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Impact of Florida's prescription drug monitoring program on drug- related fatal vehicle crashes: a difference-in-differences approach

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ABSTRACT

Background Prescription drug use has soared in the USA within the last two decades. Prescription drugs can impair motor skills essential for the safe operation of a motor vehicle, and therefore can affect traffic safety. As one of the epicentres of the opioid epidemic, Florida has been struck by high opioid misuse and overdose rates, and has concurrently suffered major threats to traffic disruptions safety caused by driving under the influence of drugs. To prevent prescription opioid misuse in Florida, Prescription Drug Monitoring Programs (PDMPs) were implemented in September 2011.

Objective To examine the impact of Florida's implementation of a mandatory PDMP on drug-related MVCs occurring on public roads.

Methods We employed a difference-in-differences approach to estimate the difference in prescription drug-related fatal crashes in Florida associated with its 2011 PDMP implementation relative to those in Georgia, which did not use PDMPs during the same period (2009–2013). The analyses were conducted in 2020.

Results In Florida, there was a significant decline in drug-related vehicle crashes during the 22 months post-PDMP. PDMP implementation was associated with approximately two (−2.21; 95% CI −4.04 to −0.37; p<0.05) fewer prescribed opioid-related fatal crashes every month, indicating 25% reduction in the number of monthly crashes. We conducted sensitivity analyses to investigate the impact of PDMP implementation on central nervous system depressants and stimulants as well as cocaine and marijuana-related fatal crashes but found no robust significant reductions.

Conclusions The implementation of PDMPs in Florida provided important benefits for traffic safety, reducing the rates of prescription opioid-related vehicle crashes.

INTRODUCTION

The overall use of prescription drugs has increased among US adults over the last two decades.[1–3] Prescription drugs, especially opioids and central nervous system (CNS) depressants, can impair the functioning of motor skills that are essential for the safe operation of a motor vehicle[4 5] and significantly increase the risk of fatal crash involvement.[4 6 7] The prevalence of prescription opioid use in drivers who died in fatal crashes increased from 1% to 7% between 1995 and 2015 in the USA.[7 8] Motor vehicle injuries along with drug overdoses are the leading causes of unintentional injury death.[9 10]

Florida has been one of the epicentres of the opioid epidemic. In 2010, ninety of the top 100 oxycodone-purchasing physicians and 49 of the top 50 oxycodone-dispensing clinics in the USA were located in Florida.[11] Also, drugged driving has been an important traffic safety issue in the USA and especially in Florida.[12] Our analysis of the Fatality Analysis Reporting System (FARS) data shows that, in 2010, nearly 5% and 10% of vehicle crash fatalities in Florida involved a driver who tested positive for prescription opioid and all prescription drugs, respectively.[13] From 2001 to 2013, 52% of all drug-related fatalities in Florida were unintentional (eg, MVCs, falls, drowning).[14]

In September 2011, Florida implemented a mandatory Prescription Drug Monitoring Program (PDMP) for both prescribers and dispensers to help address its prescription drug epidemic.[15] Under a PDMP, prescribers and dispensers have access to online systems that enable them to check patient information, such as the number and type of prescriptions, and identify high-risk individuals based on their prescription history and preventing drug interactions.[16 17] Additionally, PDMPs help prescribers identify individuals who visit multiple prescribers and dispensers to obtain prescriptions (referred to as 'doctor shopping') and restrict drug diversion and reduce misuse-related harms including drug-related fatal crashes.[17 18] The success of the PDMPs heavily depends on the legal characteristics of the PDMPs. States that mandated the utilisation of the PDMP for all prescribers, dispensers and pharmacies might have better control over the prescribed drugs. Also, the frequency of updating the patient records on the PDMP system is an essential factor and limits high-risk individuals' access to prescribed drugs. Updated data collection within the PDMP system varies among states and ranges from the point of sale to up to 14 days. Florida has mandatory query of the PDMP by prescribers and dispensers, and they should update the system no longer than the next business day.[19] Only 1 year after PDMP implementation in Florida, 18 000 prescribers registered with the PDMP, and 2.3 million queries of the PDMP system were reported.[20]

Recent research found that Florida's PDMP was associated with a 1.4% decrease in opioid prescriptions and a 2.5% decrease in opioid volume 1 year after PDMP implementation.[21] Another study reported a significant decline in diversion rates for

prescription drugs such as oxycodone, methadone, morphine and hydrocodone after Florida's PDMP implementation. From the first quarter of 2010 to the third quarter of 2012, oxycodone and hydrocodone diversion rates decreased from 49.8 per 100 000 population to 7.6, and from 21.2 per 100 000 population to 5.4, respectively.[22] After the PDMP was implemented, oxycodone-caused mortality also declined by 25% in Florida.[23]

While research has focused on the effect of the PDMP implementation in Florida on opioid prescriptions and diversion, the impact of PDMP on drug-related fatal vehicle crashes remains unknown. To address this research gap, we use a difference-in-differences (DID) approach to analyse a census-level database of fatal crashes on Florida roadways to evaluate the impact of its PDMP implementation on prescription drug-related crashes compared with a neighbouring state, Georgia, which did not implement a PDMP.

METHODS

Study setting and design

This retrospective longitudinal study included drivers involved in fatal vehicle crashes on public roadways who tested positive for prescribed drugs. To determine the change of drug-related fatal vehicle crashes in the state of Florida attributable to the PDMP implementation, we compared the number of drug-related fatal vehicle crashes in Florida (the treatment group) and Georgia (the control group) before and after PDMP implementation.

We chose Georgia as the control group because it shares many similarities with Florida. The states are neighbours and are similar in size and weather patterns. Commuting characteristics in Florida and Georgia are almost identical, and their population's sociodemographic makeup (eg, education, income and poverty rate) is also comparable (online supplemental appendix table 1).[24] Moreover, Georgia did not have an operational PDMP during the analysis period.

Study sample and data

We used the FARS database, which is a nationwide, annual census-level database of all fatal crashes occurring on US public roadways.[13] FARS is compiled by the US National Highway Traffic Safety Administration using data from crash scene investigations reported by each state. FARS provides detailed information on each crash including location, vehicle characteristics, driver characteristics, crash victims and toxicology data. However, there are limitations and complexities on drug-involved driving in the FARS data set. From 2008 to 2012, half of drivers involved in fatal motor vehicle traffic crashes were not tested for drugs in the USA. In general, testing rates in FARS are higher for drivers who died in crashes. In addition, the FARS data set informs only about drug presence but not the concentration of a prescription drug, therefore, testing positive does not necessarily mean impaired by the drug, and policies or procedures for testing procedures may vary across states.[25] The percentage of drug testing of fatally injured drivers varies widely among the states. We examined all fatal crashes in which drivers tested positive for prescribed drugs in toxicological testing conducted by the states of Florida and Georgia for drivers suspected of drugged driving. In 2009, 58% and 52% of drivers involved in fatal motor vehicle traffic crashes were tested for drugs in Florida and Georgia.[26] Both states report no drivers with unknown testing status.

We included prescription drugs such as opioids, CNS depressants or stimulants in the analysis. We conducted the analysis for all prescription drugs and then repeated it for each category (ie, opioids, CNS depressant and stimulant). The main outcome of the study was the number of monthly fatal motorised vehicle crashes where a driver involved tested positive for prescription drugs in blood and/or urine in toxicological testing. Moreover, it is possible that the PDMP may have resulted in a substitution of prescription drugs for illicit drugs such as cocaine, marijuana or heroin. We conducted sensitivity analyses and included these schedule-I drugs.

We included data from 1 January 2009 to 30 June 2013 (right before the implementation of PDMP in Georgia in July 2013). Hence, our data include fatal crashes in the 32 months before and 22 months after Florida's PDMP implementation in September 2011. In total, 990 prescription drug-related vehicle crashes were reported in Florida during the course of the analysis. This includes 606 cases before and 384 cases after Florida's PDMP implementation. In Georgia, 482 prescription drug-related fatal vehicle crashes were reported, including 274 crashes before and 208 crashes after Florida's PDMP implementation (see figure 1).

We used drug-related vehicle crash counts as the main analysis input. To ensure that our count-based analysis is robust, we investigated vehicle miles travelled in both states as well as changes in monthly populations over time. We used monthly gasoline consumption obtained from the US Department of Transportation as a proxy for vehicle miles travelled in Florida

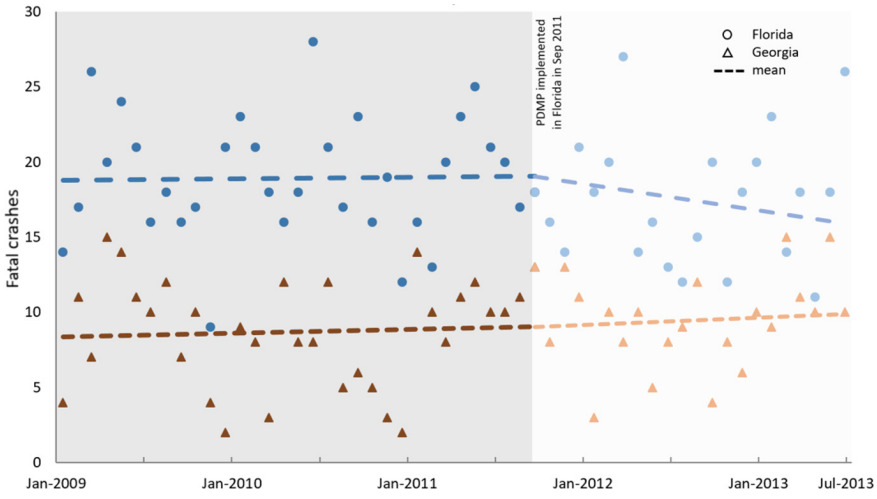

Figure 1 Average prescription drug-related vehicle crashes in Florida and Georgia before and after Prescription Drug Monitoring Program (PDMP) implementation in Florida.

and Georgia.[27] Online supplemental appendix figure 1 shows that slopes of vehicle miles travelled trends were the same in both states. We also inquired about potential policies implemented during the time of this analysis. We used the national population estimates to calculate drug-related vehicle crash rates.[28 29] Additional sensitivity analyses were conducted using population-based rates to control for population changes—the results were similar (see the Results section); hence, count is a robust unit of measure during the course of this analysis.

Statistical analysis

We used DID regression analysis to estimate the difference in prescription drug-related fatal crashes in Florida. The DID methodology is a quasiexperimental design that is widely used to examine the causal impact of health policies and interventions.[30] It is a rigorous method when attention is focused on specification choice. We followed the checklist proposed for DID analysis to validate the accuracy of estimates in the DID model.[31] Additionally, we conducted further sensitivity analyses using negative binomial regression.

We defined an indicator variable for pre-PDMP versus post-PDMP implementation. This was assigned a value of 0 and 1 for before and after Florida's PDMP implementation, respectively. We also defined another indicator variable that was assigned a value of 1 if the crash occurred in Florida and a value of 0 if the crash occurred in Georgia. The analyses were conducted in 2020 using Stata SE V.15.1 (College Station, Texas) statistical package.

RESULTS

Figure 1 shows average prescription drug-related fatal vehicle crashes in Florida and Georgia before and after PDMP implementation in Florida (September 2011). A difference in trends in the data was not statistically significant between Florida and Georgia prior to September 2011, and thus the parallel trends assumption required for the DID analysis was not rejected. Data period selection confirms that data exist on the study outcomes before and after the policy implementation for both treatment and control groups. We also performed the Dickey-Fuller test to make sure the baseline outcome levels were unrelated to expectations of changes over time. A Breusch and Pagan test confirmed that standard statistical assumptions were appropriately addressed, and study outcomes are homoscedastic.

Results from the DID analysis are presented in table 1. The results suggest that PDMP implementation in Florida was associated with lower opioid-related monthly vehicle crashes (−2.21; 95% CI −4.04 to −0.37; p<0.05). Thus, the PDMP resulted in two fewer monthly opioid-related fatal crashes in Florida. While prescription CNS depressant-related vehicle crashes were marginally decreased at p<0.1 level (−1.86; 95% CI −3.48 to −0.23), no significant changes were observed in all categories or stimulants.

We repeated the DID analysis using negative binomial regression because the outcome is a count variable. Results were substantively the same as those acquired using the linear DID model (see online supplemental appendix tables 2–4), building more confidence in our DID analysis.

We also examined illicit drug-related fatal crashes and found no statistically significant difference in the number of cocaine-related vehicle crashes before and after PDMP implementation. We found a marginal decrease in the number of marijuana-related crashes at the marginal significance level of p<0.1 (see online supplemental appendix table 5). There were not enough observations to conduct the analysis for heroin-related vehicle crashes.

In addition, we repeated the DID analysis using per capita rates of prescription drug-related vehicle crashes (see online supplemental appendix table 6). The results were similar to those of the count-based DID, indicating that PDMP implementation in Florida was associated with lower prescription opioid-related vehicle crash rates (−0.014 fatal crashes per 100 000 population; 95% CI −0.028 to −0.0277; p<0.05), which are approximately equal to 2.7 fewer monthly fatal crashes. It should be noted that the marginal decrease in CNS depressant at p<0.1 (table 1) was not observed in our rate-based sensitivity analysis (online supplemental appendix table 6). Finally, we repeated the analyses using number of fatalities instead of number of fatal crashes, but results did not substantively change (online supplemental appendix table 7).

Table 1 DID model results for prescription drug-related fatal vehicle crashes pre-PDMP and post-PDMP implementation in Florida compared with Georgia*

	Monthly fatal crashes†			
Variable	**All categories**	**Opioids**	**CNS depressant**	**Stimulant**
Before PDMP implementation (January 2009 to August 2011)				
Control: Georgia	8.56	3.47	4.88	2.97
Treated: Florida	18.94	8.31	9.69	7.13
Treatment-control difference (*A*)	10.38***	4.84***	4.81***	4.16***
After PDMP implementation (September 2011 to June 2013)				
Control: Georgia	9.45	4.05	4.91	3.87
Treated: Florida	17.45	6.68	7.86	7.41
Treatment-control difference (*B*)	8.00***	2.64***	2.95***	3.54***
Difference in differences				
(*B-A*)	−2.38	−2.21**	−1.86*	−0.62
95% CI	−5.34 to 0.59	−4.04 to −0.37	−3.48 to −0.23	−2.50 to 1.28

*Linear regression model estimates are based on the data from the Fatality Analysis Reporting System (FARS) database. We included fatal crashes in which drivers tested positive for prescribed drugs in toxicological testing.
†***P<0.01; **p<0.05; *p<0.10.
CNS, central nervous system; DID, difference in differences; PDMP, Prescription Drug Monitoring Program.

DISCUSSION

Our analysis examined the impact of PDMP implementation on prescription drug-related fatal vehicle crashes on public roads in Florida. Our results showed that PDMP implementation in Florida was associated with approximately two fewer prescribed opioid-related vehicle crashes per month when compared with Georgia, which did not have an operational PDMP during the study period. However, we found no statistically significant differences in CNS depressant, stimulant or all drug-related fatal crashes pre-PDMP and post-PDMP.

Our findings were consistent with the results of another study that explored the impact of the New York's PDMP, known as Internet System for Tracking Over-Prescribing (I-STOP). They found that the number of opioid prescriptions declined following the implementation of the I-STOP programme.[32] Other studies in Florida also reported a significant reduction in the number of opioid prescriptions and opioid-related mortalities after PDMP implementation.[23 33] Little is known about the impact of Florida's PDMP implementation on prescription drugs other than opioids, but our study suggests a differential impact of the PDMP on opioid-related crashes versus other drug-related crashes. More research is needed to explore reasons for this differential impact.

From 2010 to 2015, 80% of counties in Florida reported a decrease in the number of opioid prescriptions per capita.[33] It is feasible that restricting of access to frequently misused prescribed medications may result in substitution with illicit drugs such as heroin, cocaine or marijuana.[34 35] However, our analysis did not indicate any significant change (at 0.05 significance level) in drugged-driving fatal vehicle crashes due to these potential substitute drugs.

This study is subject to limitations. We included drivers who tested positive for prescribed drugs involved in fatal vehicle crashes without distinction as to whether or not the drug itself caused the vehicle operator any impairment leading to the crash. Unlike alcohol-impaired driving, there are no established, consistent criteria for identifying drug-impaired driving. However, it is well researched that drug use (including the use of opioids, CNS depressants and stimulants) is associated with a significantly increased risk of fatal crash involvement,[6] therefore, we assumed that a positive drug test result is likely to contribute to the impairment of a motor vehicle operator. There were not enough observations to stratify and analyse age and sex-specific crash rates. Finally, our study does not stratify multidrug combinations and concurrent use of alcohol as associated factors for crashes, and therefore our findings may be conservative estimates of the impact of the PDMP. Future research is needed to examine the impact of PDMPs on traffic crashes involving alcohol or multidrug use.

The overall number of car crash fatalities from all causes decreased by 6% and 8.7% from 2009 to 2013 in Florida and Georgia, respectively.[36 37] We chose Georgia as the control group for the DID analysis because Georgia is geographically proximate to Florida and has similar population sociodemographics and commuting characteristics; but Georgia did not have a PDMP in place during the study period. Thus, the use of Georgia for the DID analysis allows the estimation of a counterfactual trend in fatal vehicle crashes for Florida in the absence of the PDMP. We also studied potential policies implemented during the time of this analysis. For example, the DEA crackdown on pill mills started in Florida in February 2010,[38] but during the following 19 months until the implementation of PDMP (February 2010 to September 2011), the slopes of the average lines for prescription drug-related fatal vehicle crashes in Florida and Georgia remain the same (see figure 1). However, possible unobserved changes in state policies that significantly impacted traffic safety in either Florida or Georgia post-PDMP may have affected the DID estimates.

Finally, the economic cost of vehicle crashes such as the loss of productivity, medical costs and property damages is approximately 2% of the total US domestic product.[39] Therefore, empirical studies evaluating the cost-effectiveness of PDMP implementation are warranted. Future research can also investigate the generalisability of our findings by conducting similar analyses in other states. Moreover, given that the opioid crisis is a multilayer complex public health problem,[40] further research can employ systems science methods such as simulation modelling to project the future effects of policy scenarios,[41] and conduct economic evaluation of these policies.[42]

CONCLUSIONS

PDMP implementation in Florida resulted in two fewer monthly opioid-related fatal vehicle crashes on public roads (24.8% decrease) and a marginal decrease in prescription CNS depressant-related vehicle crashes. Also, no significant changes were observed in all categories, stimulants and illicit drugs. Our findings suggest that PDMP policies may have essential secondary benefits in improving public health outcomes such as traffic safety in response to the prescription drug misuse in the USA.

What is already known on the subject

- Prescription drugs can impair the functioning of motor skills essential for the safe operation of a motor vehicle.
- Prescription drugs can affect traffic safety and increase the chance of involvement in an MVC.
- The prevalence of prescription opioid use in drivers who died in fatal crashes increased in the USA in the last two decades.

What this study adds

- The implementation of the Prescription Drug Monitoring Program (PDMP) in Florida provided important benefits for traffic safety.
- PDMPs reduced the rates of prescription opioid-related vehicle crashes in Florida.
- No changes were observed in central nervous system depressants, stimulants, and cocaine and marijuana-related fatal crashes after PDMP implementation in Florida.

Contributors MT as the corresponding author is responsible for data integrity and data analysis accuracy, and performed the statistical analyses, drafted the manuscript and had full access to all study data. All authors (MT, MSJ, HJT, LWC, OMA and FAW) contributed to concept and design, and critically revised the manuscript for important intellectual content. They approved the final version of the manuscript and are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. MT and FAW provided administrative, technical and material support.

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