Association of state marijuana legalization policies for medical and recreational use and vaping associated lung disease

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Introduction

From June 2019 to January 2020, over 2,500 cases of e-cigarette or vaping associated lung injury (EVALI) were reported to the CDC. The specific cause of EVALI is unknown, but most patients report using e-cigarettes to consume tetrahydrocannabinol (THC), the primary psychoactive component of marijuana. The CDC and others have hypothesized that black-market THC products may cause EVALI[1,2].

Some states have legalized marijuana and THC-containing products for recreational use. Many other states allow purchases for qualifying medical purposes. In remaining states, all forms of consumption and distribution are illegal, and those who use THC likely obtain it from the black market. If black market THC products are responsible for EVALI, then case rates may be lower in recreational marijuana states. The goal of this cross-sectional study was to measure the extent to which states where marijuana is legal have lower rates of EVALI than states where it is illegal.

Data

We conducted a cross-sectional analysis at the state-level (n = 51). We obtained data on the number of reported EVALI cases for each state in 2019 from the CDC[2], estimates of the prevalence of e-cigarette use in each state in 2017 from BRFSS[3], and estimates of state populations in 2017 from SEER[4]. We defined the EVALI case rate in each state as the mid-point of the CDC reported range of cases per million population. We classified states as medical marijuana states if the state had a medical marijuana law by January 2019, but no recreational dispensaries. We coded states as recreational marijuana states if the state had a recreational marijuana law and there was at least one recreational dispensary open in the state by January 2019.

Methods

Throughout, the unit of analysis was the state and all analyses are unweighted. We estimated a linear regression of the state EVALI case rate per 1 million people on indicator variables for recreational and medical marijuana states, leaving prohibition states as the reference group. The coefficients on the marijuana law variables are estimates of the difference in mean unadjusted EVALI case rates in recreational compared to prohibition states and medical compared to prohibition states.

Differences in e-cigarette use might confound the estimated relationship between EVALI and state marijuana laws if (i) the prevalence of e-cigarette use differs across states with recreational, medical, and prohibition laws, and (ii) the prevalence of e-cigarette use is correlated with EVALI rates. We investigate this possibility by fitting linear regressions of the state-level prevalence of e-cigarette use on indicator

variables for recreational and medical marijuana laws. We also fit an augmented regression of EVALI case rates on both the indicators for state marijuana laws and e-cigarette prevalence. All regressions use heteroskedasticity robust standard errors. We used two-tailed t-tests to assess the null hypotheses of no effect and rejected the null if the p-value was less than .05.

Results

The top panel of Figure 1A shows the number of reported EVALI cases/million in each state. Recreational marijuana states have among the lowest EVALI rates of all states. To test for differences in average EVALI case rates across states with different marijuana policies, we regressed EVALI case rates on indicators for recreational and medical marijuana laws. The results are in the bottom panel of Figure 1A. The average recreational marijuana state had 1.7 EVALI cases/million (95% CI: 0.3 to 3.1). In contrast, the EVALI case rate was 8.8 cases/million (95% CI: 5.1 to 12.5) in medical marijuana states and 8.1 cases/million (95% CI: 4.1 to 12.0) in prohibition states. A test of the difference in mean case rates implies that recreational marijuana states have 7.1 ($p < .001$; 95% CI: -10.9 to -3.2) fewer cases/million than medical marijuana states, and 6.4 ($p = .004$; 95% CI: -10.4 to -2.3) fewer cases/million than prohibition states. The difference in the EVALI case rate between medical and prohibition states is not statistically significant (coef = 0.7, $p = .783$; 95% CI: -4.5 to 5.9).

The top panel of Figure 1B shows the prevalence of e-cigarette use in each state. To test for systematic differences in e-cigarette use, we regressed e-cigarette prevalence on marijuana law indicators. The bottom panel of Figure 1B shows that the average e-cigarette use rate is quantitatively similar across the three groups of states and none of the differences are statistically significant at conventional levels.

Figure 2 shows a scatter plot of EVALI case rates against e-cigarette use rates. The graph suggests no association between EVALI cases rate and the prevalence of e-cigarette in each state, but it does show that EVALI rates are lower in recreational marijuana states. We also used multivariable regression to estimate the association between the EVALI case rate and marijuana laws after adjusting for the prevalence of e-cigarette use. The results confirm our earlier findings. The regressions imply that average EVALI case rates are 7.2 cases/million lower in recreational marijuana states ($p = .003$; 95% CI: -11.8 to -2.6) than in prohibition states. There is no significant difference between EVALI case rates in prohibition and medical marijuana states (coef = 0.3; $p = .93$; 95% CI: -5.3 to 5.8). There is no significant relationship between the prevalence of e-cigarette use and EVALI case rates (coef = -1.3; $p = .20$; 95% CI: -3.3 to 0.7).

Discussion

The data suggest EVALI cases are concentrated in states where consumers do not have legal access to recreational marijuana dispensaries. This relationship is not driven by state-level differences in e-cigarette use, and EVALI case rates are not strongly correlated with state-level prevalence of e-cigarette use. One possible inference from our results is that the presence of legal markets for marijuana has helped mitigate or is protective against EVALI.

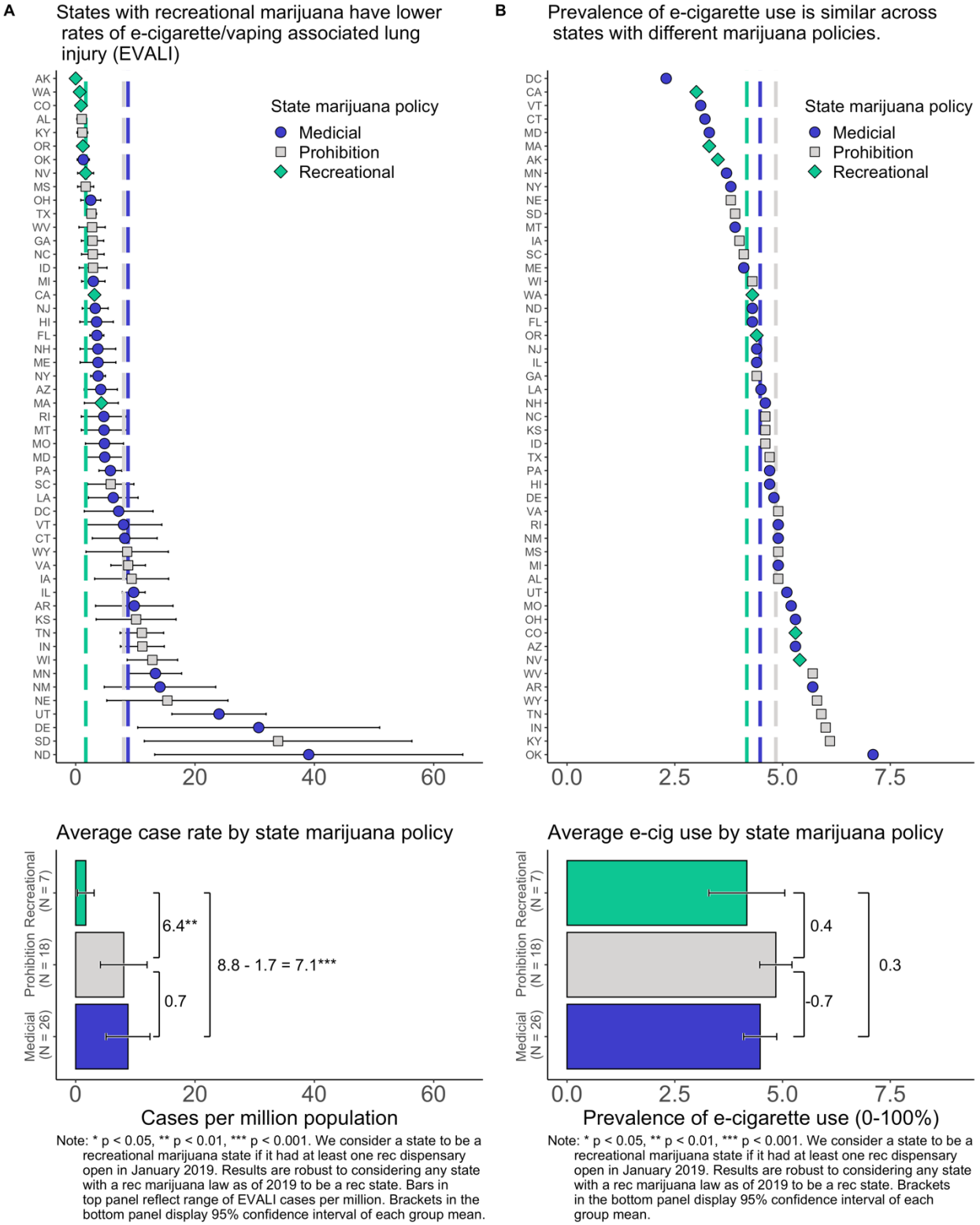
The reason for the relationship is not yet clear. It is possible that in recreational states people tend to purchase marijuana products at legal dispensaries, which may be less likely to sell the contaminated products that cause EVALI. In addition, the data are not informative about the potentially complicated interactions between safety regulations, bans, and prohibitions for goods like marijuana, tobacco, and vaping products. Future research should examine these issues in more detail.

The statistical analysis and generalizability of results in this note have limitations. The data are aggregate state-level data and may not accurately reflect changes at the individual-level. The results are based on simple cross-sectional comparisons and do not exploit an experimental or quasi-experimental research design that would mitigate concerns about the potential for confounding. The CDC data on EVALI cases by state provide the best available information about EVALI. However, they are reported as ranges rather than specific counts. There is also no way to know whether under reporting is a serious concern or whether under reporting varies across states.

Acknowledgements

Dr. Wing and Dr. Hollingsworth had full access to all the data in the study and take full responsibility for the integrity of the data and the accuracy of the data analysis. Dr. Wing and Dr. Hollingsworth are responsible for ensuring that this report followed STROBE guidelines for cross-sectional studies. No authors of this study have relevant financial or conflicts of interest to disclose.

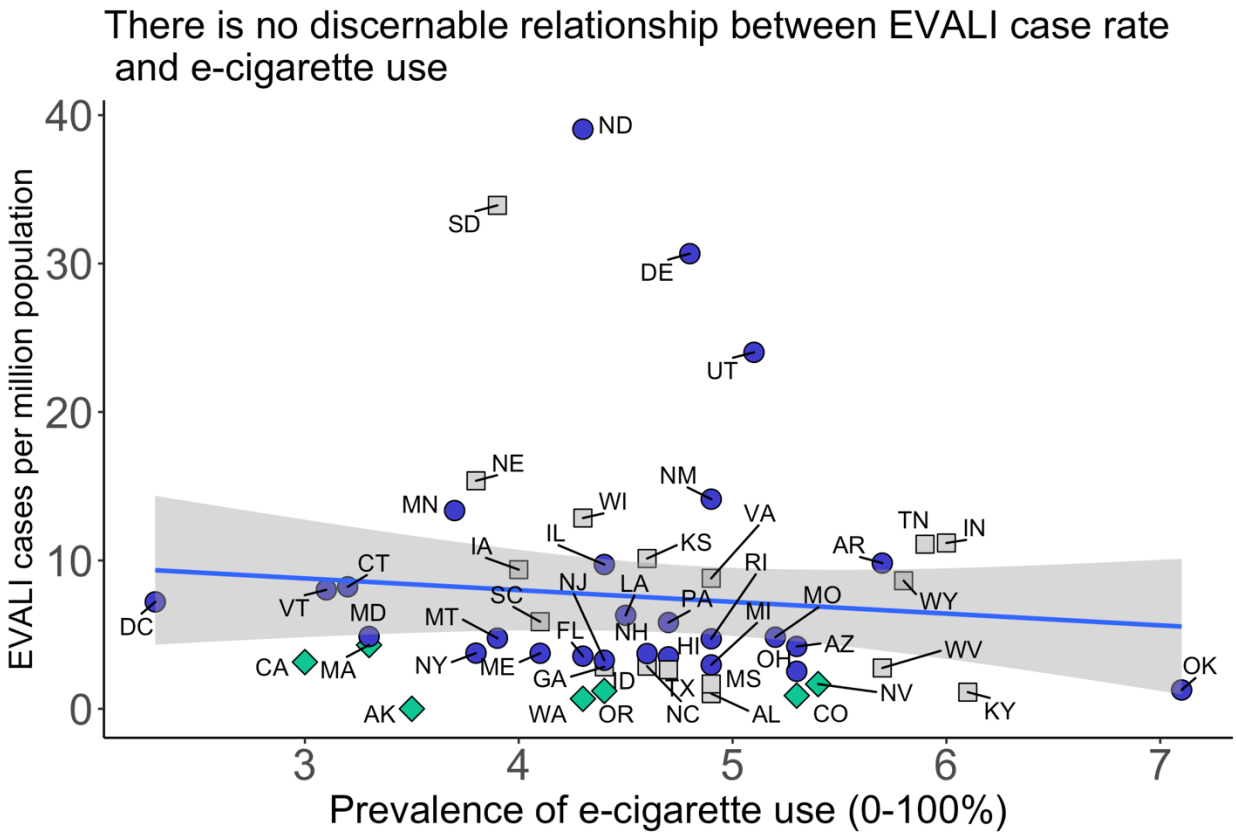
Figure 1



Note: * p < 0.05, ** p < 0.01, *** p < 0.001. We consider a state to be a recreational marijuana state if it had at least one rec dispensary open in January 2019. Results are robust to considering any state with a rec marijuana law as of 2019 to be a rec state. Bars in top panel reflect range of EVALI cases per million. Brackets in the bottom panel display 95% confidence interval of each group mean.

Note: * p < 0.05, ** p < 0.01, *** p < 0.001. We consider a state to be a recreational marijuana state if it had at least one rec dispensary open in January 2019. Results are robust to considering any state with a rec marijuana law as of 2019 to be a rec state. Brackets in the bottom panel display 95% confidence interval of each group mean.

Figure 2



Note: Best fit line is displayed in blue with a slope of -0.8 and a robust standard error of 0.9 (p-value of 0.36). 95% confidence interval is denoted by gray shaded area. Results are robust to weighting by state population.

References

[1] Layden JE, Ghinai I, Pray I, et al. Pulmonary illness related to e-cigarette use in Illinois and Wisconsin — preliminary report. N Engl J Med. DOI: 10.1056/NEJMoa1911614.

[2] Perrine CG, Pickens CM, Boehmer TK, et al. Characteristics of a Multistate Outbreak of Lung Injury Associated with E-cigarette Use, or Vaping — United States, 2019. MMWR Morb Mortal Wkly Rep 2019;68:860–864. DOI: http://dx.doi.org/10.15585/mmwr.mm6839e1

[3] Centers for Disease Control and Prevention (CDC). Behavioral Risk Factor Surveillance System Survey Data. Atlanta, Georgia: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, 2017.

[4] Surveillance, Epidemiology, and End Results (SEER) Program Populations (1969-2017) (www.seer.cancer.gov/popdata), National Cancer Institute, DCCPS, Surveillance Research Program, released December 2018.