Testimony in opposition to SB0708: Cannabis legalization and regulation

Submitted by Christine L. Miller, Ph.D., 6508 Beverly Rd, Idlewylde, MD 21239 CMiller@millerbio.com; Neuroscientist and Science Advisor for Smart Approaches to Marijuana www.learnaboutsam.org and Moms Strong www.momsstrong.org; author of: "The Impact of Marijuana on Mental Health, in: Contemporary Health Issues on Marijuana, Oxford University Press, 2018" and "Marijuana and Suicide: Case-control Studies, Population Data, and Potential Neurochemical Mechanisms, in: Cannabis in Medicine. An Evidence Based Approach, Springer Press, 2020.

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 (refs. and data, p.2-8).

- **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). Warning labels would enable safer use of medical marijuana, but will not discourage unsafe use by most recreational users. The mental health impacts are greatest for youth, but can also occur in young adults and later in life (p. 9-11).

- **Psychosis is expensive $$$$**, for the individual, their family and society. The marijuana taxes are unlikely to cover this plus other social costs (e.g. p.12-13; see also p.19-20).

- **Drug-induced mental disorders are associated with becoming homeless**; homelessness now plagues major cities in states with recreational marijuana and the per capita homeless rate is over 2.5-times higher in those states (pages 14-15).

- **Marijuana is associated with increased risk for suicide** (p. 16).

- **A more unpredictable risk profile 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 9-10)
    - 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, can occur in the teen years and be lifelong (pages 9-10)

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 17)

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

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.

Editorial
Author Audio Interview
Supplemental content

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Author Affiliations: Author affiliations are listed at the end of this article.

Corresponding Author: Magdalena Cerdá, DrPH, Division of Epidemiology, Department of Population Health, New York University School of Medicine, 180 Madison Ave, Fourth Floor (4-16), New York, NY 10016 (magdalena.cerda@nyumc.org).

Results from one state (CA) mirrored what was seen in the aggregate of other states early during their post legalization period (youth use rose 23% in CA after legalization, but also found greatest impact on Asians and African Americans)

Recreational Marijuana Legalization and Use Among California Adolescents: Findings From a Statewide Survey

MALLIE J. PASCHALL, PH.D.,[a,*] GRISEL GARCÍA-RAMÍREZ, PH.D.,[a] & JOEL W. GRUBE, PH.D.[a]

[a]*Prevention Research Center, Pacific Institute for Research and Evaluation, Berkeley, California*

ABSTRACT. Objective: The legalization of recreational marijuana use and retail sales raises concerns about possible effects on marijuana use among adolescents. We evaluated the effects of recreational marijuana legalization (RML) in California in November 2016 on use among adolescents and investigated subgroup differences in these effects. **Method:** We analyzed data from successive cross-sectional samples of 7th, 9th, and 11th grade students (N = 3,330,912) who participated in the California Healthy Kids Survey from 2010–2011 to 2018–2019. Participants reported grade, sex, ethnicity, race, and lifetime and past-30-day marijuana use. **Results:** Multilevel analyses showed that RML was associated with increases in the likelihood of lifetime (odds ratio = 1.18, 95% CI [1.15, 1.21], $p < .01$) and past-30-day marijuana use (odds ratio = 1.23, 95% CI [1.20, 1.26], $p < .01$) relative to previous downward trends. RML was more strongly associated with increases in prevalence of marijuana use among 7th versus 9th and 11th graders, females versus males, non-Hispanic versus Hispanic youth, and White versus African American, American Indian/Native Alaskan, and multiracial youth. Overall, RML was not significantly associated with frequency of past-30-day use among users, although stronger positive associations between RML and frequency of use were found for 11th graders, Asian Americans, and African Americans. The association was weaker for females. **Conclusions:** RML in California was associated with an increase in adolescent marijuana use in 2017–2018 and 2018–2019. Demographic subgroup differences in these associations were observed. Evidence-based prevention programs and greater local control on retail marijuana sales may help to reduce marijuana availability and use among adolescents. (*J. Stud. Alcohol Drugs, 82,* 103–111, 2021)

IN RECENT YEARS there has been a move toward liberalization of marijuana laws in the United States. As of January 2021, recreational marijuana use is legal for adults who are at least 21 years old in 15 states (AK, AZ, CA, CO, IL, OR, MA, ME, MI, MO, NJ, NV, SD, VT, WA) and Washington, D.C., and recreational marijuana sales are legal in 10 of those 15 states (Alcohol Policy Information System, 2020). California legalized adult possession and recreational use of marijuana through ballot Proposition 64 on November 9, 2016, and retail sales of recreational marijuana beginning on January 1, 2018 (California Bureau of Cannabis Control, 2019a). Additional states have bills pending that would legalize adult recreational use of marijuana. This liberalization of marijuana laws raises public health concerns, especially about potential effects on marijuana use by adolescents, as marijuana use during adolescence has been associated with a range of adverse consequences (National Academies of Science, Engineering, and Medicine, 2017).

Research on the effects of recreational marijuana legalization (RML) on marijuana use among adolescents is relatively limited and results are mixed. A recent national study with Youth Risk Behavior Survey data found evidence of an 8% decrease in the likelihood of any past-30-day marijuana use and a 9% decrease in the likelihood of frequent past-30-day use among high school students after RML (Anderson et al., 2019). The authors conjectured that these counter-intuitive effects may, in part, reflect the closer regulation of the legal market, which made it more difficult for teens to obtain marijuana. A study by Cerdá et al. (2017) with national Monitoring the Future data found 2.0% and 4.1% increases in past-30-day marijuana use from pre-RML years (2010–2012) to post-RML years (2013–2015) among 8th and 10th graders, respectively, in Washington State, but decreases in marijuana use among 8th and 10th graders in states that did not legalize recreational marijuana use. However, no significant differences were observed for 12th graders in Washington State or among youth in all three grades in Colorado compared with those in non-RML states from 2010–2012 to 2013–2015. However, in a more recent study with data from the Washington Healthy Youth Survey, legalization of recreational marijuana in Washington State was associated with decreases in use among 8th and 10th graders, and no changes in use among 12th graders (Dilley et al., 2019). Also, in contrast to the study by Cerdá et al. (2017), results of the National Survey on Drug Use and Health indicated a significant increase in the prevalence of past-30-day marijuana use among 12- to 17-year-olds in Colorado, from 7.6% in 2006 to 12.6% in 2014 (after RML in 2012), compared with a smaller increase from 6.7% to 7.2% for adolescents in the United States as a whole (Colorado Department of Public Safety, 2016). A more recent study based on data from the Healthy Kids Colorado Survey

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*Correspondence may be sent to Mallie J. Paschall at the Prevention Research Center, Pacific Institute for Research and Evaluation, 2150 Shattuck Avenue, Suite 601, Berkeley, CA 94704, or via e-mail at: paschall@prev.org.

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 <u>55%</u> 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.

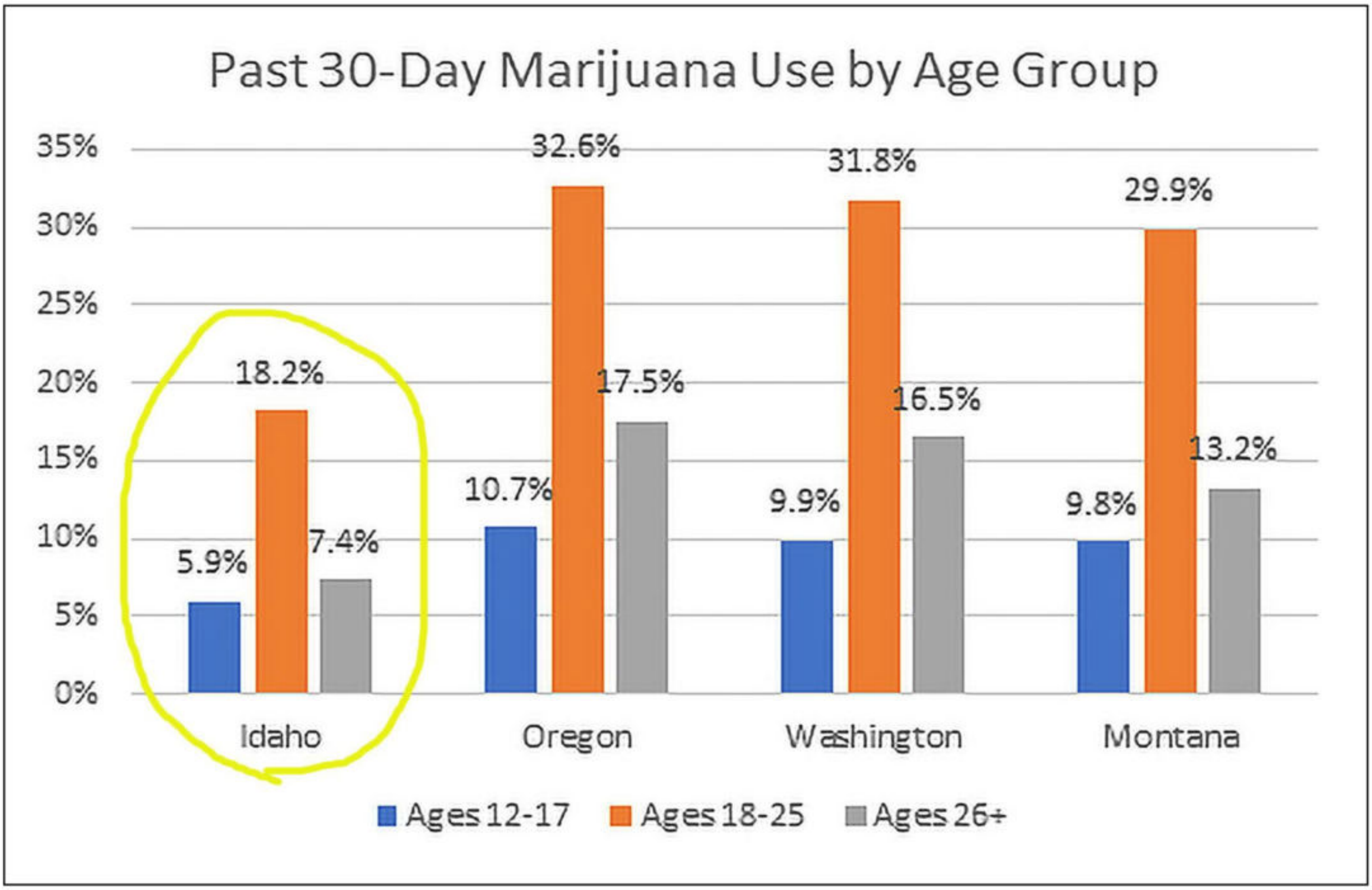
[a] Difference between the 2017-2018 and 2018-2019 population percentages is statistically significant at the 0.05 level.

[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 (vaping of concentrates, potent THC products)

Jacob T. Borodovsky[a,b], **Dustin C. Lee**[c], **Benjamin S. Crosier**[a], **Joy L. Gabrielli**[d], **James D. Sargent**[d], and **Alan J. Budney**[a]

[a]Center for Technology and Behavioral Health Geisel School of Medicine at Dartmouth, 46 Centerra Parkway, Lebanon, NH 03766, United States

[b]The Dartmouth Institute for Health Policy and Clinical Practice, Geisel School of Medicine at Dartmouth, 74 College St. Hanover, NH 03755, United States

[c]Behavioral Pharmacology Research Unit, Johns Hopkins University School of Medicine 5510 Nathan Shock Drive, Baltimore, MD 21224-6823

[d]C. Everett Koop Institute, Dartmouth-Hitchcock Norris Cotton Cancer Center, One Medical Center Drive Lebanon, NH 03756, United States

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.

Corresponding Author: Jacob T. Borodovsky, Jacob.t.borodovsky.gr@dartmouth.edu, Center for Technology and Behavioral Health, Geisel School of Medicine at Dartmouth, 46 Centerra Parkway, Lebanon, NH 03766, United States.

Youth admitted for marijuana-related psychiatric episodes in Colorado more than doubled by the 3rd year of legalization

Journal of Adolescent Health 63 (2018) 239–241

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JOURNAL OF ADOLESCENT HEALTH

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Adolescent health brief

Impact of Marijuana Legalization in Colorado on Adolescent Emergency and Urgent Care Visits

George Sam Wang, M.D. [a,b,e,*], Sara Deakyne Davies, M.P.H. [a,c,e], Laurie Seidel Halmo, M.D. [a,e], Amy Sass, M.D. [a,d,e], and Rakesh D. Mistry, M.D., M,S, [a,b,e]

[a] *University of Colorado Anschutz Medical Campus, Aurora, Colorado*
[b] *Section of Emergency Medicine, Children's Hospital Colorado, Aurora, Colorado*
[c] *Research Informatics, Children's Hospital Colorado, Aurora, Colorado*
[d] *Section of Adolescent Medicine, Children's Hospital Colorado, Aurora, Colorado*
[e] *Department of Pediatrics, Children's Hospital Colorado, Aurora, Colorado*

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Keywords: Marijuana; Cannabis; Adolescent; Emergency Department; Colorado; Mental Health; Drug Abuse

A B S T R A C T

Purpose: Approximately 6%–8% of U.S. adolescents are daily/past-month users of marijuana. However, survey data may not reliably reflect the impact of legalization on adolescents. The objective was to evaluate the impact of marijuana legalization on adolescent emergency department and urgent cares visits to a children's hospital in Colorado, a state that has allowed both medical and recreational marijuana.
Methods: Retrospective review of marijuana-related visits by International Classification of Diseases codes and urine drug screens, from 2005 through 2015, for patients ≥ 13 and < 21 years old.
Results: From 2005 to 2015, 4,202 marijuana-related visits were identified. Behavioral health evaluation was obtained for 2,813 (67%); a psychiatric diagnosis was made for the majority (71%) of these visits. Coingestants were common; the most common was ethanol (12%). Marijuana-related visits increased from 1.8 per 1,000 visits in 2009 to 4.9 in 2015. ($p = < .0001$)
Conclusions: Despite national survey data suggesting no appreciable difference in adolescent marijuana use, our data demonstrate a significant increase in adolescent marijuana-associated emergency department and urgent cares visits in Colorado.

IMPLICATIONS AND CONTRIBUTION

Adolescent marijuana-associated emergency department and urgent cares visits increased in a state that has legalized medical and recreational marijuana. As more states begin to legalize marijuana, it is critical that multiple modalities of surveillance are used to fully evaluate the health impact on the adolescent population.

According to national survey data, 6%–8% of adolescents in the U.S. are daily or past-month users of marijuana and their risk perception of use has decreased [1,2]. Although over 50% of states have legalized marijuana, usage rates have remained similar [3,4]. In one of the first states to legalize recreational marijuana use, subanalyses from national data sources have suggested increased adolescent marijuana use in Washington [5]. On the contrary, Colorado, another state that has legalized medical and recreational marijuana, has not confirmed these findings [5,6]. However, survey data may not reliably reflect the impact of legalization on adolescent health, in part due to the heterogeneity of decriminalization practices across the United States [7]. Futhermore, the impact of legalization on other comorbid aspects of adolescent health, such as drug use and behavioral health, needs to be better understood [8,9]. The Drug Abuse Warning Network reported a 61% increase of marijuana-related emergency

Conflict of Interest: Dr. Wang receives royalties from UpToDate for authorship contributions to related topics. He also has a Colorado Department of Public Health and Environment grant evaluating the pharmacokinetics of CBD in pediatric epilepsy.

* Address correspondence to: George Sam Wang M.D., Section of Emergency Medicine, Department of Pediatrics, Children's Hospital Colorado, 13123 E 16th Ave B251, Aurora, CO 80045.
E-mail address: George.wang@childrenscolorado.org (G.S. Wang).

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https://doi.org/10.1016/j.jadohealth.2017.12.010

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).

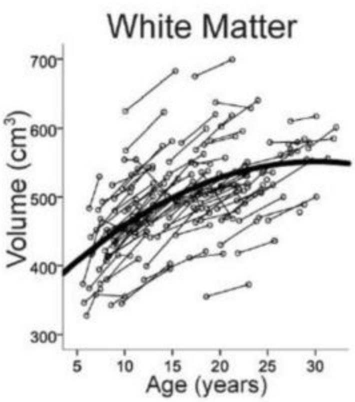
- **Those who experience psychotic symptoms from marijuana use and who quit are more likely to recover** than those who persist in using (Gonzalez-Pinto et al., 2009; Kuepper et al., 2011; Schoeler et al., 2016)

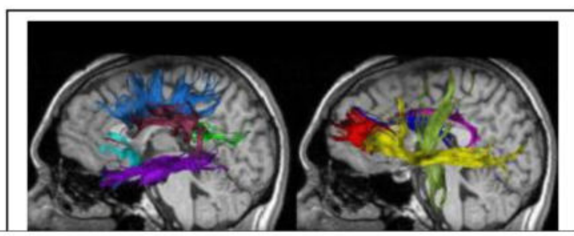
- **Of all the recreational drugs of abuse, it is marijuana that leads to a chronic psychotic disorder in the highest percentage of users** (Nielsen et al., 2017); of those who experience a drug-induced psychotic break, approximately 50% of the marijuana users do not recover (Arendt et al., 2008; Niemi-Pynttari 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).

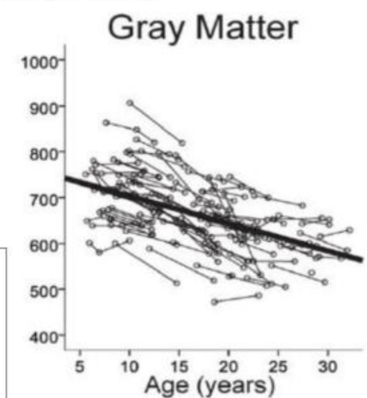
Wiring of cortical and subcortical white matter continues through late 20's; healthy controls





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

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



Arseneault L, Cannon M, Poulton R, Murray R, Caspi A, Moffitt TE, 2002, Cannabis use in adolescence and risk for adult psychosis: longitudinal prospective study.BMJ. 2002 Nov 23;325(7374):1212-3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC135493/pdf/1212.pdf

Bhattacharyya S, Crippa JA, Allen P, et al.. Induction of psychosis by Δ9-tetrahydrocannabinol reflects modulation of prefrontal and striatal function during attentional salience processing. Arch Gen Psychiatry. 2012;69(1):27-36. https://pubmed.ncbi.nlm.nih.gov/22213786/

Camchong J, Lim KO, Kumra S. Adverse Effects of Cannabis on Adolescent Brain Development: A Longitudinal Study. Cereb Cortex. 2017;27(3):1922-1930. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5963818/pdf/bhw015.pdf

Di Forti M, Marconi A, et al.. Proportion of patients in south London with first-episode psychosis attributable to use of high potency cannabis: a case-control study. Lancet Psychiatry. 2015;2(3):233-8 http://dx.doi.org/10.1016/S2215-0366(14)00117-5.

Di Forti M, Quattrone D, Freeman TP, et al.. The contribution of cannabis use to variation in the incidence of psychotic disorder across Europe (EU-GEI): a multicentre case-control study. Lancet Psychiatry. 2019;6(5):427-436. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7646282/pdf/main.pdf

D'Souza DC, Perry E, MacDougall L, Ammerman Y, Cooper T, Wu YT, Braley G, Gueorguieva R, Krystal JH. The psychotomimetic effects of intravenous delta-9-tetrahydrocannabinol in healthy individuals: implications for psychosis. Neuropsychopharmacology. 2004 Aug;29(8):1558-72.

Freeman D, Dunn G, Murray RM, et al. How cannabis causes paranoia: using the intravenous administration of Δ9-tetrahydrocannabinol (THC) to identify key cognitive mechanisms leading to paranoia. Schizophr Bull. 2015;41(2):391-9. doi: 10.1093/schbul/sbu098. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4332941/pdf/sbu098.pdf

González-Pinto A, Alberich S, Barbeito S, et al. Cannabis and first-episode psychosis: different long-term outcomes depending on continued or discontinued use. Schizophr Bull. 2011;37(3):631-9. Epub 2009. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3080669/pdf/sbp126.pdf

*Henquet C, Krabbendam L, Spauwen J, et al. Prospective cohort study of cannabis use, predisposition for psychosis, and psychotic symptoms in young people. BMJ. 2005;330:11–15.*http://www.ncbi.nlm.nih.gov/pmc/articles/PMC539839/pdf/bmj33000011.pdf

Hjorthøj C, Larsen MO, Starzer MSK, Nordentoft M. Annual incidence of cannabis-induced psychosis, other substance-induced psychoses and dually diagnosed schizophrenia and cannabis use disorder in Denmark from 1994 to 2016. Psychol Med. 2019:1-6. https://pubmed.ncbi.nlm.nih.gov/31839011/

Kuepper R, van Os J, Lieb R, Wittchen HU, Höfler M, Henquet C. Continued cannabis use and risk of incidence and persistence of psychotic symptoms: 10 year follow-up cohort study.BMJ. 2011 Mar 1;342: d738 http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3047001/pdf/bmj.d738.pdf

Lebel C, Beaulieu C. Longitudinal development of human brain wiring continues from childhood into adulthood. J Neurosci. 2011;31(30):10937-47 http://www.jneurosci.org/content/31/30/10937.long

Marconi A, Di Forti M, Lewis CM, Murray RM, Vassos E. Meta-analysis of the Association Between the Level of Cannabis Use and Risk of Psychosis. Schizophr Bull. 2016;42(5):1262-9. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4988731/

Miller CL, 2018, The Impact of Marijuana on Mental Health, in Contemporary Health Issues on Marijuana, Oxford University Press, 319 pp. https://www.oxfordclinicalpsych.com/view/10.1093/med-psych/9780190263072.001.0001/med-9780190263072

Morrison PD, Nottage J, Stone JM, et al. Disruption of frontal ϑ coherence by Δ9-tetrahydrocannabinol is associated with positive psychotic symptoms. Neuropsychopharmacology. 2011;;36(4):827-36. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3055738/pdf/npp2010222a.pdf

Nielsen SM, Toftdahl NG, Nordentoft M, Hjorthøj C. Association between alcohol, cannabis, and other illicit substance abuse and risk of developing schizophrenia: a nationwide population based register study. Psychol Med. 2017;47(9):1668-1677. https://pubmed.ncbi.nlm.nih.gov/28166863/

Niemi-Pynttäri JA, Sund R, Putkonen H, Vorma H, Wahlbeck K, Pirkola SP. Substance-induced psychoses converting into schizophrenia: a register-based study of 18,478 Finnish inpatient cases. J Clin Psychiatry. 2013 74(1):e94-9. https://www.psychiatrist.com/jcp/article/Pages/2013/v74n01/v74n0115.aspx

Schoeler T, Petros N, Di Forti M, et al. Effects of continuation, frequency, and type of cannabis use on relapse in the first 2 years after onset of psychosis: an observational study. Lancet Psychiatry. 2016;3(10):947-953 https://www.thelancet.com/journals/lanpsy/article/PIIS2215-0366(16)30188-2/fulltext

Starzer MSK, Nordentoft M, Hjorthøj C. Rates and Predictors of Conversion to Schizophrenia or Bipolar Disorder Following Substance-Induced Psychosis. Am J Psychiatry. 2018;175(4):343-350. https://pubmed.ncbi.nlm.nih.gov/29179576/

van Os J, Bak M, Hanssen M, Bijl RV, de Graaf R, Verdoux H. Cannabis use and psychosis: a longitudinal population-based study. Am J Epidemiol. 2002 Aug 15;156(4):319-27. https://pubmed.ncbi.nlm.nih.gov/12181101/

Zammit S, Allebeck P, Andreasson S, Lundberg I, Lewis G, 2002, Self reported cannabis use as a risk factor for schizophrenia in Swedish conscripts of 1969: historical cohort study. BMJ. 2002 Nov 23;325(7374):1199. http://www.bmj.com/content/325/7374/1199.full.pdf

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

https://www.cbc.ca/news/canada/nova-scotia/covid-19-mental-health-substance-use-1.5829149

Study looks at link between substance use and psychosis during pandemic

In-patient admissions in Halifax increased for the 35-44 age group during early days of COVID

Michael Gorman · CBC News · Posted: Dec 05, 2020 6:00 AM AT | Last Updated: December 5, 2020

Dr. Jason Morrison is interim chief of psychiatry for Nova Scotia Health's Central Zone. (CBC)

In the months after a state of emergency was declared in Nova Scotia and widespread lockdowns were initiated, the interim chief of psychiatry for Nova Scotia Health's central zone said in-patient doctors started noticing changes in who was coming to hospital.

The frequency where substance use was thought to be a contributing factor was also higher than usual.

"Typically, we see someone with the first episode of psychosis in their teens or their 20s, so to see previously well people with no psychiatric history developing a first psychosis in their 30s and 40s was very unusual," said Morrison.

It was that finding and the increased association with drug use — in particular cannabis and cocaine — that caused Morrison's team at the hospital to decide to take a closer look.

Morrison said there is lots of research when it comes to substance-related psychosis in young people who use daily, but the surprise was the findings for patients between 35 and 44 years old.

"We typically say if you're going to start smoking cannabis a lot, wait until you're after 25 at least, and I think this study kind of made us pause a little bit about that," he said.

If people are going to be using cannabis daily, Morrison recommends they consider products with lower THC levels.

$91 billion dollars annual cost to U.S. in 2021 dollars

The Economic Burden of Schizophrenia in the United States in 2002

Eric Q. Wu, Ph.D.; Howard G. Birnbaum, Ph.D.; Lizheng Shi, Ph.D.; Daniel E. Ball, M.B.A.; Ronald C. Kessler, Ph.D.; Matthew Moulis, B.A.; and Jyoti Aggarwal, M.H.S.

Objective: This study quantifies excess annual costs associated with schizophrenia patients in the United States in 2002 from a societal perspective.

Method: Annual direct medical costs associated with schizophrenia were estimated separately for privately (N = 1090) and publicly (Medicaid; N = 14,074) insured patients based on administrative claims data, including a large private claims database and the California Medicaid program (Medi-Cal) database, and compared separately to demographically/geographically matched control samples (1 case:3 controls). Medicare costs of patients over age 65 years were imputed using the Medicare/Medi-Cal dual-eligible patients (N = 1491) and published statistics. Excess annual direct non–health care costs were estimated for law enforcement, homeless shelters, and research/training related to schizophrenia. Excess annual indirect costs were estimated for 4 components of productivity loss: unemployment, reduced workplace productivity, premature mortality from suicide, and family caregiving using a human capital approach based on market wages. All costs were adjusted to 2002 dollars using the Medical Care Consumer Price Index and were based on the reported prevalence in the National Comorbidity Survey Replication.

Results: The overall U.S. 2002 cost of schizophrenia was estimated to be $62.7 billion, with $22.7 billion excess direct health care cost ($7.0 billion outpatient, $5.0 billion drugs, $2.8 billion inpatient, $8.0 billion long-term care). The total direct non–health care excess costs, including living cost offsets, were estimated to be $7.6 billion. The total indirect excess costs were estimated to be $32.4 billion.

Conclusion: Schizophrenia is a debilitating illness resulting in significant costs. The indirect excess cost due to unemployment is the largest component of overall schizophrenia excess annual costs.

(J Clin Psychiatry 2005;66:1122–1129)

Received March 14, 2005; accepted June 20, 2005. *From Analysis Group, Inc., Boston, Mass. (Drs. Wu and Birnbaum, Mr. Moulis, and Ms. Aggarwal); Eli Lilly and Company, Indianapolis, Ind. (Dr. Shi and Mr. Ball); the Departments of Health System Management and Psychiatry and Neurology, Tulane University, New Orleans, La. (Dr. Shi); and the Department of Health Care Policy, Harvard Medical School, Boston, Mass. (Dr. Kessler).*

Research was funded by an unrestricted research grant from Eli Lilly and Company, Indianapolis, Ind.

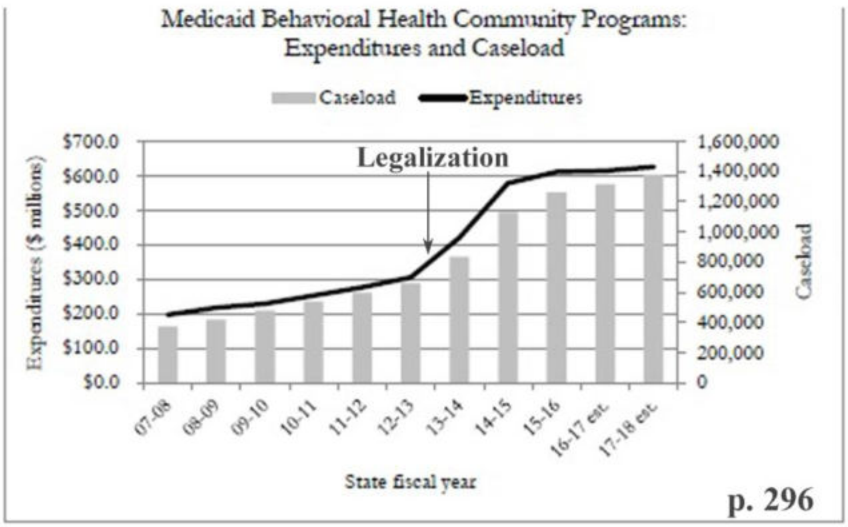
Drs. Wu, Birnbaum, and Kessler and Mr. Moulis and Ms. Aggarwal have served as consultants for Lilly. Dr. Shi is no longer an employee of Lilly. Mr. Ball is an employee and stockholder of Lilly.

Corresponding author and reprints: Eric Q. Wu, Ph.D., Analysis Group, Inc., 111 Huntington Ave., 10th Floor, Boston, MA 02199 (e-mail: ewu@analysisgroup.com).

The American Psychiatric Association (APA) Guidelines[1] define schizophrenia as a chronic and debilitating mental illness in which patients often have a diminished capacity for learning, working, self-care, interpersonal relationships, and maintaining general living skills. Crown et al.[2] estimate that 40% to 60% of schizophrenia patients are likely to suffer from lifelong impairments. Kessler et al.[3] state that schizophrenia affects a minimum of 0.5% (range, 0.3%–1.6%) of the U.S. population, although they note that this survey-based prevalence estimate is a lower bound due to the underrepresentation of schizophrenia patients in epidemiologic surveys.

Previous U.S. cost-of-illness studies have documented that schizophrenia is a costly disease. Cost-of-schizophrenia studies in the early 1990s by Wyatt et al.[4] and Rice and Miller[5] estimated the annual costs of schizophrenia to be $65 billion and $33 billion, respectively. These estimates should be considered as measures of the economic impact of the disease to society, i.e., excess costs of patients with schizophrenia compared to their costs had they never had schizophrenia. The 2 studies' estimates of total direct costs were similar, in the range of $18 billion to $19 billion. The discrepancy between their total cost estimates arises mainly from differences in estimated indirect costs due to inclusion of different cost components, application of different methodologies, and use of different data sources. For example, to estimate lost earnings from premature mortality, Wyatt et al.[4] applied a steady-state methodology, whereas Rice and Miller[5] projected the earnings for the duration of the patient's life, had that person not committed suicide, and discounted the results to 1990 values.

Medicaid Behavioral Health Caseload Increased Substantially in Colorado after Legalization

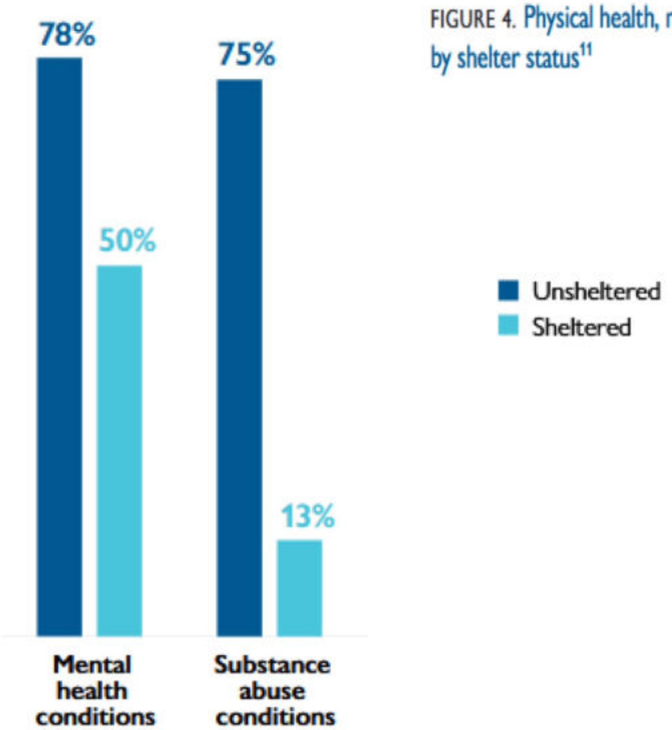


https://leg.colorado.gov/publications/fy-2017-18-appropriations-report

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

FIGURE 4. Physical health, mental health, substance abuse, and trimorbidity by shelter status[11]



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/

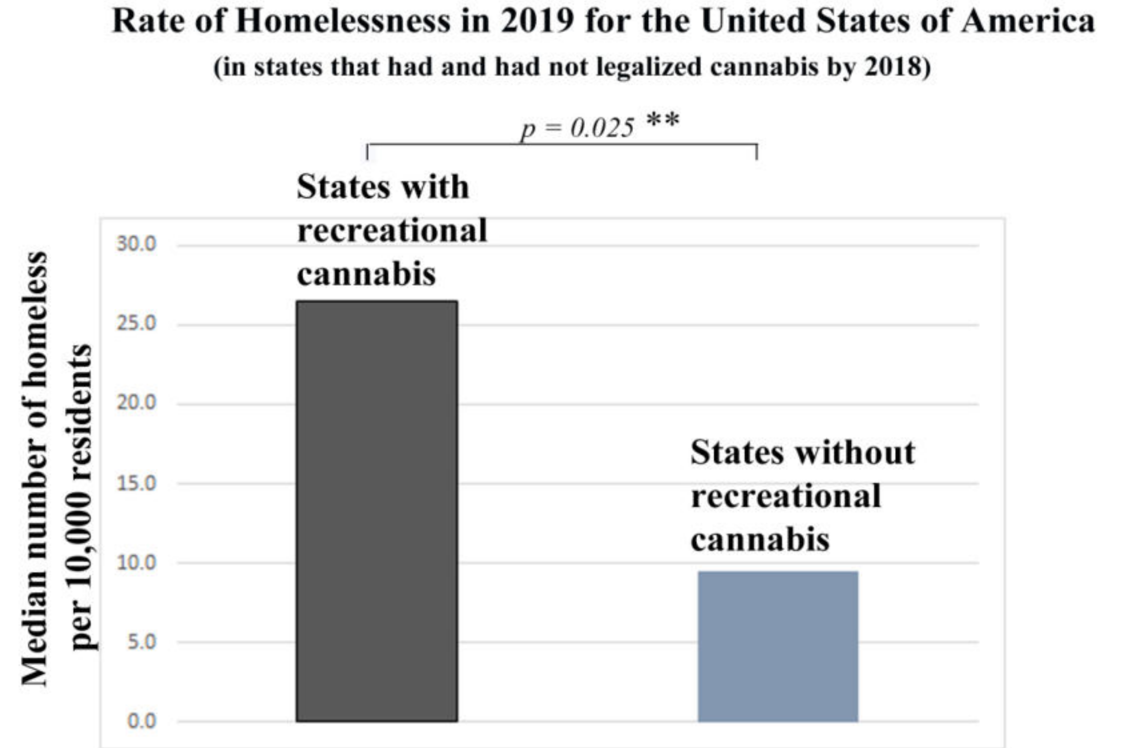
Anchorage: https://www.ktoo.org/2018/07/20/anchorage-struggles-to-balance-homeless-camping-problems/

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

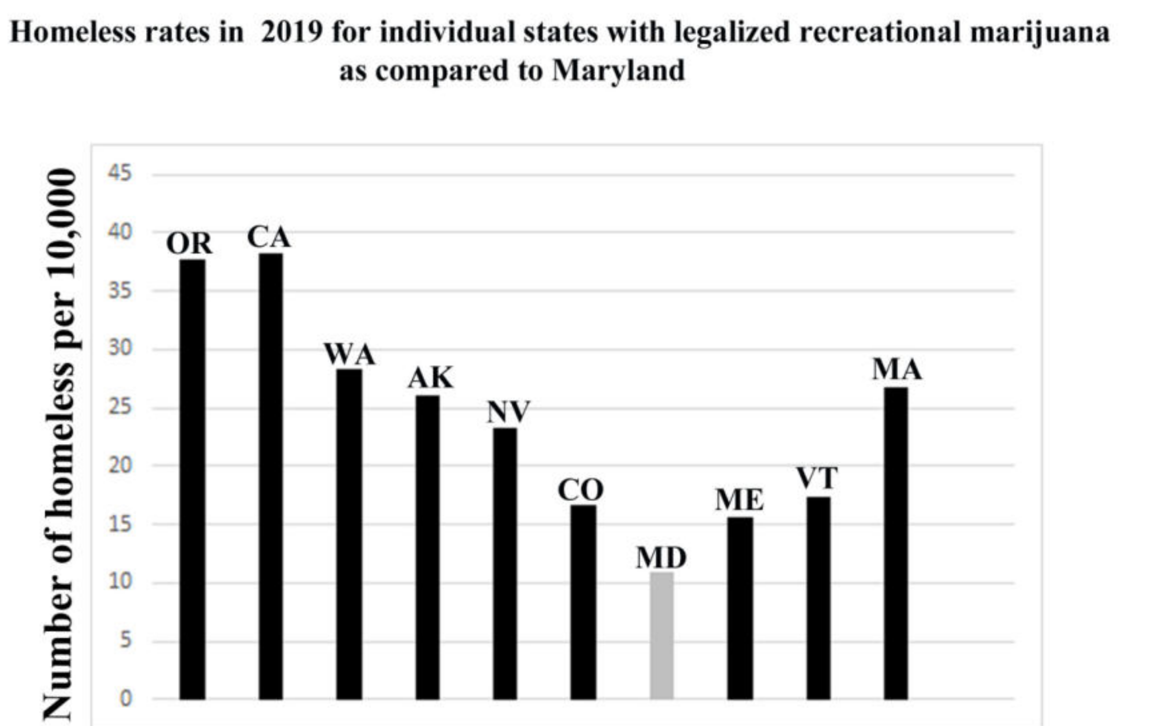
With even international news speculating that marijuana legalization may be a contributing factor: https://www.theguardian.com/us-news/2017/feb/27/marijuana-legal-homeless-denver-colorado

States with recreational marijuana have greater rates of homelessness

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



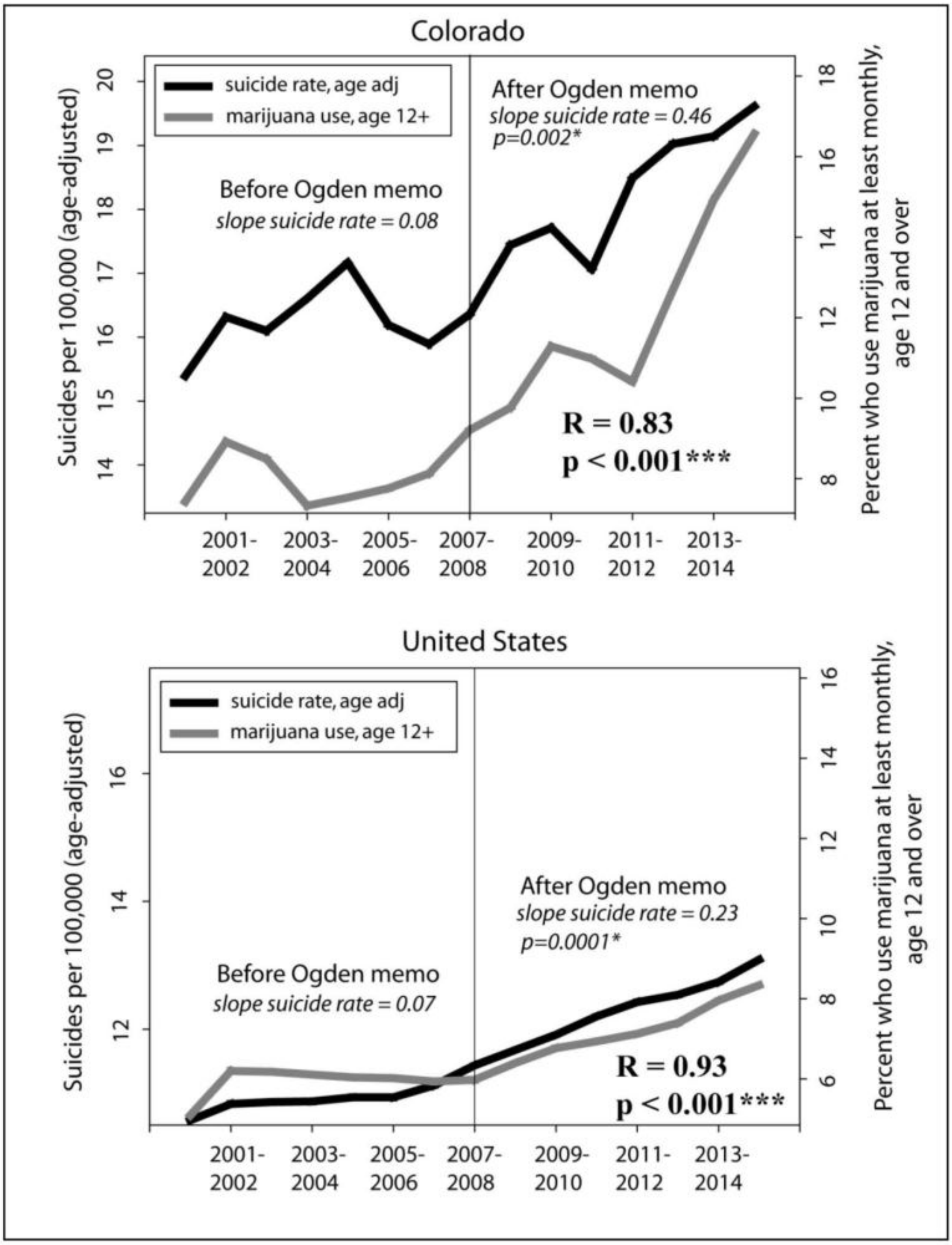
Jurisdictions with recreational marijuana by 2018: California,Oregon,Washington, Massachusetts,Alaska,Nevada,Vermont,Colorado,Maine, District of Columbia



States with recreational marijuana by 2018: Oregon, California,Washington, Nevada, Alaska, Colorado, Maine, Vermont, Massachusetts

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.

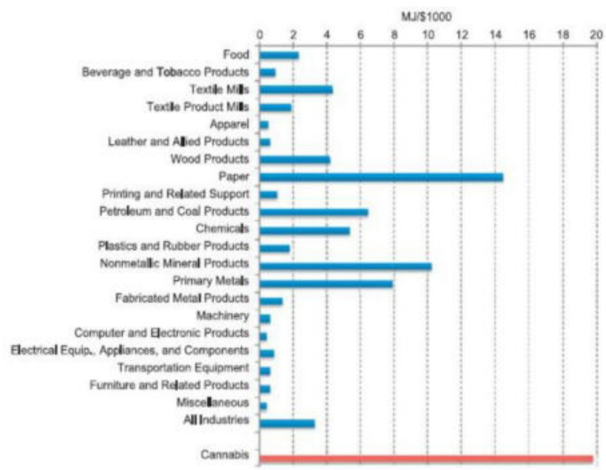


Fig. 3. Comparative energy intensities, by sector (2006).

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

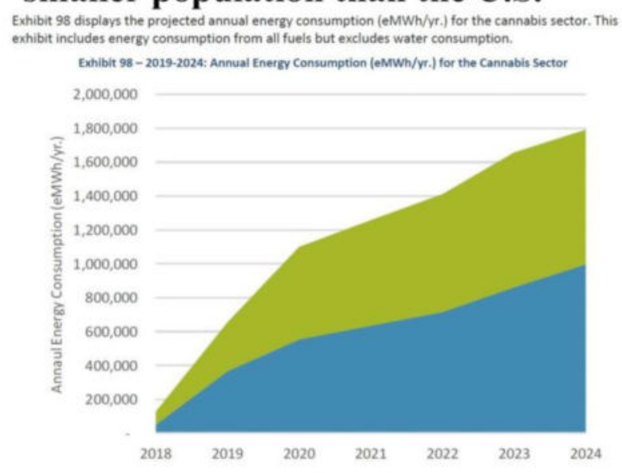
https://eq-research.com/wp-content/uploads/2016/09/A-Chronic-Problem.pdf

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

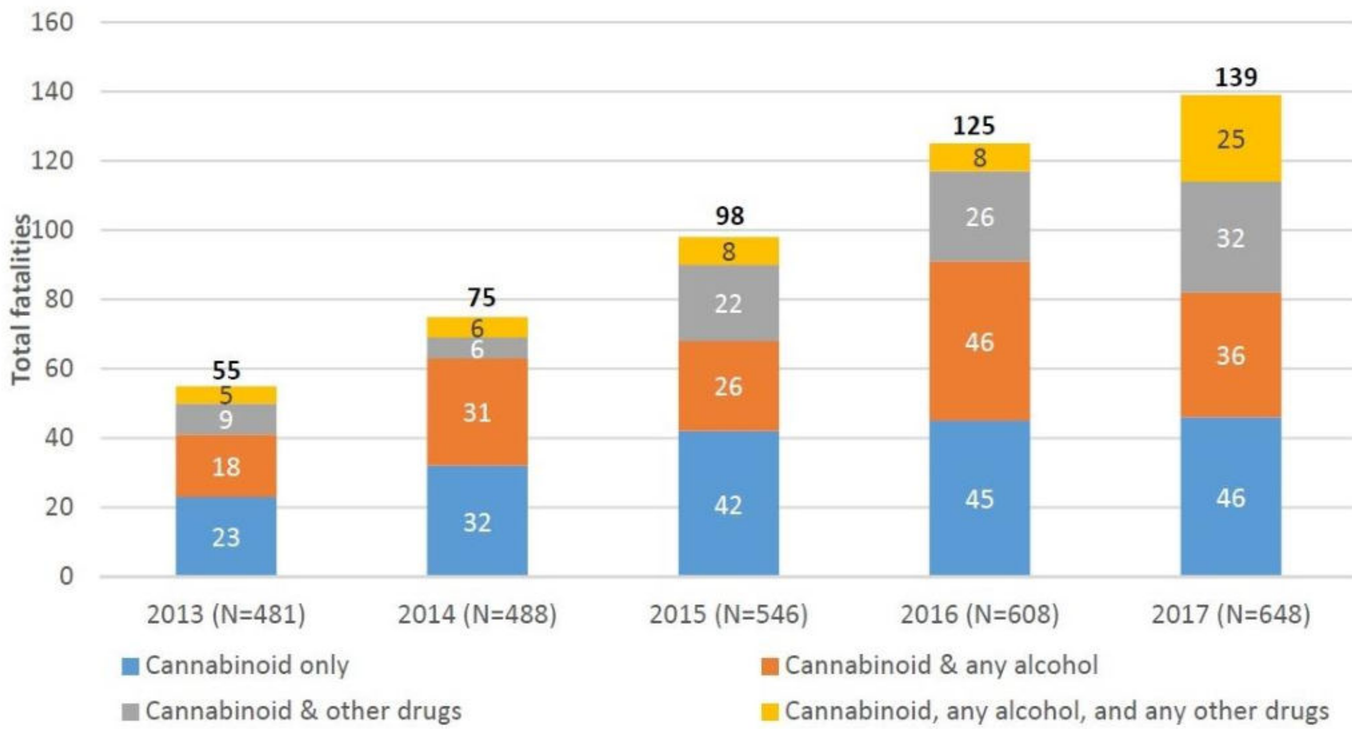
Projections of growth in energy consumption by the cannabis industry in Canada, a much smaller population than the U.S.



Posterity Group report in Canada (Greenhouse Energy Profile Study, https://www.ieso.ca/)

Since vote to legalize in 2012, Colorado traffic fatalities involving positive tests for THC in drivers more than doubled by 2017

Figure 16. Colorado fatalities involving drivers testing positive for cannabinoids, 2013–2017



Source: Colorado Department of Transportation, Data Intelligence Group, Toxicology Data (2018).
Note: A) Numbers are based on toxicology results where at least one driver was tested for drugs after a crash; see Table 21 for number and percent of drivers tested each year; B) the presence of a cannabinoid does not necessarily indicate recent use of marijuana or impairment.

Traffic fatality rates: legalized states trending up since 2012, other states without recreational marijuana (controls) trending down

Accessed April 21, 2020. https://www.whitehouse.gov/briefings-statements/remarks-president-trump-vice-president-pence-members-coronavirus-task-force-press-briefing-19/

3. Vigdor N. Man fatally poisons himself while self-medicating for coronavirus, doctor says. *New York Times*. March 24, 2020. Accessed April 17, 2020. https://www.nytimes.com/2020/03/24/us/chloroquine-poisoning-coronavirus.html.

4. Liu M, Caputi TL, Drezde M, Kesselheim AS, Ayers JW. Internet searches for unproven COVID-19 therapies in the United States. *JAMA Intern Med*. Published online April 29, 2020. doi:10.1001/jamainternmed.2020.1764

5. International Society of Antimicrobial Chemotherapy. Statement on IJAA paper. April 3, 2020. Accessed April 10, 2020. http://www.isac.world/news-and-publications/official-isac-statement

6. Chen Z, Hu J, Zhang Z, et al Efficacy of hydroxychloroquine in patients with COVID-19: results of a randomized clinical trial. Preprint. Posted online April 10, 2020. medRxiv. doi:10.1101/2020.03.22.20040758

7. Marsh T. Live updates: which drugs are in shortage because of COVID-19? GoodRx website. Accessed April 13, 2020. https://www.goodrx.com/blog/covid-19-drug-shortages-updates/.

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.

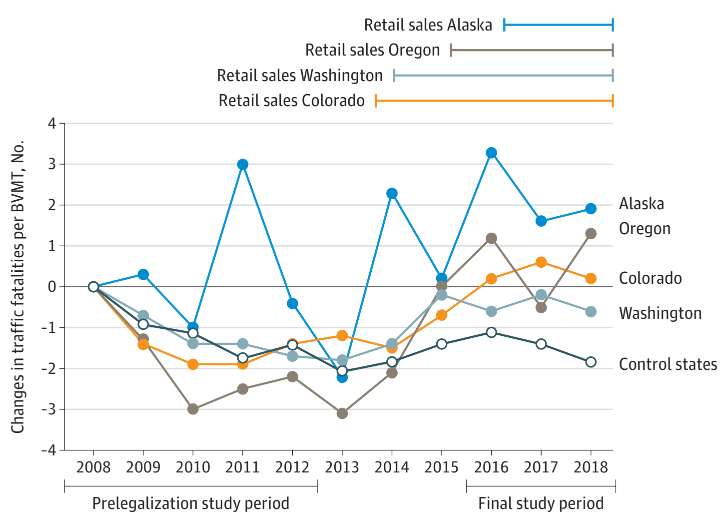
Methods | Traffic fatality rates were obtained from the National Highway Traffic Safety Administration's Fatality Analysis Reporting System.[6] The first 4 states to legalize recreational marijuana (Colorado, Washington, Oregon, and Alaska) comprised the experimental group. These states are the only 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.

Russell S. Kamer, MD
Stephen Warshafsky, MD
Gordon C. Kamer

Author Affiliations: Department of Medicine, New York Medical College, Valhalla, New York (R. S. Kamer, Warshafsky); Harvard College, Harvard University, Cambridge, Massachusetts (G. C. Kamer).

Corresponding Author: Russell S. Kamer, MD, Department of Medicine, New York Medical College, 15 N Broadway, White Plains, NY 10601 (drkamer@drkamer.com).

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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.

1. Hartman RL, Huestis MA. Cannabis effects on driving skills. *Clin Chem*. 2013; 59(3):478-492. doi:10.1373/clinchem.2012.194381

2. Aydelotte JD, Brown LH, Luftman KM, et al. Crash fatality rates after recreational marijuana legalization in Washington and Colorado. *Am J Public Health*. 2017;107(8):1329-1331. doi:10.2105/AJPH.2017.303848

3. Hansen B, Miller K, Weber C. Early evidence on recreational marijuana legalization and traffic fatalities. *Econ Inq*. 2018. doi:10.3386/w24417

4. Lane TJ, Hall W. Traffic fatalities within US states that have legalized recreational cannabis sales and their neighbours. *Addiction*. 2019;114(5):847-856. doi:10.1111/add.14536

5. Aydelotte JD, Mardock AL, Mancheski CA, et al. Fatal crashes in the 5 years after recreational marijuana legalization in Colorado and Washington. *Accid Anal Prev*. 2019;132:105284. doi:10.1016/j.aap.2019.105284

6. National Highway Traffic Safety Administration. Fatality Analysis Reporting System (FARS) encyclopedia. Accessed November 22, 2019. https://www-fars.nhtsa.dot.gov/States/StatesFatalitiesFatalityRates.aspx Published 2019.