	0.004426	3.21E-04	6090062
0.001	0.871134	0.027180	0.035268	0.014376	0.052462	2.35E-04	752201
0.01	0.724266	0.073494	0.104009	0.021284	0.075208	2.83E-04	3918137
0.028	0.688706	0.214622	0.092161	0.027794	0.011949	2.12E-04	10155624
0.002	0.648373	0.032672	0.069309	0.063040	0.144425	0.001440727	738516
0.019	0.844189	0.019057	0.128359	0.042752	0.011505	0.001028922	4081943
0.005	0.902758	0.035087	0.058514	0.023969	0.003687	3.19E-04	3132499
0.026	0.815146	0.123543	0.037050	0.021452	0.002024	1.05E-04	11641879
0.004	0.250074	0.018471	0.104050	0.377518	0.002101	0.062506461	1422029
0.024	0.680154	0.191743	0.091656	0.063171	0.002730	1.73E-04	8413774
0.001	0.844697	0.018791	0.037019	0.014648	0.087160	1.30E-04	864289
0.006	0.745011	0.020553	0.485440	0.015060	0.095533	3.44E-04	2092434
0.021	0.833317	0.061908	0.052966	0.047466	0.010671	1.34E-04	5527358
0.056	0.743071	0.120701	0.391661	0.046916	0.004879	2.19E-04	27885195
0.006	0.845929	0.058375	0.117099	0.028717	0.008268	1.51E-04	2908776
0.012	0.870833	0.079751	0.035752	0.014144	0.002227	1.20E-04	4440204
0.005	0.874894	0.047702	0.106723	0.023155	0.009073	2.90E-04	1904760

0.005	0.931818	0.036482	0.015047	0.007946	0.002005	1.02E-04	1829054

MHY	Year	QuinCI	Quin	QuinCN	Stat20	FINo	NFIOrigins	FINo_FIOr
65323	2015	(0.0968,0.122]	Quintile 3	(0.0817,0.113]	Decriminalized	4218	208	877344
79363	2015	[0.0472,0.072]	Quintile 1	(0.064,0.0743]	Illegal	2539	214	543346
47942	2015	[0.0472,0.072]	Quintile 1	(0.064,0.0743]	Illegal	163	47	7661
70116	2015	(0.0968,0.122]	Quintile 3	(0.113,0.171]	Legal	1208	89	107512
82604	2015	(0.0968,0.122]	Quintile 3	(0.113,0.171]	Legal	NA	NA	NA
77378	2015	(0.0968,0.122]	Quintile 3	(0.113,0.171]	Legal	1414	136	192304
54938	2015	(0.0968,0.122]	Quintile 3	(0.0817,0.113]	Legal	851	80	68080
76106	2015	(0.0968,0.122]	Quintile 3	(0.0817,0.113]	Decriminalized	92	25	2300
68811	2015	(0.146,0.171]	Quintile 5	(0.113,0.171]	Legal	835	74	61790
60076	2015	(0.146,0.171]	Quintile 5	(0.113,0.171]	Legal	11	8	88
63575	2015	(0.072,0.0968]	Quintile 2	(0.0743,0.0817]	Legal	3019	140	422660
43567	2015	[0.0472,0.072]	Quintile 1	[0.0472,0.064]	Decriminalized	14	12	168
57598	2015	(0.072,0.0968]	Quintile 2	(0.0743,0.0817]	Legal	779	60	46740
59445	2015	(0.072,0.0968]	Quintile 2	(0.0743,0.0817]	Illegal	949	73	69277
50972	2015	[0.0472,0.072]	Quintile 1	[0.0472,0.064]	Misdemeanor	651	72	46872
65627	2015	(0.072,0.0968]	Quintile 2	(0.0743,0.0817]	Decriminalized	6	3	18
55679	2015	(0.072,0.0968]	Quintile 2	(0.0743,0.0817]	Illegal	1965	130	255450
63296	2015	(0.122,0.146]	Quintile 4	(0.113,0.171]	Decriminalized	47	18	846
54325	2015	(0.072,0.0968]	Quintile 2	(0.0817,0.113]	Misdemeanor	226	41	9266
53267	2015	(0.072,0.0968]	Quintile 2	(0.0743,0.0817]	Illegal	9108	257	2340756
68374	2015	[0.0472,0.072]	Quintile 1	[0.0472,0.064]	Misdemeanor	226	21	4746
81868	2015	(0.072,0.0968]	Quintile 2	(0.0817,0.113]	Decriminalized	334	39	13026
59209	2015	[0.0472,0.072]	Quintile 1	(0.064,0.0743]	Illegal	110	31	3410
55425	2015	(0.122,0.146]	Quintile 4	(0.113,0.171]	Legal	99	56	5544
62268	2015	[0.0472,0.072]	Quintile 1	[0.0472,0.064]	Misdemeanor	31	16	496
74057	2015	(0.122,0.146]	Quintile 4	(0.113,0.171]	Decriminalized	32	23	736
45726	2015	(0.072,0.0968]	Quintile 2	(0.064,0.0743]	Illegal	13	6	78
53089	2015	[0.0472,0.072]	Quintile 1	[0.0472,0.064]	Misdemeanor	23	13	299
48486	2015	[0.0472,0.072]	Quintile 1	[0.0472,0.064]	Illegal	93	30	2790
71228	2015	(0.0968,0.122]	Quintile 3	(0.0817,0.113]	Legal	6734	217	1461278
52559	2015	(0.0968,0.122]	Quintile 3	(0.0817,0.113]	Illegal	28	12	336
56213	2015	(0.072,0.0968]	Quintile 2	(0.0817,0.113]	Illegal	676	51	34476
51015	2015	(0.072,0.0968]	Quintile 2	(0.0817,0.113]	Misdemeanor	113	45	5085
53560	2015	(0.072,0.0968]	Quintile 2	(0.0743,0.0817]	Illegal	220	43	9460
63473	2015	[0.0472,0.072]	Quintile 1	[0.0472,0.064]	Decriminalized	33	15	495
51424	2015	[0.0472,0.072]	Quintile 1	[0.0472,0.064]	Illegal	15	12	180
52413	2015	(0.072,0.0968]	Quintile 2	(0.064,0.0743]	Decriminalized	890	78	69420
76715	2015	(0.146,0.171]	Quintile 5	(0.113,0.171]	Legal	1553	82	127346
59393	2015	(0.122,0.146]	Quintile 4	(0.113,0.171]	Legal	204	19	3876
58580	2015	[0.0472,0.072]	Quintile 1	[0.0472,0.064]	Illegal	14	11	154
54533	2015	(0.072,0.0968]	Quintile 2	(0.0743,0.0817]	Decriminalized	346	70	24220
78084	2015	(0.072,0.0968]	Quintile 2	(0.0743,0.0817]	Decriminalized	752	66	49632
71564	2015	[0.0472,0.072]	Quintile 1	(0.064,0.0743]	Misdemeanor	1375	124	170500
56499	2015	[0.0472,0.072]	Quintile 1	(0.064,0.0743]	Misdemeanor	31	6	186
48059	2015	(0.0968,0.122]	Quintile 3	(0.0817,0.113]	Decriminalized	24	8	192
68411	2015	(0.072,0.0968]	Quintile 2	(0.0743,0.0817]	Decriminalized	669	56	37464
59570	2015	[0.0472,0.072]	Quintile 1	[0.0472,0.064]	Illegal	4591	159	729969
57422	2015	(0.072,0.0968]	Quintile 2	(0.064,0.0743]	Misdemeanor	13	10	130
48392	2015	[0.0472,0.072]	Quintile 1	(0.064,0.0743]	Misdemeanor	621	44	27324
59116	2015	[0.0472,0.072]	Quintile 1	[0.0472,0.064]	Decriminalized	31	17	527

44921	2015	[0.0472,0.0721]	Quintile 1	(0.064,0.0743]	Misdemeanor	[	1	]

CaseRt	DthRt	MortRt	QuinCddInt	QuinCddNo	QuinCsRtInt	QuinCsRtNo
0.002275154	2.65E-05	0.011627646	Quintile 4	Quintile 1	Quintile 1	Quintile 1
7.74E-04	9.12E-06	0.011780105	Quintile 5	Quintile 2	Quintile 4	Quintile 1
5.88E-04	2.55E-05	0.043367347	Quintile 5	Quintile 3	Quintile 4	Quintile 1
4.40E-04	2.06E-05	0.046772685	Quintile 4	Quintile 1	Quintile 5	Quintile 1
3.96E-04	4.38E-06	0.011070111	Quintile 5	Quintile 5	Quintile 5	Quintile 1
3.54E-04	3.66E-06	0.010343401	Quintile 5	Quintile 2	Quintile 5	Quintile 1
2.86E-04	6.13E-06	0.021448664	Quintile 4	Quintile 1	Quintile 5	Quintile 1
2.83E-04	5.86E-06	0.020750988	Quintile 5	Quintile 3	Quintile 5	Quintile 1
2.59E-04	4.34E-06	0.016783217	Quintile 4	Quintile 1	Quintile 5	Quintile 1
2.53E-04	1.44E-05	0.056962025	Quintile 5	Quintile 5	Quintile 5	Quintile 1
1.98E-04	2.03E-06	0.01023622	Quintile 4	Quintile 1	Quintile 5	Quintile 2
1.94E-04	2.68E-06	0.013816926	Quintile 5	Quintile 4	Quintile 5	Quintile 2
1.83E-04	3.42E-06	0.018656716	Quintile 5	Quintile 3	Quintile 5	Quintile 2
1.73E-04	1.72E-06	0.009918846	Quintile 4	Quintile 1	Quintile 5	Quintile 2
1.73E-04	4.51E-07	0.002601908	Quintile 5	Quintile 2	Quintile 5	Quintile 2
1.72E-04	2.11E-06	0.012269939	Quintile 5	Quintile 5	Quintile 5	Quintile 2
1.59E-04	5.44E-06	0.03410475	Quintile 5	Quintile 2	Quintile 5	Quintile 2
1.56E-04	0	0	Quintile 5	Quintile 5	Quintile 5	Quintile 2
1.47E-04	3.62E-06	0.024514811	Quintile 5	Quintile 2	Quintile 5	Quintile 2
1.41E-04	1.70E-06	0.012068966	Quintile 3	Quintile 1	Quintile 5	Quintile 2
1.30E-04	3.28E-07	0.002525253	Quintile 5	Quintile 5	Quintile 5	Quintile 3
1.29E-04	8.33E-07	0.006451613	Quintile 5	Quintile 3	Quintile 5	Quintile 3
1.27E-04	1.73E-06	0.013661202	Quintile 5	Quintile 2	Quintile 5	Quintile 3
1.26E-04	7.50E-07	0.005952381	Quintile 5	Quintile 3	Quintile 5	Quintile 3
1.20E-04	0	0	Quintile 5	Quintile 5	Quintile 5	Quintile 3
1.18E-04	7.44E-07	0.006329114	Quintile 5	Quintile 5	Quintile 5	Quintile 3
1.17E-04	6.69E-07	0.005698006	Quintile 5	Quintile 4	Quintile 5	Quintile 3
1.14E-04	1.78E-06	0.015625	Quintile 5	Quintile 5	Quintile 5	Quintile 3
1.11E-04	6.17E-07	0.005555556	Quintile 5	Quintile 3	Quintile 5	Quintile 3
1.07E-04	2.17E-06	0.02022365	Quintile 1	Quintile 1	Quintile 5	Quintile 3
1.05E-04	9.60E-07	0.009174312	Quintile 5	Quintile 5	Quintile 5	Quintile 4
9.57E-05	1.87E-06	0.019548872	Quintile 4	Quintile 2	Quintile 5	Quintile 4
9.20E-05	1.82E-06	0.019736842	Quintile 5	Quintile 3	Quintile 5	Quintile 4
8.54E-05	1.48E-06	0.017307692	Quintile 5	Quintile 3	Quintile 5	Quintile 4
8.51E-05	0	0	Quintile 5	Quintile 5	Quintile 5	Quintile 4
8.22E-05	2.04E-06	0.02484472	Quintile 5	Quintile 4	Quintile 5	Quintile 4
8.19E-05	3.94E-07	0.004807692	Quintile 5	Quintile 2	Quintile 5	Quintile 4
7.85E-05	1.35E-06	0.017241379	Quintile 5	Quintile 5	Quintile 5	Quintile 4
7.77E-05	2.69E-06	0.034700315	Quintile 5	Quintile 2	Quintile 5	Quintile 4
7.50E-05	9.58E-07	0.012765957	Quintile 5	Quintile 5	Quintile 5	Quintile 4
7.48E-05	1.29E-06	0.017221584	Quintile 4	Quintile 1	Quintile 5	Quintile 5
7.45E-05	0	0	Quintile 5	Quintile 5	Quintile 5	Quintile 5
7.20E-05	1.19E-06	0.01650165	Quintile 5	Quintile 2	Quintile 5	Quintile 5
6.60E-05	1.16E-06	0.01754386	Quintile 5	Quintile 5	Quintile 5	Quintile 5
6.50E-05	4.78E-07	0.007352941	Quintile 5	Quintile 4	Quintile 5	Quintile 5
6.22E-05	3.62E-07	0.005813953	Quintile 5	Quintile 3	Quintile 5	Quintile 5
6.04E-05	8.61E-07	0.01426025	Quintile 4	Quintile 1	Quintile 5	Quintile 5
5.98E-05	1.38E-06	0.022988506	Quintile 5	Quintile 5	Quintile 5	Quintile 5
5.56E-05	1.13E-06	0.020242915	Quintile 5	Quintile 3	Quintile 5	Quintile 5
4.31E-05	0	0	Quintile 5	Quintile 5	Quintile 5	Quintile 5

4.16E-05	5.47E-07	0.013157895	Quintile 5	Quintile 5	Quintile 5	Quintile 5

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State	Year	cigmon	bngalc	mrjmon	mrjmdays	anlyr	PainRelyr	amphyr	cocyr
Alabama	2019	0.021	0.014	0.012	0.013	0.016	0.02	0.017	0.013
Alaska	2019	0.002	0.002	0.004	0.004	0.002	0.003	0.002	0.002
Arizona	2019	0.021	0.019	0.025	0.029	0.036	0.024	0.017	0.022
Arkansas	2019	0.013	0.007	0.008	0.008	0.015	0.013	0.012	0.005
California	2019	0.082	0.12	0.148	0.141	0.086	0.122	0.088	0.164
Colorado	2019	0.016	0.022	0.031	0.03	0.021	0.025	0.03	0.035
Connecticut	2019	0.01	0.014	0.013	0.012	0.011	0.011	0.014	0.011
Delaware	2019	0.003	0.003	0.003	0.003	0.004	0.003	0.003	0.003
Florida	2019	0.063	0.062	0.063	0.069	0.084	0.079	0.051	0.061
Georgia	2019	0.031	0.028	0.027	0.021	0.016	0.029	0.034	0.028
Hawaii	2019	0.003	0.004	0.004	0.004	0.005	0.004	0.002	0.004
Idaho	2019	0.005	0.005	0.004	0.005	0.009	0.006	0.004	0.002
Illinois	2019	0.036	0.045	0.038	0.036	0.022	0.027	0.046	0.043
Indiana	2019	0.025	0.02	0.021	0.017	0.032	0.027	0.023	0.019
Iowa	2019	0.011	0.011	0.007	0.006	0.009	0.01	0.011	0.005
Kansas	2019	0.009	0.01	0.006	0.005	0.008	0.009	0.011	0.006
Kentucky	2019	0.021	0.011	0.012	0.011	0.027	0.015	0.01	0.012
Louisiana	2019	0.018	0.015	0.011	0.01	0.017	0.018	0.015	0.008
Maine	2019	0.005	0.004	0.007	0.009	0.004	0.004	0.004	0.004
Maryland	2019	0.016	0.019	0.019	0.016	0.013	0.017	0.018	0.016
Massachusetts	2019	0.02	0.028	0.029	0.028	0.043	0.019	0.038	0.032
Michigan	2019	0.034	0.033	0.04	0.044	0.026	0.031	0.045	0.026
Minnesota	2019	0.016	0.019	0.017	0.016	0.005	0.016	0.029	0.021
Mississippi	2019	0.013	0.008	0.006	0.007	0.012	0.011	0.008	0.005
Missouri	2019	0.023	0.019	0.017	0.013	0.018	0.02	0.016	0.009
Montana	2019	0.004	0.004	0.005	0.006	0.005	0.003	0.005	0.003
Nebraska	2019	0.006	0.007	0.005	0.006	0.005	0.005	0.007	0.005
Nevada	2019	0.012	0.009	0.014	0.015	0.012	0.014	0.007	0.01
New Hampshire	2019	0.004	0.005	0.006	0.006	0.007	0.004	0.005	0.005
New Jersey	2019	0.025	0.029	0.022	0.021	0.027	0.022	0.025	0.02
New Mexico	2019	0.007	0.006	0.009	0.008	0.005	0.006	0.002	0.006
New York	2019	0.05	0.059	0.061	0.052	0.032	0.044	0.061	0.079
North Carolina	2019	0.036	0.027	0.024	0.026	0.033	0.026	0.029	0.028
North Dakota	2019	0.003	0.003	0.002	0.002	0.001	0.002	0.002	0.001
Ohio	2019	0.045	0.036	0.031	0.034	0.081	0.041	0.042	0.026
Oklahoma	2019	0.015	0.011	0.009	0.007	0.017	0.012	0.008	0.01
Oregon	2019	0.011	0.013	0.025	0.027	0.013	0.017	0.018	0.019
Pennsylvania	2019	0.044	0.043	0.034	0.038	0.048	0.038	0.041	0.039
Rhode Island	2019	0.003	0.004	0.005	0.006	0.002	0.003	0.006	0.005
South Carolina	2019	0.02	0.017	0.013	0.014	0.015	0.015	0.019	0.015
South Dakota	2019	0.003	0.003	0.002	0.001	0.005	0.003	0.003	0.001
Tennessee	2019	0.025	0.016	0.017	0.017	0.016	0.019	0.018	0.017
Texas	2019	0.082	0.083	0.052	0.053	0.031	0.08	0.058	0.056
Utah	2019	0.006	0.005	0.005	0.006	0.006	0.008	0.009	0.007
Vermont	2019	0.002	0.002	0.004	0.005	0.004	0.002	0.003	0.004
Virginia	2019	0.023	0.024	0.019	0.018	0.027	0.023	0.025	0.024
Washington	2019	0.025	0.02	0.04	0.048	0.029	0.024	0.026	0.027
West Virginia	2019	0.009	0.004	0.005	0.006	0.008	0.005	0.003	0.005
Wisconsin	2019	0.019	0.023	0.015	0.018	0.02	0.02	0.025	0.021
Wyoming	2019	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001

WhPc	BlPc	HisPc	AsPc	AIANPc	NHPIpc	MHY	FINo
0.681947	0.265832	0.041759	0.013281	0.005257	8.86E-05	48486	93
0.648373	0.032672	0.069309	0.063040	0.144425	0.001440727	76715	1553
0.772187	0.043943	0.311416	0.032949	0.044565	5.87E-04	56213	676
0.770019	0.154136	0.073245	0.014708	0.006700	1.47E-04	45726	13
0.601017	0.057930	0.388814	0.143155	0.007573	6.26E-04	71228	6734
0.841704	0.041210	0.214204	0.031222	0.009850	4.04E-04	68811	835
0.763612	0.105615	0.156859	0.044344	0.002708	6.84E-05	76106	92
0.689740	0.221056	0.090906	0.038676	0.003639	1.47E-04	65627	6
0.753908	0.161004	0.251708	0.027147	0.002822	1.40E-04	53267	9108
0.590433	0.314572	0.094049	0.039087	0.003252	1.24E-04	55679	1965
0.250074	0.018471	0.104050	0.377518	0.002101	0.062506461	78084	752
0.904878	0.006835	0.123872	0.014076	0.013503	6.01E-04	53089	23
0.716701	0.142271	0.169625	0.053880	0.002485	1.23E-04	63575	3019
0.835908	0.093330	0.067838	0.021844	0.002249	1.60E-04	54325	226
0.902758	0.035087	0.058514	0.023969	0.003687	3.19E-04	58580	14
0.845929	0.058375	0.117099	0.028717	0.008268	1.51E-04	57422	13
0.870833	0.079751	0.035752	0.014144	0.002227	1.20E-04	48392	621
0.622072	0.322264	0.050373	0.017127	0.005633	9.35E-05	47942	163
0.944781	0.013416	0.016072	0.011192	0.006229	6.98E-05	55425	99
0.561875	0.297844	0.098096	0.062344	0.002606	1.37E-04	81868	334
0.784752	0.074750	0.115535	0.064797	0.002122	1.06E-04	77378	1414
0.785197	0.138130	0.050002	0.030570	0.005346	1.09E-04	54938	851
0.833317	0.061908	0.052966	0.047466	0.010671	1.34E-04	68411	669
0.585926	0.376689	0.030278	0.009473	0.004580	7.16E-05	43567	14
0.822379	0.115745	0.040904	0.019166	0.004426	3.21E-04	53560	220
0.888561	0.004445	0.037456	0.007629	0.064593	3.51E-04	52559	28
0.874894	0.047702	0.106723	0.023155	0.009073	2.90E-04	59116	31
0.662061	0.089339	0.284516	0.080296	0.012264	0.002658023	57598	779
0.930332	0.015269	0.035989	0.026886	0.001555	7.59E-05	74057	32
0.679110	0.134743	0.199060	0.093720	0.002100	9.91E-05	79363	2539
0.745011	0.020553	0.485440	0.015060	0.095533	3.44E-04	48059	24
0.637917	0.156388	0.188883	0.083102	0.004060	1.34E-04	65323	4218
0.688706	0.214622	0.092161	0.027794	0.011949	2.12E-04	52413	890
0.871134	0.027180	0.035268	0.014376	0.052462	2.35E-04	63473	33
0.815146	0.123543	0.037050	0.021452	0.002024	1.05E-04	54533	346
0.724266	0.073494	0.104009	0.021284	0.075208	2.83E-04	51424	15
0.844189	0.019057	0.128359	0.042752	0.011505	0.001028922	59393	204
0.808482	0.111273	0.070764	0.033452	0.001943	1.03E-04	59445	949
0.808720	0.065544	0.150347	0.033752	0.005190	2.08E-04	63296	47
0.672526	0.270254	0.055627	0.015150	0.003367	1.73E-04	51015	113
0.844697	0.018791	0.037019	0.014648	0.087160	1.30E-04	56499	31
0.776750	0.168016	0.052984	0.016977	0.002683	1.51E-04	50972	651
0.743071	0.120701	0.391661	0.046916	0.004879	2.19E-04	59570	4591
0.864287	0.011776	0.138612	0.022923	0.010724	6.35E-04	68374	226
0.943308	0.012893	0.018684	0.016927	0.003370	1.82E-04	60076	11
0.680154	0.191743	0.091656	0.063171	0.002730	1.73E-04	71564	1375
0.760316	0.036995	0.124970	0.083274	0.013030	9.33E-04	70116	1208
0.931818	0.036482	0.015047	0.007946	0.002005	1.02E-04	44921	1
0.855941	0.063814	0.066762	0.027578	0.008726	9.74E-05	59209	110
0.914361	0.009522	0.097907	0.008174	0.024153	1.94E-04	62268	31

NFIOrigins	FINo_FIOr	CaseRt	DthRt	Stat202	Area	Pop	PopDens
30	2790	1.11E-04	6.17E-07	Illegal	50645.326	4864680	96.0539
82	127346	7.85E-05	1.35E-06	Legal	570640.95	738516	1.2942
51	34476	9.57E-05	1.87E-06	Illegal	113594.084	6946685	61.1536
6	78	1.17E-04	6.69E-07	Illegal	52035.477	2990671	57.4737
217	1461278	1.07E-04	2.17E-06	Legal	155779.22	39148760	251.3093
74	61790	2.59E-04	4.34E-06	Legal	103641.888	5531141	53.3678
25	2300	2.83E-04	5.86E-06	Decriminalized	4842.355	3581504	739.6203
3	18	1.72E-04	2.11E-06	Decriminalized	1948.543	949495	487.2846
257	2340756	1.41E-04	1.70E-06	Illegal	53624.759	20598139	384.1162
130	255450	1.59E-04	5.44E-06	Illegal	57513.485	10297484	179.0447
66	49632	7.45E-05	0	Decriminalized	6422.628	1422029	221.4092
13	299	1.14E-04	1.78E-06	Illegal	82643.117	1687809	20.4229
140	422660	1.98E-04	2.03E-06	Legal	55518.93	12821497	230.9392
41	9266	1.47E-04	3.62E-06	Illegal	35826.109	6637426	185.2678
11	154	7.50E-05	9.58E-07	Illegal	55857.13	3132499	56.0806
10	130	5.98E-05	1.38E-06	Illegal	81758.717	2908776	35.5776
44	27324	5.56E-05	1.13E-06	Illegal	39486.338	4440204	112.4491
47	7661	5.88E-04	2.55E-05	Illegal	43203.905	4663616	107.9443
56	5544	1.26E-04	7.50E-07	Legal	30842.923	1332813	43.2129
39	13026	1.29E-04	8.33E-07	Decriminalized	9707.241	6003435	618.4492
136	192304	3.54E-04	3.66E-06	Legal	7800.058	6830193	875.6593
80	68080	2.86E-04	6.13E-06	Legal	56538.901	9957488	176.1175
56	37464	6.22E-05	3.62E-07	Decriminalized	79626.743	5527358	69.4158
12	168	1.94E-04	2.68E-06	Decriminalized	46923.274	2988762	63.6947
43	9460	8.54E-05	1.48E-06	Illegal	68741.522	6090062	88.5936
12	336	1.05E-04	9.60E-07	Illegal	145545.801	1041732	7.1574
17	527	4.31E-05	0	Decriminalized	76824.171	1904760	24.7938
60	46740	1.83E-04	3.42E-06	Legal	109781.18	2922849	26.6243
23	736	1.18E-04	7.44E-07	Decriminalized	8952.651	1343622	150.0809
214	543346	7.74E-04	9.12E-06	Illegal	7354.22	8881845	1207.7209
8	192	6.50E-05	4.78E-07	Decriminalized	121298.148	2092434	17.2503
208	877344	0.002275154	2.65E-05	Decriminalized	47126.399	19618453	416.2943
78	69420	8.19E-05	3.94E-07	Decriminalized	48617.905	10155624	208.8865
15	495	8.51E-05	0	Decriminalized	69000.798	752201	10.9013
70	24220	7.48E-05	1.29E-06	Decriminalized	40860.694	11641879	284.9163
12	180	8.22E-05	2.04E-06	Illegal	68594.921	3918137	57.1199
19	3876	7.77E-05	2.69E-06	Legal	95988.013	4081943	42.5255
73	69277	1.73E-04	1.72E-06	Illegal	44742.703	12791181	285.8831
18	846	1.56E-04	0	Decriminalized	1033.814	1056611	1022.0514
45	5085	9.20E-05	1.82E-06	Illegal	30060.696	4955925	164.8639
6	186	6.60E-05	1.16E-06	Illegal	75811	864289	11.4006
72	46872	1.73E-04	4.51E-07	Illegal	41234.896	6651089	161.2976
159	729969	6.04E-05	8.61E-07	Illegal	261231.711	27885195	106.7451
21	4746	1.30E-04	3.28E-07	Illegal	82169.62	3045350	37.0618
8	88	2.53E-04	1.44E-05	Legal	9216.657	624977	67.8095
124	170500	7.20E-05	1.19E-06	Illegal	39490.086	8413774	213.0604
89	107512	4.40E-04	2.06E-05	Legal	66455.521	7294336	109.7627
1	1	4.16E-05	5.47E-07	Illegal	24038.21	1829054	76.0894
31	3410	1.27E-04	1.73E-06	Illegal	54157.805	5778394	106.6955
16	496	1.20E-04	0	Illegal	97093.141	581836	5.9926

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3-4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6-7
Objectives	3	State specific objectives, including any prespecified hypotheses	7
Methods			
Study design	4	Present key elements of study design early in the paper	8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	8
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8-9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8-9
Bias	9	Describe any efforts to address potential sources of bias	8-9
Study size	10	Explain how the study size was arrived at	8-9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	8-9
		(*c*) Explain how missing data were addressed	8-9
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	8-9
		(*e*) Describe any sensitivity analyses	8-9

Continued on next page

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	11-13
		(b) Give reasons for non-participation at each stage	11-13
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11-13
		(b) Indicate number of participants with missing data for each variable of interest	11-13
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	11-13
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	11-13
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11-13
		(*b*) Report category boundaries when continuous variables were categorized	11-13
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	11-13
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	12-13
Discussion			
Key results	18	Summarise key results with reference to study objectives	14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	16-17
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14, 16
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.