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Effects of State Opioid Prescribing Laws on Rates of Fatal Crashes in the U.S.

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Abstract

Background: State opioid prescribing cap laws, mandatory prescription drug monitoring program query or enrollment laws, and pill mill laws have been implemented across U.S. states to curb high-risk opioid prescribing. Previous studies have measured the impact of these laws on opioid use and overdose death, but no prior work has measured the impact of these laws on fatal crashes in a multi-state analysis.

Methods: To study the association between state opioid prescribing laws and fatal crashes, 13 treatment states that implemented a single law of interest in a 4-year period were identified, together with unique groups of control states for each treatment state. Augmented synthetic control analyses were used to estimate the association between each state law and the overall rate of fatal crashes, and the rate of opioid-involved fatal crashes, per 100,000 licensed drivers in the state. Fatal crash data came from the Fatality Analysis Reporting System (FARS).

Results: Results of augmented synthetic control analyses showed small-in-magnitude, non-statistically significant changes in all fatal crash outcomes attributable to the 13 state opioid prescribing laws. While non-statistically significant, results attributable to the laws varied in either direction – from an increase of 0.14 (−0.32, 0.60) fatal crashes per 100,000 licensed drivers attributable to Ohio's opioid prescribing cap law, to a decrease of 0.30 (−1.17, 0.57) fatal crashes/ 100,000 licensed drivers attributable to Mississippi's pill mill law.

Conclusion: These findings suggest that state-level opioid prescribing laws are insufficient to help address rising rates of fatally injured drivers who test positive for opioids. Other options will be needed to address this continuing injury problem.

INTRODUCTION

Unintentional injury is the fourth leading cause of death among the U.S. public, primarily due to overdose deaths and followed by motor vehicle traffic deaths; together, these sources

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of unintentional injury resulted in over 147,000 deaths in 2021.[1] The two issues intersect with rising rates of opioid-involved fatal crashes, with the prevalence of fatally injured drivers testing positive for opioids increasing from 1% in 1995 to 7% in 2016,[2] and most recently estimated at 14% during 2020.[3, 4] Use of opioids impairs motor functioning skills that are necessary for operating a motor vehicle,[5] and drivers' use of opioids has been shown to increase their likelihood of initiating fatal car crashes.[6–8]

Rates of opioid prescribing peaked in 2011 but remain over twice as high as prescribing rates in 1999.[9] While the ongoing opioid epidemic is presently driven by synthetic opioids, such as fentanyl, overdose deaths involving prescription opioids in 2021 were still nearly five times the number in 1999.[10] Multiple policies have been put in place to curb the high rates of opioid prescribing that drove the early phase of the opioid epidemic in the U.S., but there is limited evidence on how these policies have influenced fatal motor vehicle crashes.

Since 2010, there have been 4 primary types of state laws designed to curb potentially risky opioid prescribing:[11–15] opioid prescribing cap laws limiting the dose or duration of opioid prescriptions; mandatory prescription drug monitoring program (PDMP) enrollment laws requiring opioid prescribers to enroll in their state's PDMP, giving them access to —but not requiring them to check—the PDMP database; PDMP query laws requiring prescribers to check the PDMP before prescribing an opioid; and pill mill laws regulating pain management clinics to prevent rogue clinics from prescribing opioids without medical indication. Research on how these laws affect opioid prescribing show mixed results due to variation in data, study design, and populations examined.[16–18] Reviews have found limited evidence to support associations between PDMP and pill mill laws and reductions in high-risk opioid prescribing practices, such as high dose prescribing.[16–18] In contrast, opioid prescribing laws have been associated with reductions in prescribing for acute,[16, 19] but not chronic,[15, 20] pain. Studies on mandatory PDMP query and pill mill laws implemented concurrently in Florida have suggested a reduction in fatal vehicle crashes attributable to these laws.[21, 22] In this study, we build upon this prior research to examine the association between state mandatory PDMP enrollment, mandatory PDMP query, pill mill, and opioid prescribing cap laws on fatal crashes.

METHODS

Design

This study was designed to examine state-specific effects of opioid prescribing laws on patterns of fatally injured drivers in a set of states that implemented 1 law of interest and no potentially confounding laws in a 4-year period. Specifically, it was designed to compare changes in trends in fatally injured drivers before and after a state implemented an opioid prescribing law of interest to trends in fatally injured comparison states without the law of interest, or introduction of any confounding laws, over the same period. We identified "treatment states" that implemented 1 of the 4 types of state opioid prescribing laws of interest in 2008 or later and no other opioid prescribing laws or driving under the influence of drugs (DUID) laws–explained in more detail below–2 years before and 1.5–2 years after the law of interest. Treatment states could have other opioid prescribing/DUID laws in place,

so long as those laws were not newly implemented during the study period. Each treatment state and its control group had a distinct 3.5 to 4-year study period.

Thirteen states met these criteria: 4 states implementing opioid prescribing cap laws (Delaware, Kentucky, New York, and Ohio), 2 implementing mandatory PDMP enrollment laws (Colorado and Idaho), 4 implementing mandatory PDMP query laws (New York, Oklahoma, Pennsylvania, and Virginia), and 3 implementing pill mill laws (Mississippi, Ohio, and Texas). Two states (New York and Ohio) were included twice because they implemented 2 different laws with sufficient time between laws to meet inclusion criteria. Nine treatment states had full 4-year study periods, with 2 years of data pre- and post-law. While our initial goal was to include 2 years pre- and 2 years post-law data for all analyses, 4 treatment states (CO, PA, VA, and OH) had post-law periods truncated by 5 or fewer months due to that state's implementation of a DUID law at the end of the study period. Study periods, control states, and law details are shown in Table 1. This research was approved by the Johns Hopkins Bloomberg School of Public Health Institutional Review Board.

Data

We used data from the National Highway Traffic Safety Administration (NHTSA)'s Fatality Analysis Reporting System (FARS). FARS is a nationwide database of fatal crashes occurring on public roadways in the United States reporting on all related deaths within 30 days of a vehicle crash.[23] FARS uses crash scene investigation data reported by each state, which contains vehicle and driver characteristics (including toxicology data) and crash victim characteristics. Importantly, there are major limitations to identifying drug-involved crashes in FARS due to incomplete toxicology testing data.[24] From 2008 through 2019 (the full range of 4-year study periods in our study), just over 46% of drivers were tested for any type of drug. As discussed below, we therefore focused on overall fatal crashes as the primary outcome of interest, with a measure of opioid-involved fatal crashes as a secondary outcome.

The state law data were compiled by public health attorneys using standard legal epidemiology techniques, including systematic searches of statutes and regulations in the Westlaw legal database.[25] Once identified, laws were reviewed to determine their provisions and implementation dates. The legal data included the 4 types of state laws of interest in this study: opioid prescribing cap laws, pill mill laws, and mandatory PDMP query or enrollment laws. We included potentially confounding laws establishing a state PDMP, laws requiring identification to pick up an opioid prescription, laws requiring a physical examination before opioids are prescribed, and "doctor-shopping" laws prohibiting people from seeking overlapping opioid prescriptions from multiple providers. Additionally, data included potentially confounding DUID laws that aim to curb motor vehicle deaths attributable to opioids and other drugs. State DUID laws included "zero tolerance" laws that make it illegal to drive with any measurable amount of specified drugs in the body, and "*per se*" laws that make it illegal for the amount of specified drugs to exceed a set limit.[26, 27] Similarly, states have developed marijuana drug-impaired driving laws particular to THC and THC metabolites that are zero tolerance and non-zero *per se* laws and are included in

our legal mapping.[26, 28] If a state implemented 1 of these laws within 1.5 years of the law of interest, it was ineligible for inclusion as a treatment state, and control states were ineligible if they implemented 1 of these laws during the study period.

Covariates, described below, included state demographic characteristics from the United States American Community Survey (ACS) Census data and information on licensed drivers and average miles traveled by residents of a given state from the Federal Highway Administration Highway Statistics data.[29]

Analytic samples

For each treatment state and its control group, we identified drivers involved in a fatal motor vehicle crash anytime during our 4-year study period as the primary analytic sample. We limited our secondary sample to drivers who had a positive toxicology screen for opioids and died within an hour of the crash, following previous studies using this strategy to reduce measurement error related to missing toxicology screens.[6, 30–32] In our analytic data, 73.1% of drivers who died within an hour of the crash had a toxicology test. We also conducted sensitivity analyses among subsamples of drivers who:1) had a positive toxicology screen for any drug, 2) were involved in a single vehicle crash, or 3) were over 65 years of age; previous studies have shown that the proportion of drivers testing positive for opioids is higher in single vehicle crashes, and drivers over 65 have the highest rates of filled opioid prescriptions and a heightened risk of opioid-involved fatal crashes.[33, 34] Patients were not involved in the research process as it was focused on fatally injured drivers.

Measures

All measures were constructed at the state-month level. State laws were coded as binary indicators that changed from 0 to 1 the first month that a state law was effective for 15 or more days. The main outcome measure was the rate of crashes with fatally injured drivers – hereafter, “fatal crashes” – per 100,000 licensed drivers in the state. The secondary outcome was the rate of opioid-involved fatal crashes per 100,000 licensed drivers. Sensitivity analysis outcomes were the rate of fatal single vehicle crashes per 100,000 licensed drivers and the rate of fatally injured drivers over 65 years old per 100,000 licensed drivers over 65 years old. Covariates were measured at the state-year level and included the median age of the state population, the average vehicle miles traveled on public roads in the state, and the proportions of the state population that were female, were Black, were Hispanic, were living below the federal poverty line, were employed, and had a high school diploma as their highest level of educational attainment.

Statistical Analyses

We used an augmented synthetic control approach.[35] This approach weights control states so that the average outcomes during the pre-law period are identical in the treatment and control states; a weighted combination of control states – the “synthetic control” – estimates what would have happened in the treatment state in the absence of the policy change (the “counterfactual”). By creating a synthetic control that is as similar as possible (on measured characteristics) to the treatment state, we reduce potential confounding and improve ability to make causal inference. In this approach, the estimated effect of the law is the difference-

in-differences in outcomes before and after law implementation in the treatment state and its synthetic control. As the augmented synthetic control approach equalizes the pre-law outcomes in the treatment state and its synthetic control, the law's effect on an outcome at a given post-law time point is the difference in that outcome between the treatment state and its synthetic control at that time. Using the augmented synthetic control approach, our study asked, "What is the effect of a state opioid prescribing law on fatal crashes, and opioid-involved fatal crashes, relative to the expected levels of fatal crashes and opioid-involved fatal crashes in the same population absent the law?"

For the 13 treatment states, we constructed the synthetic control as the weighted average of prelaw outcomes and covariates (described above) that best approximated the prelaw trends in the treatment state. We then augmented the synthetic control approach using a linear regression model to refine the weights and equalize the outcomes in the pre-law period. The regression model controlled for the covariates described earlier and included state fixed effects, which account for unobserved state-specific factors. We estimated the change in outcomes attributable to the law averaged over the entire post-law period as well as month-by-month effects, which allowed us to examine whether the magnitude of change attributable to the law varied over the post-law period. The synthetic control approach, without augmentation, has been used in a wide range of policy evaluation applications[36–40] but has limitations including inference challenges and threats to validity in the absence of excellent pretreatment balance in outcomes and covariates in the treatment state and its synthetic control.[41] The augmented synthetic control approach overcomes these issuing by combining the synthetic control method with a parametric outcome model.[41] Sample analysis code is provided in Appendix Section G.

Results

The state-specific analytic sample sizes and balance in prelaw characteristics between the treatment state and weighted synthetic control of comparison states are shown in Appendix Section A. There was no evidence of nonparallel pre-period trends for outcomes in the augmented synthetic control analyses, shown in the fatal crash time-series graphs in Appendix Section B and the opioid-involved fatal crash time-series graphs in Appendix Section C.

Results of augmented synthetic control analyses showed small-in-magnitude, non-statistically significant changes in fatal crash outcomes attributable to state opioid prescribing laws. In each month post-law, the 13 opioid prescribing laws states were associated with a change of less than 0.50 in the rate of fatal crashes per 100,000 licensed drivers, with 95% CIs not exceeding 1 fatal crash per 100,000 licensed drivers per month in any state. (Figure 1). Changes ranged from a −0.30 (95% CI, −1.17 to 0.57) decrease in the rate of fatal crashes per 100,000 licensed drivers attributable to Mississippi's pill mill law per month, to a 0.14 (95% CI, −0.32 to 0.60) increase in the rate of fatal crashes per 100,000 licensed drivers attributable to Ohio's prescribing cap law per month. The difference-in-differences calculations that produced the outcomes are shown in Appendix Section D. For example, the estimated pre-law rate in Delaware and its synthetic control was 1.33 fatal crashes per 100,000 licensed drivers per month. After implementation of the

prescribing cap law, the estimated monthly rate of fatal crashes per 100,000 licensed drivers in Delaware was 1.14, and 1.22 in the synthetic control ([1.14–1.33]-[1.22–1.33]=−0.08). The result of this difference-in-difference is presented in manuscript figures.

Similar small-in-magnitude and non-statistically significant changes in opioid-involved fatal crashes attributable to the laws were observed. In each month during the post-law period, the 13 opioid prescribing laws states were associated with a change of less than 0.10 in the rate of opioid-involved fatal crashes per 100,000 licensed drivers, with 95% CIs not exceeding 0.20 opioid-involved fatal crashes per 100,000 licensed drivers per month (Figure 2). Changes ranged from a −0.01 (95% CI, −0.10 to 0.08) decrease in the rate of opioid-involved fatal crashes per 100,000 licensed drivers attributable to Mississippi's pill mill law per month, to a 0.10 (95% CI, −0.21 to 0.40) increase in the rate of opioid-involved fatal crashes per 100,000 licensed drivers attributable to Kentucky's prescribing cap law per month. The difference-in-differences calculations that produced these outcomes are shown in Appendix Section E. Results of all sensitivity analyses were consistent with the main findings, except for one statistically significant ($p<0.05$) decrease of −0.21 (−0.34, −0.09) in drug-involved fatal crashes per 100,000 licensed drivers per month attributable to New York's opioid prescribing law. Sensitivity analysis results are shown in Appendix Section F.

DISCUSSION

We did not find an association between state opioid prescribing laws and rates of fatal crashes. Across the 13 treatment states, small-in-magnitude and non-statistically significant changes attributable to the laws were observed for the rates of opioid-involved fatal crashes, drug-involved fatal crashes, single vehicle crashes, and fatally injured drivers over 65 years old. The magnitude of non-statistically significant changes in the rate of fatal crashes attributable to the laws ranged from an increase of 0.14 (−0.32, 0.60) fatal crashes per 100,000 licensed drivers attributable to Ohio's opioid prescribing cap law, to a decrease of 0.30 (−1.17, 0.57) fatal crashes/100,000 licensed drivers attributable to Mississippi's pill mill law. Previous studies on Florida's mandatory PDMP query and pill mill laws suggested these policies reduced driver fatalities, with one study reporting approximately two fewer prescribed-opioid-related fatal crashes every month during the 22 months post-implementation.[21, 22] We measured opioidrelated fatal crashes, not prescription opioid-related fatal crashes, but did not find similar trends in our multi-state analysis. Florida did not meet inclusion criteria for our study as it implemented a voluntary PDMP law at the same time as its pill mill law, and an opioid prescribing cap law at the same time as its mandatory PDMP query law. Thus, it may have been the combined effects of these policies, which our study did not assess, that drove declines in opioid-involved fatal crashes observed in prior work.

Our findings suggest that state opioid prescribing laws are insufficient to help address rising rates of opioid-involved fatal crashes. Another set of laws that states have passed to target driving under the influence of drugs include DUID laws. Implementing these DUID laws is challenging due to the limitations of drug-detecting technology, the lack of an agreed-upon limit to determine impairment, poor officer training to identify drug impairment, and a lack of familiarity among judges and prosecutors on DUID laws as compared to DUI

laws.[26] Further, the current evidence suggests it may never be possible to establish an impairment threshold for drugs where all (or most) drivers have their abilities impaired at concentrations above a certain limit;[42] while zero tolerance DUID laws do not need to establish a threshold for enforcement, these laws need to balance drivers that legally use prescribed opioids as they may have traceable amounts of opioids while under no impairment. As a result of these challenges, federal guidance recommends prioritizing four interrelated components: training on evidence-based drug screening, offering connections to drug treatment, using a period of intensive supervision, and utilization of combined DUI and Drug court procedures.[42] Federal guidance also recommend states test all fatally injured drivers, which would be a significant facilitator for future research involving analysis of drugged driving.

To support federal guidance to prioritize connections to drug treatment, expanded access to medications for opioid use disorder (MOUD) is needed. Treatment with FDA-approved MOUDs including buprenorphine, methadone, or naltrexone is the gold-standard of treatment for opioid use disorder.[43, 44] Recent policy changes have begun to expand access. For example, at the federal level, prescribers no longer need to obtain a waiver from the Drug Enforcement Agency (DEA) to prescribe buprenorphine for opioid use disorder; and the Substance Abuse and Mental Health Services Administration (SAMHSA) has made permanent a COVID-era rule expanding eligibility allowances for take-home doses of methadone.[45–47] At the state level, there are many ongoing policy initiatives – 82 laws with one or more MOUD expansion policy across 16 states in 2019 – aiming to expand access to MOUD via insurers, hospitals, and the criminal justice system, among others. [48] Future research is needed to understand the spillover effects of expanded MOUD access on rates of opioid-involved fatal crashes.

This study is subject to several limitations. First, there are limitations in using FARS data to identify drug-involved drivers due to incomplete state-level toxicology testing data.[24] Following previous studies, we limited our sample of opioid-involved fatal crashes to drivers who died within an hour of the crash which increased the testing rate nearly 30% across the entire sample. Additionally, we focused our results on reporting the rate of fatally injured drivers and included several sensitivity analyses using characteristics demonstrating higher risk of opioid use or opioid-involved fatal injury. Second, we included drivers who tested positive for opioids without being able to determine whether the opioids led to impairment of the driver; unlike alcohol-impaired driving, there is no consistent criteria for measuring drug impairment, so we are assuming that any presence of opioid presupposes impairment responsible for the crash. Studies have shown that prescription opioid use increases risk of fatal car crashes,[7, 8] so we assumed a positive test contributed to driver impairment. In order to isolate the effects of the opioid prescribing laws of interest on outcomes, we limited the study period to two years pre- and 1.5–2 years post- the laws of interest. While a longer time series is beneficial for establishing trends, in our case lengthening the study period introduced confounding from other types of state opioid prescribing laws. Lastly, we are unable to measure differences in implementation and enforcement across states, which may have differentially influenced the impacts of the law.

CONCLUSION

Across the 13 states in this study, there were small-in-magnitude and non-statistically significant changes in the rate of fatal crashes and opioid-involved fatal crashes attributable to the laws. Improved toxicology data collection on fatally injured drivers across states is urgently needed to support future research on strategies to address opioid-involved fatal crashes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Key Messages:

- Previous single-state studies have shown opioid prescribing laws were associated with reductions in opioid-involved fatal crashes. No prior work has measured the impact of these laws on fatal crashes in a multi-state analysis.
- We did not find an association between state opioid prescribing laws and rates of fatal crashes during the two years after passing a law of interest across our 13 study states.
- Our findings suggest that state opioid prescribing laws are insufficient to help address rising rates of opioid-involved fatal crashes.

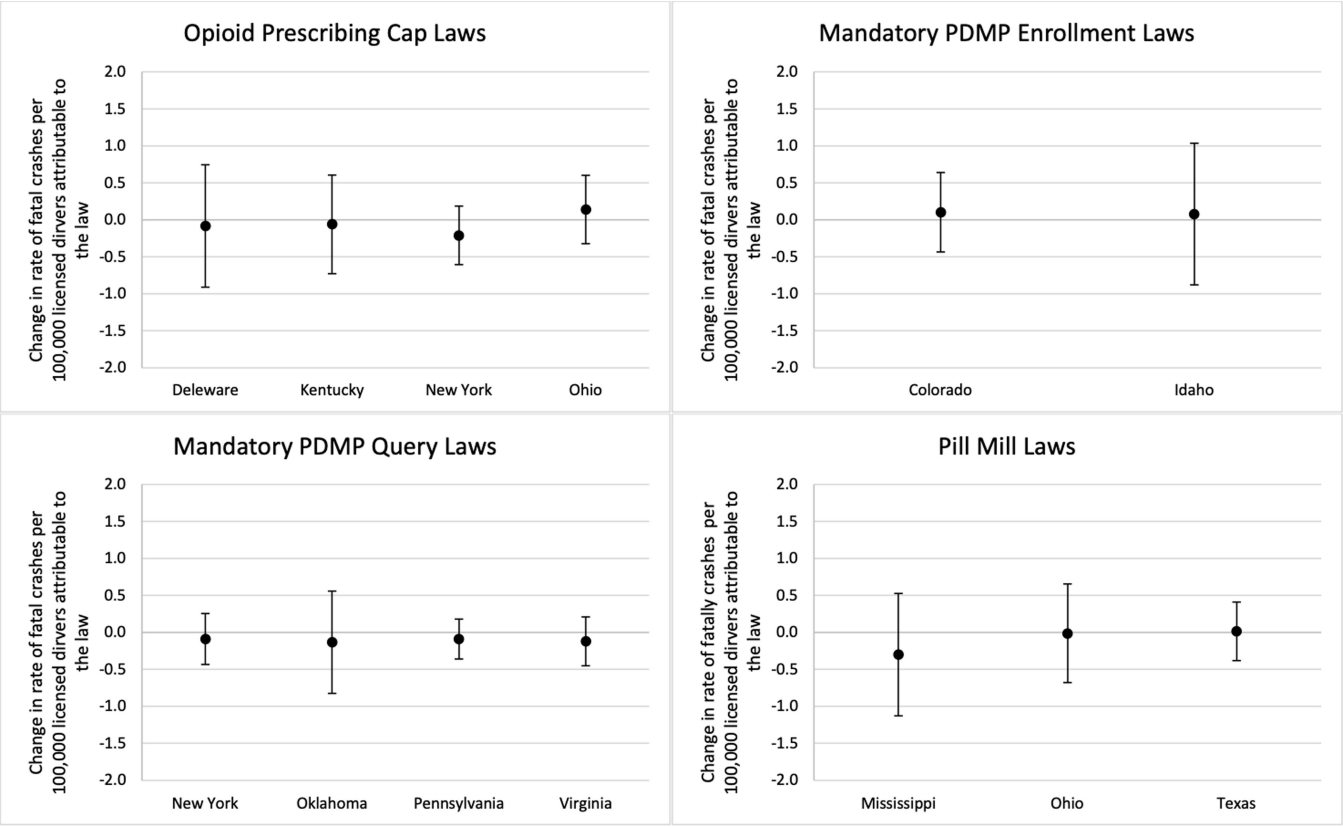

Figure 1. Changes in the rate of fatal crashes per 100,000 licensed drivers, per month, attributable to the law in its first 2 years of implementation in 13 U.S. states

PDMP = prescription drug monitoring program. Notes: This difference-in-difference outcome is the average treatment effects of opioid prescribing policies on the rate of fatally injured drivers, measured as the number of fatally injured drivers per month divided by the number of licensed drivers in the state. The sample sizes of fatally injured drivers per cohort include: Delaware cap law (17,580), Kentucky cap law (16,301), New York cap law (15,718), Ohio cap law (17,574), Colorado PDMP enrollment law (48,131), Idaho PDMP enrollment law (55,022), New York PDMP query law (49,748), Oklahoma PDMP query law (49,868), Pennsylvania PDMP query law (48,117), Virginia PDMP query law (44,060), Mississippi pill mill law (51,788), Ohio pill mill law (53,270), Texas pill mill law (66,817).

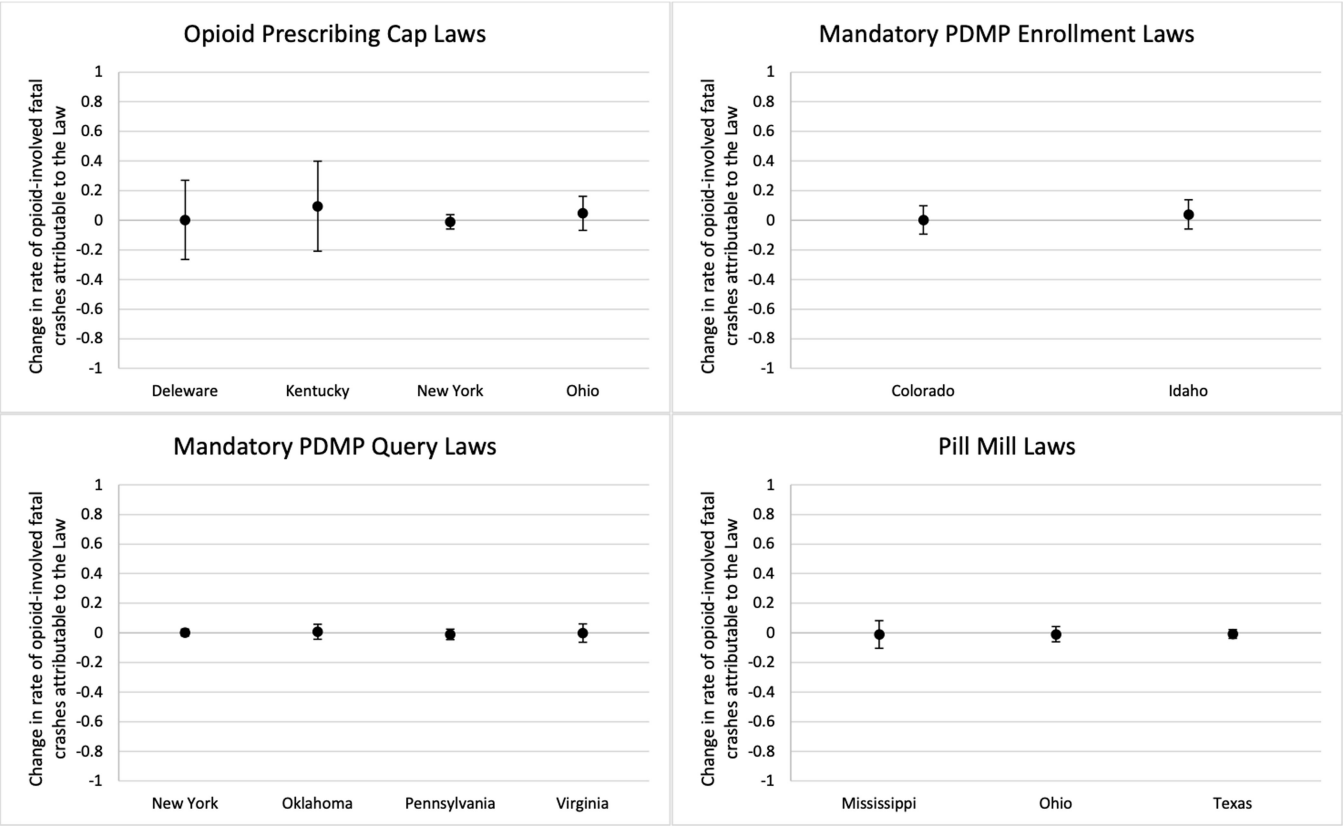

Figure 2. Changes in the rate of opioid-involved fatal crashes per 100,000 licensed drivers, per month, attributable to the law in its first 2 years of implementation in 13 U.S. states

PDMP = prescription drug monitoring program. Notes: This difference-in-difference outcome is the average treatment effects of opioid prescribing policies on the rate of fatally injured drivers who tested positive for opioids, measured as the number of fatally injured drivers who tested positive for opioids and died within an hour of the crash per month divided by the number of licensed drivers in the state. The sample sizes of fatally injured drivers who tested positive for opioid and died within an hour of the crash per cohort include: Delaware cap law (450), Kentucky cap law (771), New York cap law (414), Ohio cap law (631), Colorado PDMP enrollment law (1,159), Idaho PDMP enrollment law (1,329), New York PDMP query law (872), Oklahoma PDMP query law (1,338), Pennsylvania PDMP query law (1,256), Virginia PDMP query law (1,178), Mississippi pill mill law (873), Ohio pill mill law (1,021), Texas pill mill law (1,163). Across all 13 treatment states and their control groups, the sample included 12,455 unique fatally injured opioid-involved drivers.

Table 1.

Thirteen U.S. states that implemented opioid prescribing laws and their control states

State Law	Date Implemented	Key Provisions	Study Period	Control States	Analytic Sample Size of Treatment and Control States
Opioid Prescribing Cap Law					
Delaware	4/1/17	Limits initial opioid prescriptions (all schedules) for acute pain to a 7 days' supply	4/1/15–3/31/19	AL, IA, KS, MS, MT, ND, NM, OR, TN, WY	Total fatally injured drivers N=17,580
Kentucky	7/1/17	Limits all schedule II opioid prescriptions for acute pain to a 3 days' supply	7/1/15–6/30/19	AL, IA, KS, MS, MT, ND, NM, OR, WY	Total fatally injured drivers N=16,301
New York	7/22/16	Limits initial schedule II-IV opioid prescriptions for acute pain to a 3 days' supply	8/1/14–7/31/18	AL, IA, KS, MS, MT, ND, OR, WY	Total fatally injured drivers N=15,718
Ohio	8/31/17	Limits initial opioid prescriptions (all schedules) for acute pain to a 7 days' supply and 30 MME/day and initial opioid prescriptions for chronic non-cancer pain to a 7 days' supply and 120 MME/day	9/1/15–8/31/19	AL, IA, KS, MS, MT, ND, NM, OR, WY	Total fatally injured drivers N=17,574
Mandatory PDMP Enrollment Law					
Colorado	1/1/15	Prescribers must be enrolled in the PDMP to prescribe a controlled substance	6/1/13 *–12/31/16	AK, AZ, FL, IA, KS, KY, LA, MI, MO, MS, MT, NC, ND, NE, NM, OR, SC, SD, TN, UT, WA, WY	Total fatally injured drivers N=48,131
Idaho	7/1/14	Prescribers must be enrolled in the PDMP to prescribe a controlled substance	7/1/12–6/30/16	AK, CA, AZ, DE, FL, IA, KS, KY, LA, MI, MN, MO, NC, ND, NE, OR, SC, SD, UT, WA, WV, WY	Total fatally injured drivers N=55,022
Mandatory PDMP Query Law					
New York	8/27/13	Prescribers must check the PDMP every time they prescribe an opioid to any patient	9/1/11–8/31/15	AK, AZ, CA, IA, FL, LA, KS, MO, MI, MN, NC, ND, OR, SD, UT, WY	Total fatally injured drivers N=49,748
Oklahoma	11/1/15	Prescribers must check the PDMP for every new opioid prescription and for refills <180 days since the last check	11/1/13–10/31/17	FL, GA, IA, KS, KY, LA, MI, MO, MS, MT, ND, NE, NM, OR, SD, TN, WV, WY	Total fatally injured drivers N=49,868
Pennsylvania	6/30/15	Prescribers must check the PDMP every time they prescribe an opioid to a new patient	10/1/13 *–6/30/17	FL, GA, IA, KS, KY, LA, MI, MO, MS, MT, ND, NE, NM, OR, SD, TN, WV, WY	Total fatally injured drivers N=48,117
Virginia	7/1/15	Prescribers must check the PDMP for every new opioid prescription	10/1/13 *–6/30/17	FL, GA, IA, KS, KY, MI, MO, MS, MT, ND, NE, NM, OR, SD, TN, WV, WY	Total fatally injured drivers N=44,060
Pill Mill Laws					
Mississippi	3/1/11	Requires that pain clinics be owned by a physician with an unrestricted Mississippi license who has not been convicted of a crime related to illegal distribution of controlled substances; that clinic owners meet pain management certification requirements; and that pain clinics	3/1/09–2/28/13	AL, AZ, CO, IA, ID, IL, IN, LA, MI, MO, NC, NV, NY, ND, OK, PA, RI, SC, VA, WY	Total fatally injured drivers N=51,788

State Law	Date Implemented	Key Provisions	Study Period	Control States	Analytic Sample Size of Treatment and Control States
		undergo annual certification renewal through the State Board of Medical Licensure			
Ohio	7/1/11	Requires that pain clinic owners supervise all persons who provide chronic noncancer pain treatment at the clinic; that clinic owners meet pain management certification requirements; and that pain clinics undergo annual verification of licensure through the State Medical Board	7/1/09–5/28/13 *	AL, AZ, CO, IA, ID, IL, IN, LA, MA, MI, MO, NC, NV, NY, ND, OK, PA, RI, SC, VA, WY	Total fatally injured drivers N=53,270
Texas	9/1/10	Requires that pain clinics be owned by a physician with an unrestricted Texas license who has not been convicted of a felony or misdemeanor related to distribution of prescription drugs and that pain clinics undergo biennial certificate renewal by the State Medical Board	9/1/08–8/31/12	AL, AZ, CO, CT, ID, IL, IN, LA, MA, MI, MO, NC, NV, NY, OK, PA, RI, SC, TN, VA, WV, WY	Total fatally injured drivers N=66,817

MME = morphine milligram equivalents; PDMP = prescription drug monitoring program.

* This study period was shortened due to a study state implementing a potentially confounding DUID law during the 48-month study period; Ohio's Pill Mill study period was reduced by 1 month in the post-period due to a DUID law implemented in a control state (CO); Pennsylvania's and Virginia's Mandatory PDMP Query study periods were reduced by 3 months in the pre-period due to the same DUID law implemented in a control state (MT); Colorado's Mandatory PDMP Enrollment study period was reduced by 5 months in the pre-period due to a DUID law implemented in the treatment state (CO).