Testimony in opposition to HB0032: Cannabis legalization and regulation

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Mental Health and Societal Impacts

- **Youth use has increased in states that legalized marijuana** for recreational purposes relative to other states and they are using more potent products (references and data on pages 2-6)

- **Marijuana use leads to psychosis** in about one out of twenty daily users, an outcome more likely than from any other recreational drug (amphetamine, cocaine, LSD, PCP, opiates, alcohol; see pages 7-8).

- **Drug-induced mental disorders are associated with becoming *homeless***; homelessness now plagues major cities in states with recreational marijuana (pages 9-10). Caring for the homeless is costly and affects life quality for all involved

- **Marijuana is associated with increased risk for suicide** (case control studies and real-world data; page 11)

- **An unpredictable risk profile, different than two legal recreational drugs** (alcohol and nicotine):
    - Effects of alcohol can be predicted based on body weight and gender, but marijuana's effect is unpredictable; even those without a family history of psychosis can be vulnerable to its psychosis-inducing effects (pages 7-8)

    - The cancer risks from cigarette smoking usually take decades to occur, leaving time for the user to reverse youthful mistakes; marijuana-induced chronic psychotic disorders, including schizophrenia, can occur in the teen years and be lifelong (pages 7-8)

Environmental Impact

- **Marijuana cultivation in greenhouses and indoor grows is associated with a huge carbon footprint**, more than other types of industrial products on a standardized shipment value basis and more than any plant or animal grown for food (Mills, 2012; page 12)

Research published in a leading journal found youth use 25% higher in states that had legalized by 2015, as compared to states without legal recreational marijuana

Research

JAMA Psychiatry | Original Investigation

Association Between Recreational Marijuana Legalization in the United States and Changes in Marijuana Use and Cannabis Use Disorder From 2008 to 2016

Magdalena Cerdá, DrPH; Christine Mauro, PhD; Ava Hamilton, BA; Natalie S. Levy, MPH; Julián Santaella-Tenorio, DrPH; Deborah Hasin, PhD; Melanie M. Wall, PhD; Katherine M. Keyes, PhD; Silvia S. Martins, MD, PhD

IMPORTANCE Little is known about changes in marijuana use and cannabis use disorder (CUD) after recreational marijuana legalization (RML).

OBJECTIVES To examine the associations between RML enactment and changes in marijuana use, frequent use, and CUD in the United States from 2008 to 2016.

DESIGN, SETTING, AND PARTICIPANTS This survey study used repeated cross-sectional survey data from the National Survey on Drug Use and Health (2008-2016) conducted in the United States among participants in the age groups of 12 to 17, 18 to 25, and 26 years or older.

INTERVENTIONS Multilevel logistic regression models were fit to obtain estimates of before-vs-after changes in marijuana use among respondents in states enacting RML compared to changes in other states.

MAIN OUTCOMES AND MEASURES Self-reported past-month marijuana use, past-month frequent marijuana use, past-month frequent use among past-month users, past-year CUD, and past-year CUD among past-year users.

RESULTS The study included 505 796 respondents consisting of 51.51% females and 77.24% participants 26 years or older. Among the total, 65.43% were white, 11.90% black, 15.36% Hispanic, and 7.31% of other race/ethnicity. Among respondents aged 12 to 17 years, past-year CUD increased from 2.18% to 2.72% after RML enactment, a 25% higher increase than that for the same age group in states that did not enact RML (odds ratio [OR], 1.25; 95% CI, 1.01-1.55). Among past-year marijuana users in this age group, CUD increased from 22.80% to 27.20% (OR, 1.27; 95% CI, 1.01-1.59). Unmeasured confounders would need to be more prevalent in RML states and increase the risk of cannabis use by 1.08 to 1.11 times to explain observed results, indicating results that are sensitive to omitted variables. No associations were found among the respondents aged 18 to 25 years. Among respondents 26 years or older, past-month marijuana use after RML enactment increased from 5.65% to 7.10% (OR, 1.28; 95% CI, 1.16-1.40), past-month frequent use from 2.13% to 2.62% (OR, 1.24; 95% CI, 1.08-1.41), and past-year CUD from 0.90% to 1.23% (OR, 1.36; 95% CI, 1.08-1.71); these results were more robust to unmeasured confounding. Among marijuana users in this age group, past-month frequent marijuana use and past-year CUD did not increase after RML enactment.

CONCLUSIONS AND RELEVANCE This study's findings suggest that although marijuana legalization advanced social justice goals, the small post-RML increase in risk for CUD among respondents aged 12 to 17 years and increased frequent use and CUD among adults 26 years or older in this study are a potential public health concern. To undertake prevention efforts, further studies are warranted to assess how these increases occur and to identify subpopulations that may be especially vulnerable.

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Editorial
Author Audio Interview
Supplemental content

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Youth Use Trending Up More in Legalized States According to Most Recent Data (2019)

States with legalized recreational marijuana by 2018 are highlighted.
https://www.samhsa.gov/data/sites/default/files/reports/rpt32806/2019NSDUHsaeShortTermCHG/2019NSDUHsaeShortTermCHG/2019NSDUHsaeShortTermCHG.pdf

Youth use in 2018-2019 for the states with legal recreational marijuana now 55% higher than the states without legalization (p < 0.0001). *90% of states (9 plus DC) with recreational marijuana, experienced an increase in youth use from 2017-2018 to 2018-2019 (p = 0.004, significant, paired t-test of 10), in contrast to 63% of states without recreational marijuana (non-significant increase, paired t-test of 41).*

NSDUH Tables www.samhsa.gov

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Table 3 *Marijuana Use in the Past Month*, by Age Group and State: Percentages, Annual Averages, and *P* Values from Tests of Differences between Percentages, 2017-2018 and 2018-2019 NSDUHs

State	12+ (2017-2018)	12+ (2018-2019)	12+ (*P* Value)	12-17 (2017-2018)	12-17 (2018-2019)	12-17 (*P* Value)	18-25 (2017-2018)	18-25 (2018-2019)	18-25 (*P* Value)	26+ (2017-2018)	26+ (2018-2019)	26+ (*P* Value)	18+ (2017-2018)	18+ (2018-2019)	18+ (*P* Value)
Total U.S.	9.83[a]	10.80	0.000	6.56[a]	7.02	0.012	22.12	22.54	0.187	8.25[a]	9.39	0.000	10.16[a]	11.17	0.000
Northeast	10.25[a]	11.42	0.000	6.82[b]	7.37	0.065	24.74	24.88	0.834	8.35[a]	9.78	0.000	10.56[a]	11.79	0.000
Midwest	9.39[a]	10.28	0.000	6.47	6.64	0.507	21.85	22.47	0.293	7.70[a]	8.74	0.000	9.69[a]	10.65	0.000
South	7.96[a]	8.87	0.000	5.89	6.13	0.313	18.89	18.97	0.874	6.47[a]	7.62	0.000	8.17[a]	9.15	0.000
West	12.89[a]	13.87	0.000	7.55[a]	8.54	0.003	25.51	26.53	0.142	11.48[a]	12.49	0.003	13.44[a]	14.41	0.001
Alabama	8.31	8.67	0.467	6.18	5.80	0.520	18.67	18.34	0.798	6.91	7.49	0.341	8.53	8.96	0.424
Alaska	16.56	17.25	0.392	7.88	8.54	0.395	26.27[a]	30.71	0.015	16.10	16.25	0.882	17.51	18.20	0.444
Arizona	10.93	11.00	0.903	6.28	6.04	0.717	21.07	20.80	0.857	9.83	10.01	0.818	11.41	11.51	0.882
Arkansas	8.60	8.46	0.807	5.62	5.82	0.753	16.20	15.80	0.747	7.73	7.60	0.860	8.91	8.73	0.782
California	11.97[a]	13.47	0.000	7.05[a]	8.85	0.000	25.06	26.48	0.150	10.39[a]	11.91	0.002	12.46[a]	13.93	0.001
Colorado	17.33	17.39	0.941	9.39	9.75	0.692	33.21	34.39	0.521	15.73	15.62	0.913	18.12	18.15	0.978
Connecticut	12.06	12.34	0.691	8.35	7.46	0.239	30.08[b]	27.22	0.088	9.58	10.52	0.264	12.42	12.81	0.613
Delaware	11.16	12.26	0.106	8.19	8.26	0.924	26.72	27.58	0.615	9.22	10.53	0.102	11.44	12.63	0.106
District of Columbia	16.63	16.39	0.793	8.47	8.99	0.521	32.49	30.73	0.379	14.25	14.30	0.967	17.09	16.80	0.771
Florida	9.28[a]	10.11	0.035	7.06	6.47	0.241	22.88	21.45	0.157	7.67[a]	8.96	0.007	9.47[a]	10.42	0.027
Georgia	8.23[a]	9.20	0.026	6.05	6.04	0.991	20.18	19.56	0.595	6.53[a]	7.91	0.011	8.47[a]	9.55	0.026
Hawaii	8.80[a]	10.12	0.043	5.31	6.29	0.190	16.70	18.77	0.131	8.09[b]	9.38	0.099	9.11[b]	10.47	0.055
Idaho	8.21	8.57	0.458	6.28	5.90	0.530	16.49	18.21	0.188	7.11	7.36	0.677	8.45	8.89	0.407
Illinois	9.64[b]	10.38	0.072	6.86	7.01	0.781	22.59	21.74	0.463	7.92[a]	9.00	0.028	9.93[b]	10.72	0.080
Indiana	10.20[a]	11.56	0.022	6.77	7.52	0.308	22.85[b]	25.63	0.061	8.46[b]	9.66	0.091	10.57[a]	11.98	0.029
Iowa	7.04	6.70	0.437	5.36	5.71	0.559	17.54	16.16	0.294	5.39	5.18	0.677	7.21	6.80	0.390
Kansas	6.34[a]	7.48	0.021	4.53	5.00	0.349	14.54	15.39	0.513	5.13[a]	6.42	0.034	6.54[a]	7.75	0.026
Kentucky	8.19[a]	9.75	0.005	5.93	6.18	0.694	17.42	18.96	0.255	6.98[a]	8.71	0.010	8.42[a]	10.11	0.005
Louisiana	7.69	7.74	0.919	5.12	4.99	0.809	18.83	18.47	0.788	6.22	6.39	0.765	7.96	8.03	0.899
Maine	16.57	17.58	0.248	10.31	10.93	0.526	35.17	35.12	0.980	14.75	15.97	0.250	17.09	18.13	0.275
Maryland	9.90[b]	10.99	0.084	6.96	7.07	0.872	24.71	26.37	0.296	8.01	9.16	0.128	10.19[b]	11.37	0.086
Massachusetts	13.60[b]	14.91	0.086	9.33	9.72	0.663	31.39	31.01	0.834	11.02[b]	12.73	0.067	13.98[b]	15.36	0.093
Michigan	12.61[a]	13.80	0.021	7.87	7.42	0.453	27.50	29.30	0.131	10.70[a]	12.02	0.040	13.08[a]	14.42	0.017
Minnesota	9.48	9.96	0.357	6.25	6.53	0.655	22.09	22.47	0.798	7.89	8.44	0.379	9.81	10.31	0.380
Mississippi	6.98[b]	7.88	0.076	4.96	5.68	0.201	15.26	16.99	0.164	5.83	6.65	0.178	7.21[b]	8.12	0.099
Missouri	8.57	8.99	0.409	6.21	5.88	0.597	19.96	20.73	0.584	7.03	7.52	0.428	8.81	9.30	0.375
Montana	14.46	14.92	0.544	9.65	9.77	0.886	27.30	29.85	0.127	12.96	13.18	0.819	14.91	15.40	0.551

See notes at end of table. (continued)

Continued……

Table 3 *Marijuana Use in the Past Month*, **by Age Group and State: Percentages, Annual Averages, and *P* Values from Tests of Differences between Percentages, 2017-2018 and 2018-2019 NSDUHs (continued)**

State	12+ (2017-2018)	12+ (2018-2019)	12+ (*P* Value)	12-17 (2017-2018)	12-17 (2018-2019)	12-17 (*P* Value)	18-25 (2017-2018)	18-25 (2018-2019)	18-25 (*P* Value)	26+ (2017-2018)	26+ (2018-2019)	26+ (*P* Value)	18+ (2017-2018)	18+ (2018-2019)	18+ (*P* Value)
Nebraska	8.21	8.43	0.624	6.16	6.75	0.357	20.54	21.24	0.605	6.30	6.43	0.825	8.43	8.62	0.712
Nevada	15.05	16.10	0.215	9.17	9.67	0.584	32.09	31.49	0.736	13.31	14.69	0.188	15.64	16.74	0.234
New Hampshire	14.24	14.05	0.793	8.84	8.18	0.400	29.95	30.16	0.908	12.41	12.25	0.853	14.72	14.56	0.838
New Jersey	7.89[a]	8.99	0.015	5.61[a]	6.69	0.050	21.08	22.50	0.324	6.21[a]	7.30	0.042	8.11[a]	9.22	0.025
New Mexico	12.98	12.43	0.448	9.58	9.83	0.790	23.96	23.48	0.775	11.62	10.99	0.475	13.34	12.70	0.423
New York	9.77[a]	11.02	0.002	6.62	7.20	0.260	24.22	24.45	0.831	7.81[a]	9.35	0.002	10.05[a]	11.36	0.002
North Carolina	7.79[a]	9.16	0.003	6.66	6.87	0.726	19.24	19.41	0.892	6.13[a]	7.83	0.002	7.91[a]	9.39	0.003
North Dakota	7.62	7.67	0.906	4.93	4.76	0.769	17.12	17.10	0.986	6.03	6.19	0.772	7.87	7.95	0.873
Ohio	8.34[a]	10.22	0.000	6.16	6.45	0.588	20.67	22.02	0.231	6.66[a]	8.82	0.000	8.56[a]	10.60	0.000
Oklahoma	7.51[a]	10.07	0.000	5.31	5.84	0.382	17.57	19.22	0.268	6.09[a]	9.09	0.000	7.75[a]	10.54	0.000
Oregon	18.83	18.69	0.876	9.71	10.74	0.313	33.11	32.64	0.786	17.68	17.49	0.863	19.65	19.40	0.794
Pennsylvania	8.38[a]	9.83	0.001	5.31[b]	6.11	0.086	19.71	19.80	0.931	6.98[a]	8.73	0.001	8.66[a]	10.17	0.001
Rhode Island	14.65	15.37	0.362	8.61	8.30	0.700	29.26	31.00	0.307	12.70	13.40	0.459	15.17	15.98	0.344
South Carolina	8.32	9.17	0.121	6.34	6.56	0.717	19.18	18.34	0.525	6.89[b]	8.09	0.073	8.51	9.42	0.129
South Dakota	7.12[b]	6.35	0.084	5.26	5.10	0.779	17.70[a]	14.74	0.019	5.58	5.13	0.394	7.31[b]	6.49	0.088
Tennessee	8.55	8.75	0.692	6.11	5.70	0.508	19.88	18.22	0.237	7.07	7.65	0.339	8.79	9.05	0.639
Texas	6.06[a]	7.19	0.000	4.82[a]	5.94	0.010	14.67	15.51	0.308	4.72[a]	5.92	0.001	6.21[a]	7.34	0.001
Utah	6.06	6.42	0.366	4.46	4.58	0.803	13.81	14.50	0.561	4.62	4.96	0.491	6.28	6.68	0.379
Vermont	19.30	19.74	0.626	12.67	12.84	0.875	37.67	38.99	0.514	16.76	17.11	0.757	19.84	20.30	0.641
Virginia	7.27	7.89	0.133	5.64	5.41	0.664	19.50	20.26	0.545	5.53	6.25	0.140	7.43	8.13	0.120
Washington	16.39	17.75	0.119	9.94	9.92	0.984	30.44	31.80	0.442	15.01	16.54	0.148	17.01	18.49	0.117
West Virginia	9.42	9.48	0.910	6.25	7.05	0.212	18.91	20.88	0.189	8.37	8.12	0.704	9.70	9.69	0.998
Wisconsin	8.89	9.05	0.773	6.09	6.58	0.414	21.24	20.67	0.675	7.22	7.48	0.684	9.17	9.29	0.838
Wyoming	7.73	7.38	0.447	6.34	5.88	0.445	17.57	17.73	0.909	6.38	5.98	0.466	7.88	7.53	0.503

NOTE: State and census region estimates are based on a survey-weighted hierarchical Bayes estimation approach, with their *p* values being the Bayes significance levels for the null hypothesis of no change between the 2017-2018 and 2018-2019 population percentages. The "Total U.S." estimates, along with the *p* values, are based on design-based (direct) estimation methods.

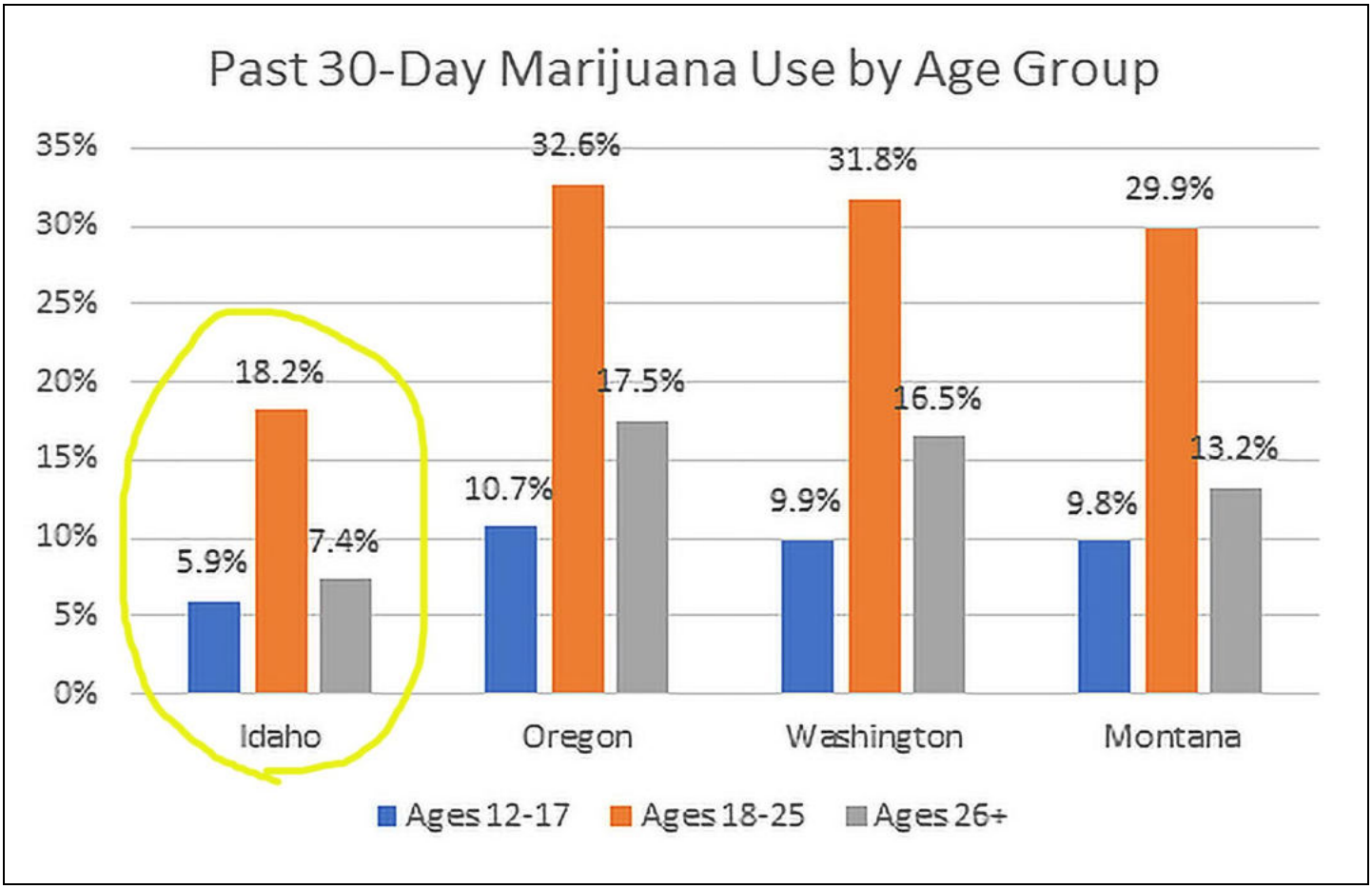
[a] Difference between the 2017-2018 and 2018-2019 population percentages is statistically significant at the 0.05 level.

[b] Difference between the 2017-2018 and 2018-2019 population percentages is statistically significant at the 0.10 level.

Source: SAMHSA, Center for Behavioral Health Statistics and Quality, National Survey on Drug Use and Health, 2017, 2018, and 2019.

Idaho, with no legal marijuana, is adjacent to states with recreational marijuana, but has managed to maintain much lower marijuana use rates than its neighbors

Figure provided by the Idaho Department of Health, 2020, based on NSDUH data for 2019, www.SAMHSA.org



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U.S. cannabis legalization and use of vaping and edible products among youth

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Background—Alternative methods for consuming cannabis (e.g., vaping and edibles) have become more popular in the wake of U.S. cannabis legalization. Specific provisions of legal cannabis laws (LCL) (e.g., dispensary regulations) may impact the likelihood that youth will use alternative methods and the age at which they first try the method - potentially magnifying or mitigating the developmental harms of cannabis use.

Results—Longer LCL duration (OR_{vaping}: 2.82, 95% CI: 2.24, 3.55; $OR_{edibles}$: 3.82, 95% CI: 2.96, 4.94), and higher dispensary density (OR_{vaping}: 2.68, 95% CI: 2.12, 3.38; $OR_{edibles}$: 3.31, 95% CI: 2.56, 4.26), were related to higher likelihood of trying vaping and edibles. Permitting home cultivation was related to higher likelihood (OR: 1.93, 95% CI: 1.50, 2.48) and younger age of onset (β: −0.30, 95% CI: −0.45, −0.15) of edibles.

Discussion

This study examined relations among specific provisions of LCL and cannabis vaping and use of edibles in youth ages 14–18. Consistent with our previous study of adult cannabis users recruited via Facebook, the present analyses indicated that longer LCL duration and higher dispensary density were related to a higher likelihood of lifetime vaping and edible use. The current study extended those findings by showing that provisions for recreational cannabis use and for permitting home cultivation were also related to a higher likelihood of lifetime vaping and edible use. Some of these increased likelihoods were substantial. For example, living in a high dispensary density state doubled the likelihood of trying vaping and tripled the likelihood of trying edibles.

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Marijuana Use and Psychotic Disorders: Proof of Causation

(links to cited references on following page, p.7)

- **Dose-response effect**: the stronger the marijuana, the more frequent its use, the more likely a psychotic outcome (Zammit et al., 2002; van Os et al., 2002; DiForti et al., 2015). On average, the effect is a 4-fold to 5-fold increased risk for heavy use of moderate to high strength product (Marconi et al., 2016; Di Forti et al., 2019), meaning one out of twenty heavy users develop some type of psychotic disorder over time.

- **Marijuana use generally precedes the psychosis, not vice-versa**: well controlled, prospective studies of thousands of teenagers (Arseneault et al., 2002; Henquet et al., 2005; Kuepper et al., 2011)

- **Administration of purified THC in the clinic elicits psychotic symptoms in subjects who lack a family history of psychosis** (D'Souza et al., 2004; Morrison et al., 2011; Freeman et al., 2015), specifically, in about 40% of subjects (Morrison et al., 2011; Bhattacharyya et al., 2012).

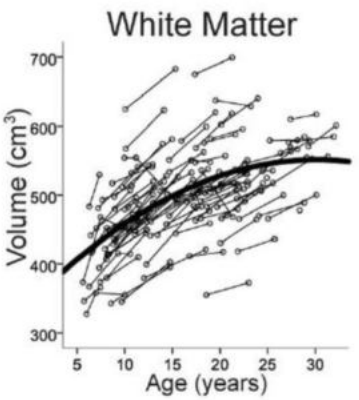
- **Those who experience psychotic symptoms from marijuana use and who quit are more likely to recover** than those who persist in using (Gonzalez-Pinto et al., 2009; Kuepper et al., 2011; Schoeler et al., 2016)

- **Of all the recreational drugs of abuse, it is marijuana that leads to a chronic psychotic disorder in the highest percentage of users** (Nielsen et al., 2017); of those who experience a drug-induced psychotic break, approximately 50% of the marijuana users do not recover (Arendt et al., 2008; Niemi-Pynttari et al., 2013), a higher risk than for amphetamines, cocaine, or hallucinogens like PCP and LSD (Niemi-Pynttari et al., 2013; Starzer et al., 2017).

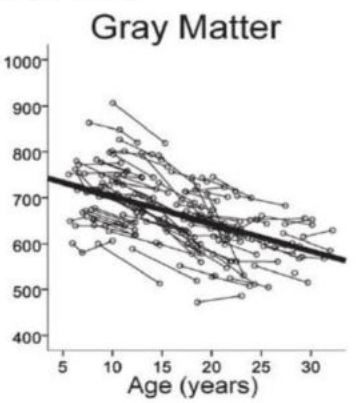
- **As marijuana use disorders have increased, the incidence of marijuana-induced schizophrenia** has increased in a country that tracks both disorders (Hjorthoj et al., 2020). The U.S. does not track psychotic disorders, although hospitalizations for marijuana-induced psychosis have noticably increased in Colorado https://www.uchealth.org/today/marijuana-related-er-visits-rising-dramatically-edibles-spraking-particular-concerns/

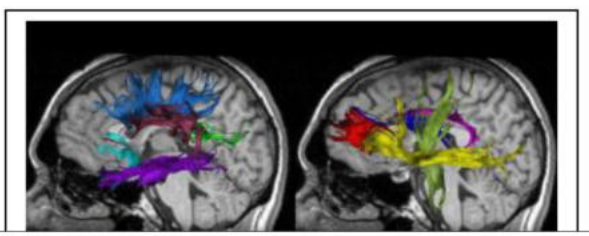
- **All of these effects are more pronounced in (but not limited to) the developing brain, where structural changes from marijuana use have been observed in longitudinal studies**: decreased functional connectivity between the anterior cingulate cortex and the superior frontal gyrus (Camchong et al., 2017); it should be noted that data from representative controls show the brain continues to develop until the late twenties (Lebel and Beaulieu, 2011, figures below).

Wiring of cortical and subcortical white matter continues through late 20's; healthy controls



"Pruning" of unnecessary gray matter also continues through late 20's; thought to be important for proper brain function; healthy controls





Key fiber tracts in a 22 year old representative male: lavender=cingulum; limegreen=corticospinal; yellow=inf.-fronto-occipital; red=genu-CC; darkerblue=sup.-fronto-occipital; royal-purple=inf.longitudinal; turquoise=uncinate; kelly-green=spleniumCC; crimson=sup.-longitudinal; lighterblue=body-of-CC; where CC is corpus collosum

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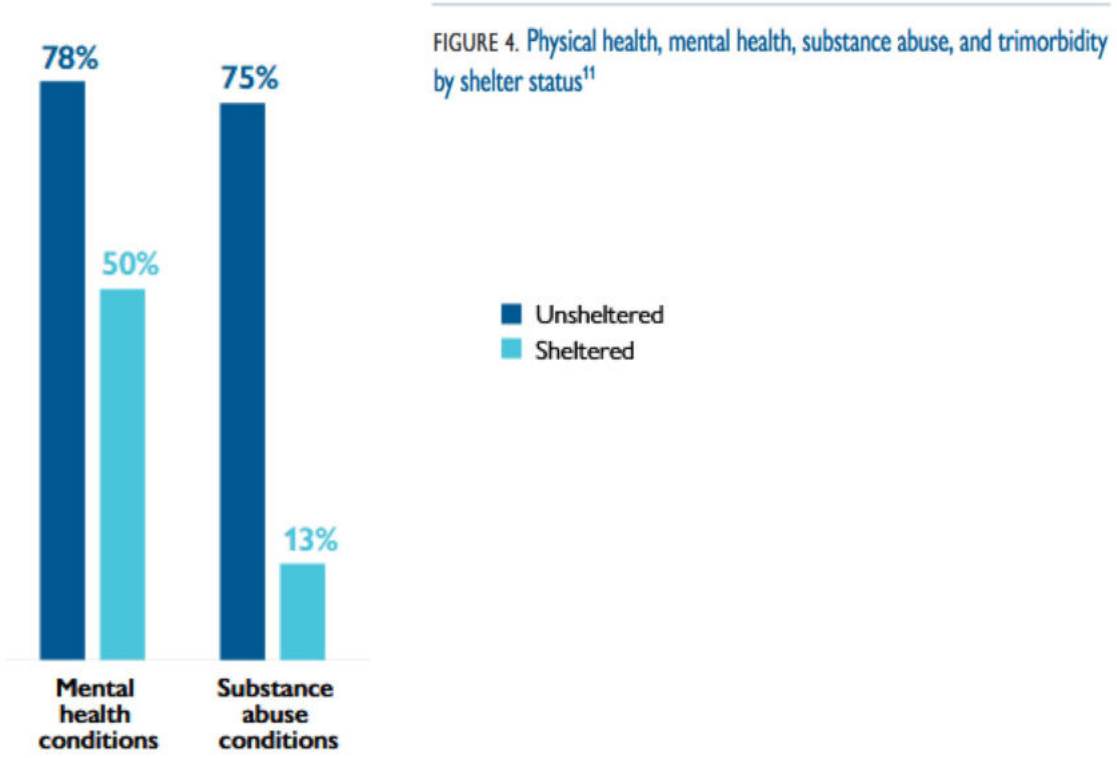
Note: You can copy and paste links into your browser if necessary to access articles

Proportion of homeless individuals who have mental Illness from a study in California, very many with a substance abuse disorder (note, marijuana is leading drug for triggering chronic psychosis, Niemi-Pynttari et al., 2013; Starzer et al., 2017):

https://www.capolicylab.org/wp-content/uploads/2019/10/Health-Conditions-Among-Unsheltered-Adults-in-the-U.S.pdf



And 68% of the mentally-ill homeless are reported to have a schizophrenia spectrum disorder: https://pubmed.ncbi.nlm.nih.gov/23703373/

Relaxing drug laws, starting with marijuana, has been paralleled by a growth in homelessness for cities in legalized states:

Seattle: https://www.youtube.com/watch?v=WijoL3Hy_Bw

San Francisco: https://www.city-journal.org/san-francisco-homelessness

Los Angeles: https://www.bbc.com/news/world-us-canada-49687478

Denver: https://www.9news.com/article/news/health/denver-lincoln-park-closure-rat-infestation/73-adfe2028-01ae-492e-a568-9c30ec816512

https://denverite.com/2020/01/15/in-definitely-not-a-sweep-denver-police-close-lincoln-park-ask-people-to-remove-their-tents/

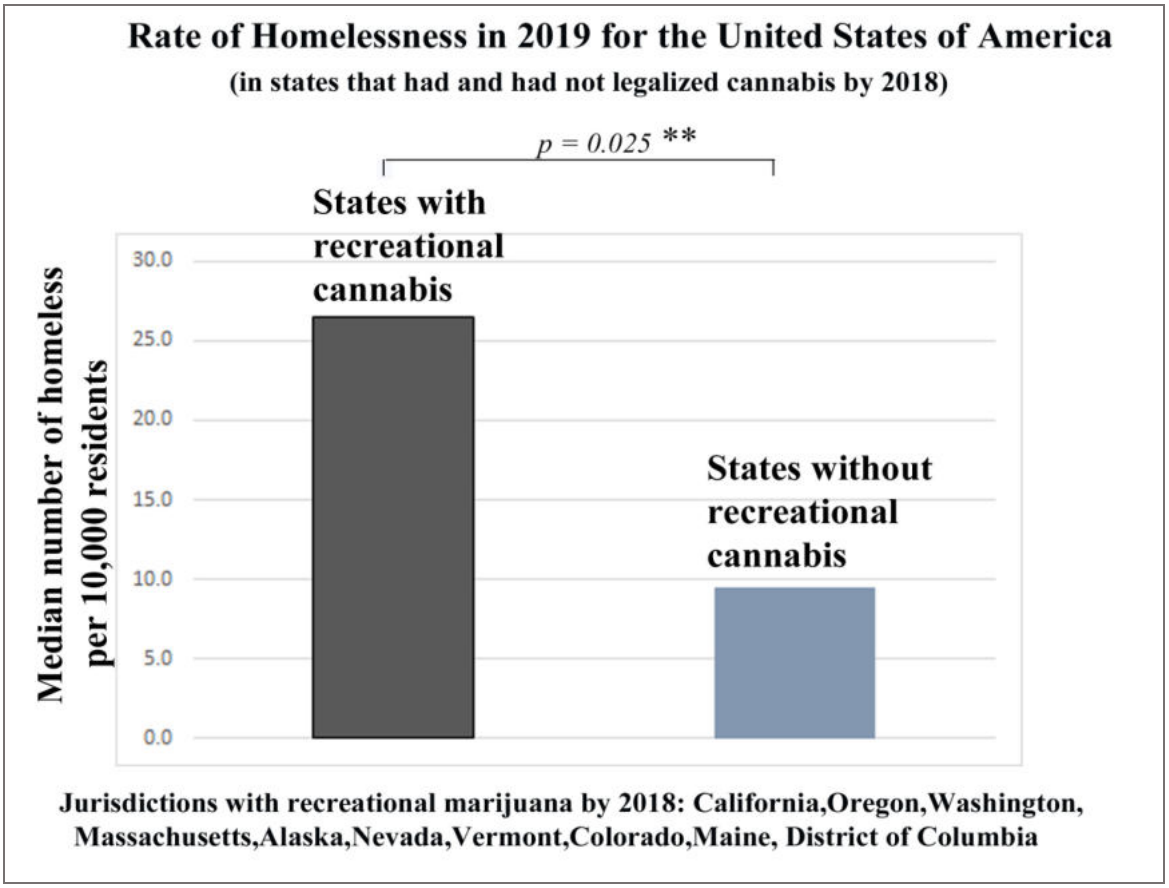
Anchorage: https://www.ktoo.org/2018/07/20/anchorage-struggles-to-balance-homeless-camping-problems/

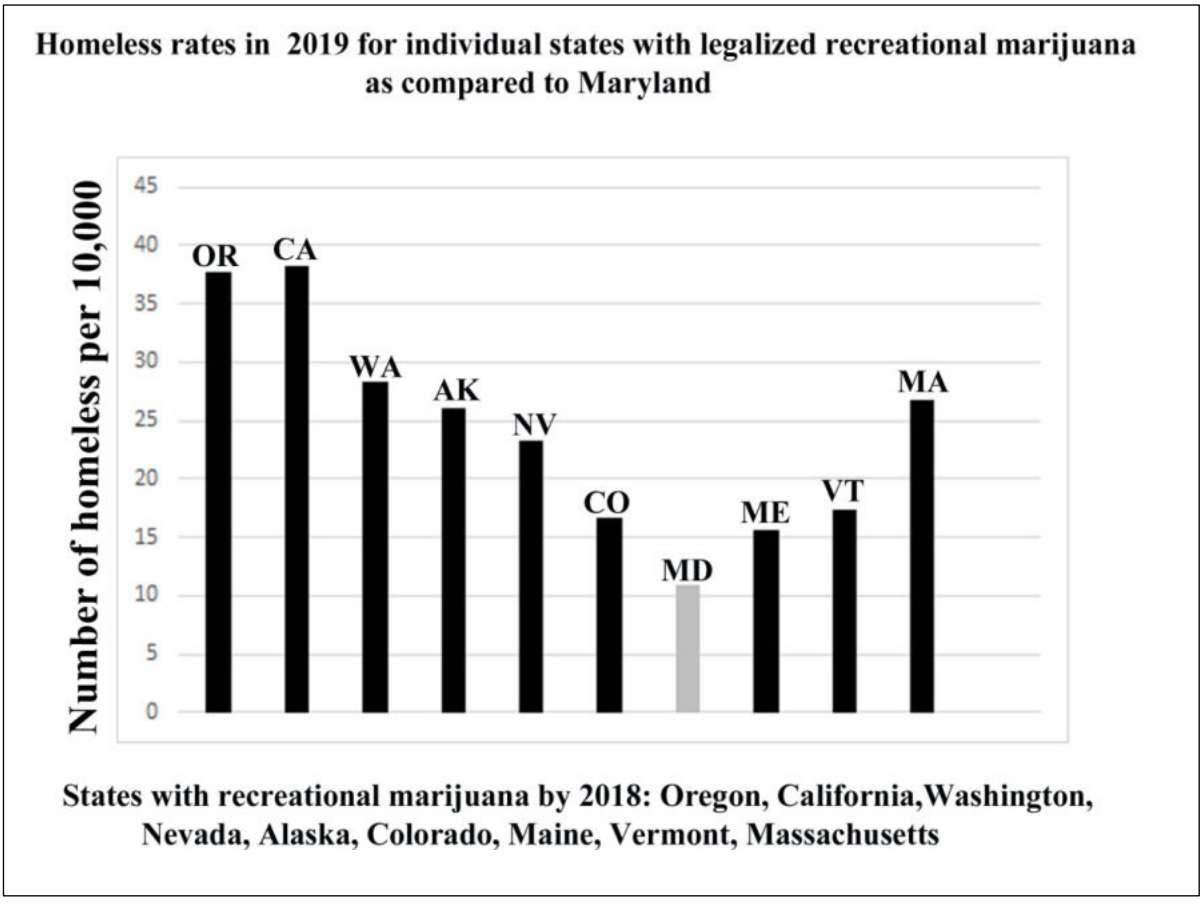
Portland: https://www.oregonlive.com/portland/2018/06/portland_homeless_accounted_fo.html

With even international news speculating that marijuana legalization may be a contributing factor: https://www.theguardian.com/us-news/2017/feb/27/marijuana-legal-homeless-denver-colorado

States with recreational marijuana have greater rates of homelessness

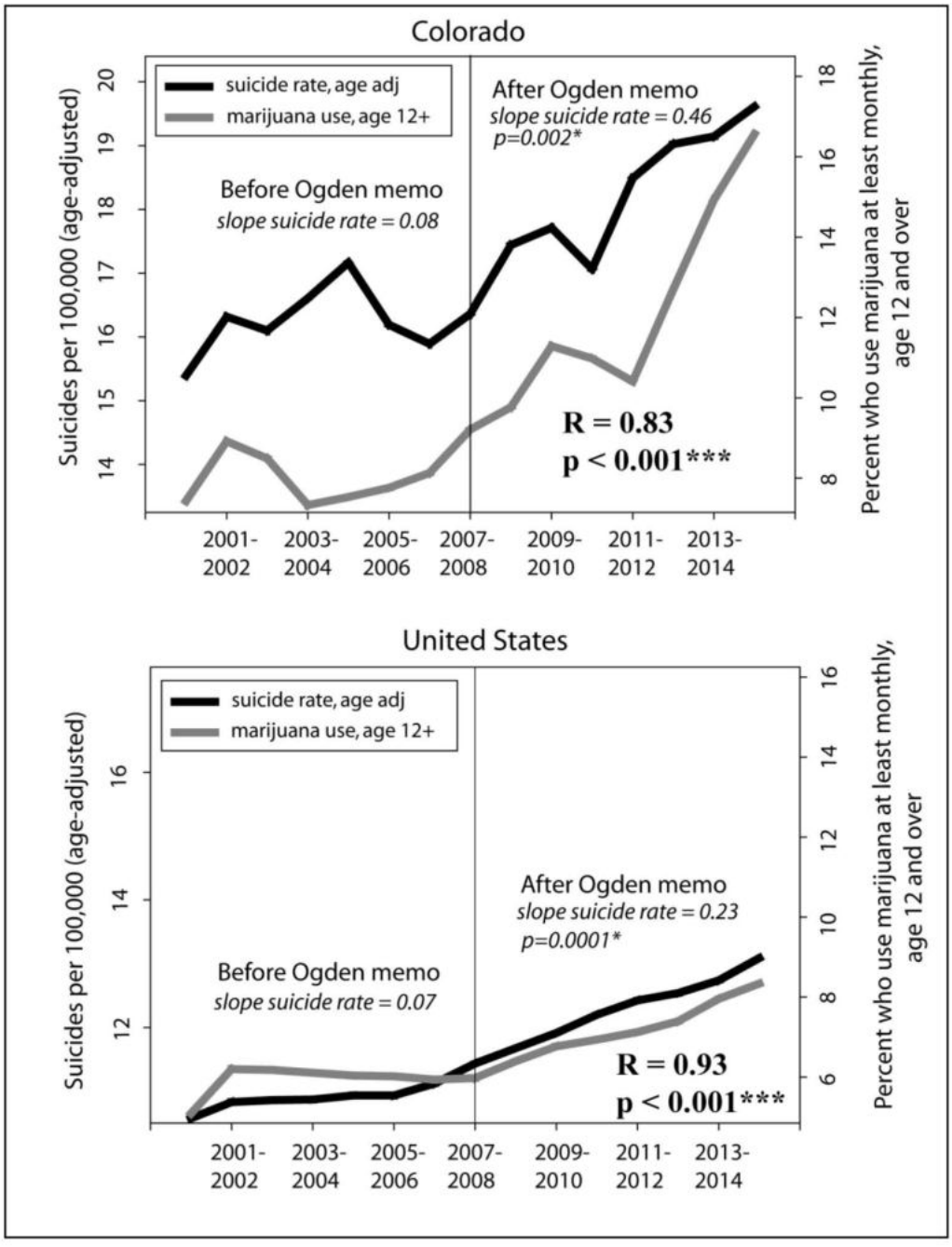
source: https://www.usich.gov/homelessness-statistics





Marijuana Use and Suicide

In addition to numerous case-control[1-3] and prospective studies[4] showing an association between marijuana use and the risk for suicide, a recent study demonstrated a dose-response effect[5]. Real world data backs up the epidemiological findings:



Multiple linear regression of the relationship between marijuana use rates and suicide rates in Colorado and in the U.S. as a whole, showed a highly significant relationship, even after correcting for other drug use rates and unemployment rates.

Figure 2 from: Miller CL, Jackson MC, Sabet K. Marijuana and Suicide: Case-control Studies, Population Data, and Potential Neurochemical Mechanisms, in: Cannabis in Medicine. An Evidence Based Approach (K Finn, ed.) Springer Press, 2020: https://www.springer.com/fr/book/9783030459673?gclid=EAIaIQobChMIrp_0wfjR6QIVSY2FCh1xfA-ZEAEYASABEgJuX_D_BwE#aboutAuthors.

1) https://www.journalofsubstanceabusetreatment.com/article/S0740-5472(12)00382-0/fulltext

2) https://europepmc.org/backend/ptpmcrender.fcgi?accid=PMC4219077&blobtype=pdf

3) https://www.thelancet.com/journals/lanpsy/article/PIIS2215-0366(14)70307-4/fulltext

4) https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6450286/ 5) https://www.tandfonline.com/doi/full/10.1080/13811118.2020.1804025

The global warming impact of legal marijuana, predominantly grown indoors or in greenhouses in Maryland, is greater than other industrial sectors per dollar value of the product.

The production of one pound of marijuana is associated with a CO2 emission of 4600 pounds because of the electricity required (Mills, 2012), http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.396.4759&rep=rep1&type=pdf a carbon budget sufficient to cover thousands of meals for the needy (http://css.umich.edu/sites/default/files/Carbon%20Footprint_CSS09-05_e2019.pdf). **The most recent statistics for medical marijuana sold in Maryland was expected to have reached 34,500 pounds in 2019**, https://mjbizdaily.com/chart-marylands-2019-medical-cannabis-sales-on-pace-to-double-2018-sales/ almost exclusively grown indoors or in greenhouses, **the equivalent of 159 million pounds of CO2 per year**. If legalized to be produced here, the growth of recreational product would be expected to be at least double that of the medical product based on market statistics from Colorado, bringing the total (medical plus recreational) marijuana CO2 footprint to nearly 500 million pounds per year in Maryland. https://www.colorado.gov/pacific/revenue/colorado-marijuana-sales-reports In contrast, the illegal recreational marijuana currently imported from grows in more favorable climates, is predominantly grown outdoors and with a very low CO2 footprint.

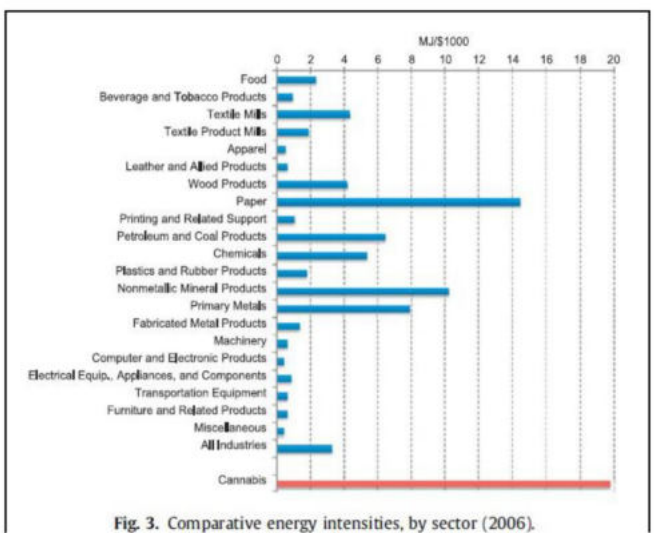


Fig. 3. Comparative energy intensities, by sector (2006).

Mills et al., 2012
http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.396.4759&rep=rep1&type=pdf

see also:

https://www.researchgate.net/publication/342364745_Energy_Use_by_the_Indoor_Cannabis_Industry_Inconvenient_Truths_for_Producers_Consumers_and_Policymakers

https://eq-research.com/wp-content/uploads/2016/09/A-Chronic-Problem.pdf

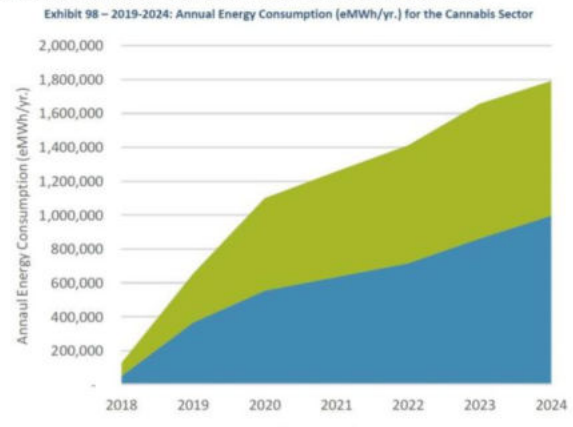
https://electricityplans.com/power-consumption-for-cannabis-growers/

https://docplayer.net/55499365-Surprising-energy-requirements.html

https://pubs.acs.org/doi/pdf/10.1021/acs.est.6b06343

Projections of growth in energy consumption by the cannabis industry in Canada, a much smaller population than the U.S.

Exhibit 98 displays the projected annual energy consumption (eMWh/yr.) for the cannabis sector. This exhibit includes energy consumption from all fuels but excludes water consumption.



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Change in Traffic Fatality Rates in the First 4 States to Legalize Recreational Marijuana

Marijuana use impairs driving,[1] but researchers have not yet conclusively determined if a state's legalizing recreational marijuana is associated with traffic fatality rates. Two early studies reported no significant change in roadway deaths following legalization in Colorado and Washington,[2,3] whereas a study including Oregon reported a temporary increase.[4] A more recent study, including 2017 data, found a statistically significant increase in fatal crashes only after commercial stores opened, suggesting that the effect of legalization may take more time to observe.[5]

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Following the recent release of 2018 roadway fatality reports by the US Department of Transportation, we analyzed data from more states over a longer period of commercial sales to get a better understanding of the relationship between legalization of recreational marijuana and traffic fatalities.

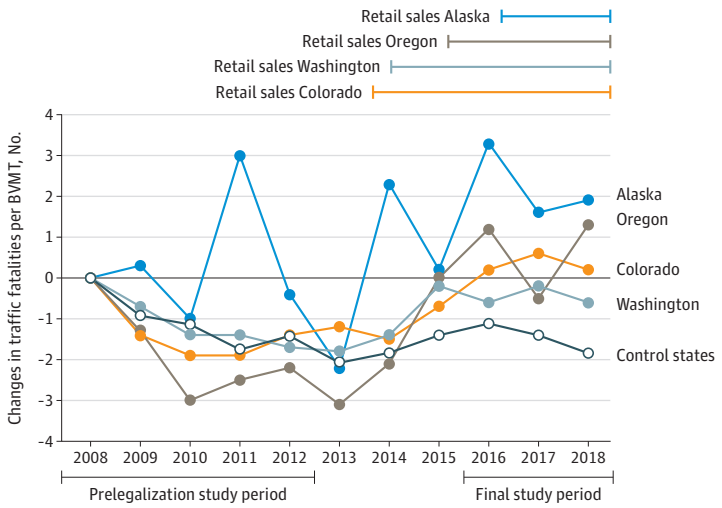
Methods | Traffic fatality rates were obtained from the National Highway Traffic Safety Administration's Fatality Analysis Reporting System.[6] The first 4 states to legalize recreational marijuana (Colorado, Washington, Oregon, and Alaska) comprised the experimental group. These states are the only ones for which there are at least 2 full years of traffic fatality data available following the opening of retail stores. All 20 states that did not legalize recreational or medical marijuana as of the beginning of 2018 served as controls.

First, parallel fatality trends in both groups of states during the 18 years preceding legalization were confirmed by graphing and inspecting the data. Then, we performed a difference-in-difference analysis with a random effects model to compare the change in traffic fatality rates between the 2 groups from the prelegalization to the postcommercialization period. The prelegalization panel data were from the 5 years preceding legalization in any state (2008-2012), and the postcommercialization data were from the years that included commercial sales in all 4 experimental states (2016-2018). Unemployment rate, maximum speed limit, and presence of a primary seatbelt law were included as covariates. We calculated our estimates using the xtreg function in Stata MP statistical software (version 16.0, StataCorp). Robust standard errors were used to generate confidence intervals. Data were analyzed from December 22, 2019 to February 29, 2020. Because the study used deidentified publicly available data, no review board approval was needed.

Results | The changes in fatality rates for the control group and each experimental state are displayed in the **Figure**. Our unadjusted difference-in-difference analysis showed an increase of 2.1 (95% CI, 1.2-2.9; $P < .001$) traffic fatalities per billion vehicle miles traveled (BVMT) in experimental states relative to control states in the postcommercialization study period. Including covariates, the increase was 2.1 (95% CI, 1.3-3.0; $P < .001$) traffic fatalities per BVMT.

Discussion | By analyzing additional experimental states over a more recent time period, we have provided additional data

Figure. Change in Traffic Fatality Rate From 2008



BVMT indicates billion vehicle miles traveled. Rates are indexed to 2008. Data points represent the change in the annual traffic fatality rate since 2008 for each experimental state and the 20-state control group mean. Colorado and Washington voted to legalize recreational marijuana in November 2012. Retail stores opened in January and July of 2014, respectively. Oregon and Alaska voted to legalize in November 2014. Retail stores opened in October 2015 and October 2016, respectively.

that legalization of recreational marijuana is associated with increased traffic fatality rates. Applying these results to national driving statistics, nationwide legalization would be associated with 6800 (95% CI, 4200-9700) excess roadway deaths each year. Despite certain methodological differences, we found an increase similar to that reported by Aydelotte et al.[4] They reported an increase of 1.8 fatal crashes (equivalent to 2.0 fatalities) per BVMT. We concur with their opinion that changes may not be detected immediately after legalization but only after a longer time period or after commercial sales begin.

We chose a control group consisting of all states with neither legal recreational nor medical marijuana to isolate the effects of marijuana. We did not require that control states have baseline attributes similar to the experimental states because the difference-in-difference technique removes biases in comparisons between experimental and control groups that result from permanent differences between those groups. Our conclusions, nonetheless, are limited by adjusting for only 3 state-specific factors that may have changed during the study period. It is possible that another confounder, rather than marijuana legalization and commercialization, caused the observed increase in roadway deaths.

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Concept and design: R. Kamer, Warshafsky.
Acquisition, analysis, or interpretation of data: All authors.
Drafting of the manuscript: All authors.
Critical revision of the manuscript for important intellectual content: R. Kamer, Warshafsky.
Statistical analysis: All authors.
Supervision: Warshafsky, G. Kamer.

Conflict of Interest Disclosures: None reported.

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