

Estimating the Impact of Opioid Control Policies

Technical Report

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Motivation

The purpose of this report is to measure the effect of various state-wide policy interventions aimed to limit the prescription of opioids in hopes of decreasing deaths due to overdoses.

Prescription opioids were first introduced in 1990 to treat forms of cancer and aid post-surgery recovery, however by 2007, we see a rise in advertisements for opioids by major pharmaceutical companies along with the malpractice of over-prescribing pain medication. Patients with chronic illnesses continue to take opioids over long periods of time in higher dosages which can significantly increase the risk of developing an addiction to opioids. From what we have seen, the rise in the prescription of opioids has led to an increase in opioid imports, prescription overdose deaths and deaths due to synthetic opioids sold on the street like heroin and fentanyl. Synthetic opioids are significantly more potent than monitored drugs, making it much easier to overdose if the improper dosage is taken.

Florida, Texas, and Washington implemented policies to limit the prescription of opioids in hope of seeing a decline opioid abuse and overdose deaths. More protocols were put in place to take into consideration the likelihood of an opioid addiction occurring in patients that required medication for pain relief. Florida saw a major spike in the prescriptions in 2010 followed by statewide raids and the closure of pain clinics which led to the state legislature prohibiting the dispensing of schedule I and II drugs from medical offices. The state implemented guidelines that required patient evaluations before prescriptions and conducting periodic reviews and in 2012 a task force was assembled to regulate wholesale drug distributors. Washington enacted similar practices in 2012 and Texas administered a prescription threshold of 120 mg. Each state has put in place slightly different policies and through our analysis we will be examining if these policies effected opioid shipments and deaths due to opioid overdoses.

Methods

To measure the effect of each states' policy intervention on opioid imports and overdose deaths we will employ two strategies to gage policy effect: pre-post and difference-in-difference comparison.

The pre-post comparison will tell us if there was a difference in observations before and after the policy was put in place. For example, we would fit the trend before and after Florida's policy was put in place. If the policy had an effect, there would be a decrease in opioid shipments and overdose mortality after policy emplacement; however, if there was no effect, we would see the shipments and mortality continue to increase. With this method, we could falsely attribute policy effect to a decline in overdose deaths when there could be other factors contributing to the change. Around 2010, the US Customs service started regulating the importation fentanyl into the States and if we were just to compare the amount of overdose deaths for Florida in 2009 to Florida in 2011, we would see a decline due to something that occurred nationally and not just in Florida. To account for this we also require another form of analysis that compares whether the change in Florida is larger than the change in other states that did not implement any policies.

Our second form of analysis is difference-in-difference which examines if the changes in overdose deaths in Florida between 2009 and 2011 are bigger than in other states that didn't change their opioid policy. For each of the three states, we have picked reference states that did not implement any opioid regulation practices and followed the same trend as its policy state. If the reference states continue to show a positive trend for overdose deaths after 2011 and Florida now has a negative trend, we can say that Florida's policy did effect overdose mortality.

Data

To conduct our analysis, we will be utilizing three different datasets that provide us information on the import of opioids, deaths due to overdoses and population for the states we are examining. We retrieved data regarding opioid shipments from the *Washington Post* (<https://www.washingtonpost.com/graphics/2019/investigations/dea-pain-pill-database/>), specifically the amount of opioids prescribed over every month from 2006 to 2012. The *US Vital Statistics* supplied us with information on overdose deaths separated by county. To compare

these amounts to the entire population we used population data from the *National Historical Geographic Information System* (<https://www.nhgis.org/>) which had census population data separated by county. To standardize the counties from the population data with the other two datasets, we added FIPS codes to all datasets to make sure we were merging data on appropriate counties since county names were not consistent across all datasets.

Summary Statistics

(Will add summary statistic tables, in progress)

For this project, we mainly use two different datasets to investigate if different policies have an impact on the shipment and mortality rates in their respective states. In the shipment dataset, to compare the effects that took place in Florida, we used Arizona, Louisiana, and South Carolina as the control states. We saw higher averages for opioid dosage after 2010 from Arizona and South Carolina prior to imputation. For Washington analysis, we pick Colorado, Arizona, and New York as reference state and found that all states show a higher mean of opioid shipment after 2012.

There were some missing values in the mortality data, so we employed K-Nearest Neighbors to impute based on other features in the dataset like year, county, population, and state. To compare against Florida's mortality data, we picked Louisiana, Nevada, and Colorado as control states. We found top 3 counties which have highest death rate during a state for the year which has the highest mean opioid dosage use. For Washington death rate analysis, we also pick three states (OR, OK, HI) as references. We found that all states show the downtrend of death rate after 2012. Among the statistics, the change of mean values in OK shows an apparent decline. For Texas, we pick (WI, NY, OR) and compare the effect of the policy change before and after 2007, we found that except for Texas, other three states show the increasing rate of death, though all of them don't show big differences of mean values between changes.

From the overview of summary statistics, we found that the results of death rate and shipment analysis are quite different, so deeper results will be found in the next two analyses.

Analysis/Interpretation

Florida:

Shipment Rate

Reference States: South Carolina, Louisiana, Arizona

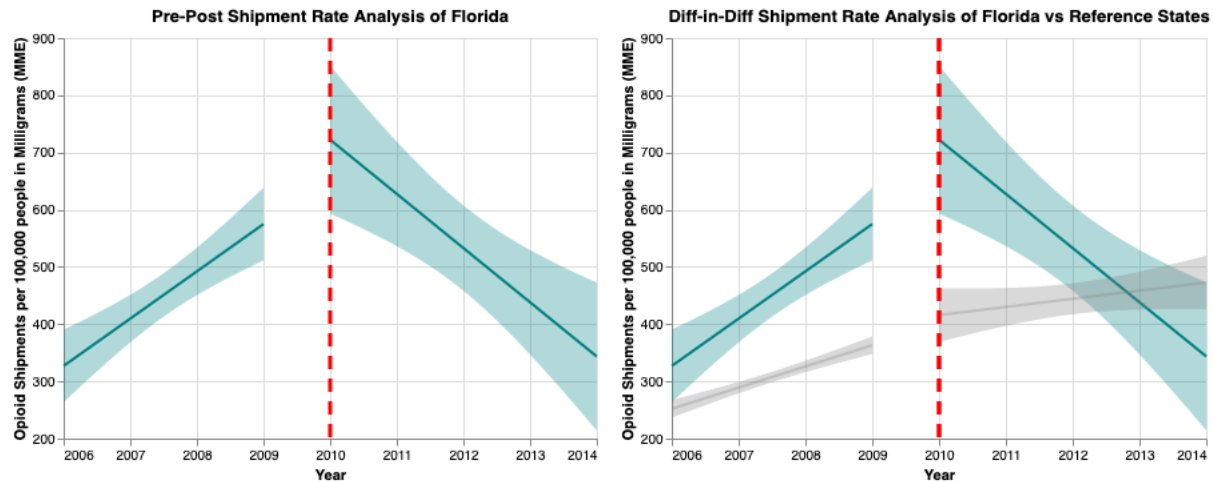


Figure 1 Caption: The graph on the left shows the trend of opioid shipments for Florida segmented before and after the state's policy to restrict the prescription of opioids was implemented. The graph on the right compares Florida's opioid shipments against control states that did not implement any policies (SC, LA, AZ).

From the pre-post analysis graph, we observe that opioid shipments per capita rise steadily until the policy was executed in 2010. After regulating the shipment of opioids, we see an immediate decline in prescriptions per capita. When comparing these effects to our control states, there is a difference in trends between the two which lets us equate the change seen in Florida to the restrictions put in place. The control states continue to increase in opioid shipments which implies that the policy did limit the amount of opioids being shipped into Florida.

Mortality Rate:

Reference States: Louisiana, Nevada, Colorado

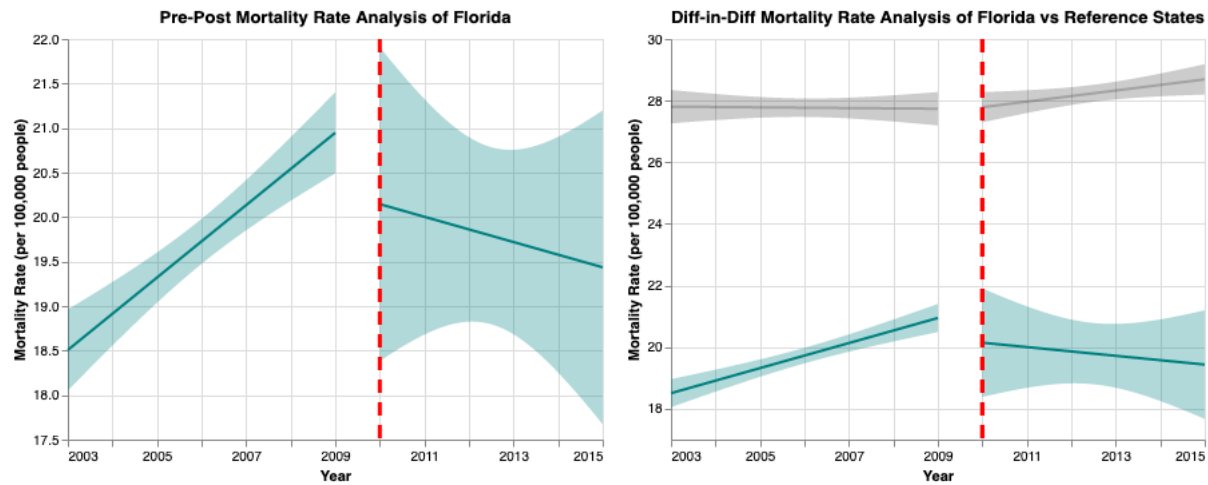


Figure 2 Caption: The graph on the left shows the trend of mortality rate for Florida segmented before and after the state's policy to restrict the prescription of opioids was implemented. The graph on the right compares Florida's mortality rate against states that did not implement any policies (LA, NV, CO).

Starting with the graph on the left, there is continued growth for mortality rate rising from 18.5 to 21 per 100,000 people prior to the adoption of the policy. The mortality declines immediately after, however, in order to determine this was a causal effect due to the regulations advocated by state legislature we compare the observed trend against the control states'. Looking at the difference-in-difference analysis, the control states exhibit an increase in mortality rate after 2010. This suggests that the regulations placed on opioid prescriptions had a positive impact on Florida by limiting the number of overdose deaths.

Washington

Shipment:

Reference States: Colorado, New York and Arizona

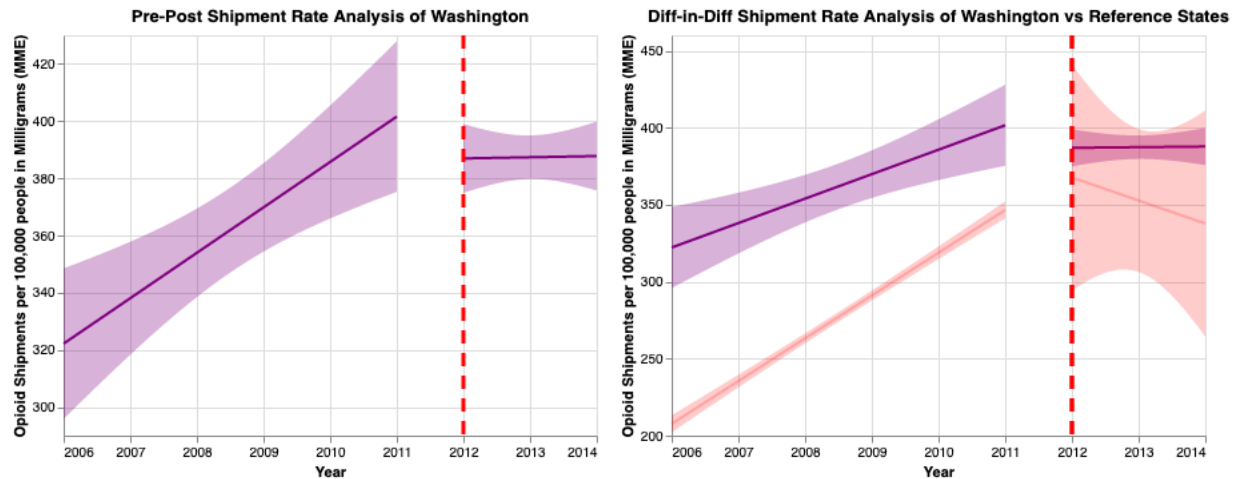


Figure 3 Caption: The graph on the left shows the trend of opioid shipments for Washington segmented before and after the state's policy to restrict the prescription of opioids was implemented. The graph on the right compares Washington opioid shipments against states that did not implement any policies (CO, NY, AZ).

Looking at the pre-post analysis on opioid prescriptions per capita rate, we take notice of the rising tendency in opioid shipments per capita from 320 to 400 mg. This incline is met with a constant trend, with no indication of an increase or decrease in rate after the policy administration in 2012. Regardless of how this presents, we require the results of the difference in difference analysis to check if treatment versus control group means differ from point of enactment. The results from the control states indicate that they experienced a decline in shipments per capita. This indicates that we cannot relate the change in opioid shipments per capita to Washington's own implementation of opioid prescription regulations.

Mortality:

Reference States: Oregon, Oklahoma, Hawaii

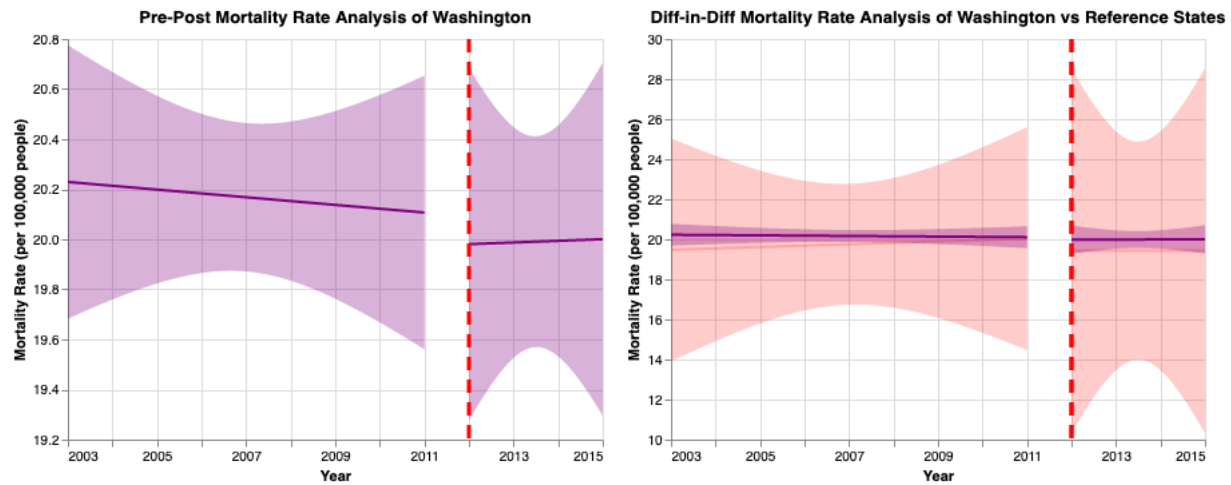


Figure 4 Caption: The graph on the left shows an overview of mortality rate for Washington segmented before and after the state's policy to restrict the prescription of opioids was implemented. The graph on the right compares Washington's mortality rate against states that did not implement any policies (OR, OK, HI).

Figure 4:

Pertaining to the effect of opioid regulations on the mortality rate in Washington, we start with the pre-post analysis on the left which exhibits a decline in mortality even before the policy was enacted. Then once the policy was imposed mortality switched to a constant trend. Without considering outside factors, it seems the policy did not manifest as expected. But this cannot be confirmed before examining the difference-in-difference analysis which revealed a similar pattern in the control states. As witnessed by both forms of the analysis we cannot conclude that the policy had any effect on this state.

Texas

Mortality:

Wisconsin, New York, Oregon

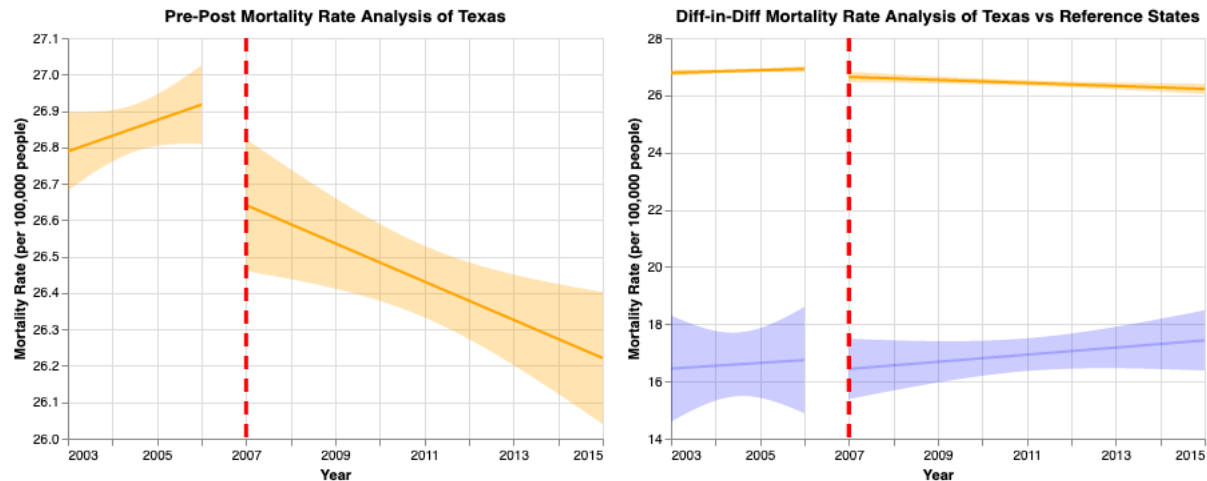


Figure 5 Caption: The graph on the left shows an overview of opioid shipments for Texas segmented by before and after the state's policy to restrict the prescription of opioids was implemented. The graph on the right compares Texas's opioid shipments against control states that did not implement any policies (WI, NY, OR).

According to the graph on the left, the average mortality rate from drug overdose increases and reaches a peak of roughly 26.9 per 100,000 people until the policy was executed in 2010. After the implementation of the policy, the death rate declines and maintains a decreasing trend, which might not have been the case had the policy not been put into effect. The difference-in-difference analysis reveals that average death rates of the reference states (WI, NY, OR) continue to rise both before and after 2007, but that of Texas shows a slight declining trend. This shows that Texas's mortality rate was decreased because of the opioid regulations.

Conclusion

Florida faced the greatest incline in opioid shipments prior to policies being put into place regulating the amount of opioids that could be prescribed and in turn affecting how much needed to be imported into the country. Florida state legislature implemented the most regulations out of the three we observed but based on the analysis we conducted, both opioid shipment and mortality experienced a positive impact due to the policy. Results of a similar effect were seen from Texas; however, we could only analyze data regarding mortality for this state. Whether the regulations affected the import of opioids into the state, we cannot conclude without that

information but the decrease in overdose deaths does allow us to conclude that over-consumption of opioids was limited.

However, we did not see such an obvious turnout in Washington which we concluded as no effect from the policy. A point of discussion is whether the control states were appropriately picked to be compared against Washington. The states being Oregon, Oklahoma, and Hawaii which were selected based on population and whether they had implemented their own opioid regulation policies. If in fact, we were correct on both terms we cannot conclude by any means that Washington's policy had any impact however if any of the control states had implemented their own opioid regulation policies prior to the 2012 which resulted in the stability of mortality rate, we would need to re-analyze the impact with new control states.

Citations

Opioid Epidemic: <https://www.hhs.gov/opioids/about-the-epidemic/index.html>

US Share of Opioids:

<https://www.health.state.mn.us/communities/opioids/prevention/painperception.html>

Drug overdose CDC: <https://www.cdc.gov/drugoverdose/deaths/prescription/practices.html>

Population: <https://www.nhgis.org/>

Estimating the Impact of Opioid Control Policies

Executive Report

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Motivation

The goal of this paper is to assess the impact of various state-wide policy measures designed to restrict the prescription of opioids in order to reduce drug overdose mortality. In 1990, prescription opioids were first made available to treat different types of cancer and help post-surgery recovery. However, overdose deaths involving synthetic opioids (mostly fentanyl produced illegally) have surged recently. From 1999 to 2019, overdose deaths involving synthetic opioids other than methadone have surged 50-fold reaching over 35,000 in 2019. And the number of prescription opioid overdose deaths has surged 4-fold but is decreasing, with less than 15,000 occurring in 2019. Additionally, the number of overdose deaths using opioids accelerated during the COVID-19 pandemic.

Florida passed a number of regulations to deal with opioid mis-prescriptions. By January 4, 2010, the Florida legislature mandated that all pain clinics using controlled substances register with the state. Operation Pill Nation, a joint effort between the Drug Enforcement Administration and other Florida law enforcement organizations, started in February 2010. Law enforcement carried out statewide raids in February 2011 that resulted in several arrests, the confiscation of property, and the closure of pain clinics. The Florida Surgeon General declared a public health emergency in July of that year, and the state legislature immediately forbade doctors from prescribing schedule II or III medications out of their offices and created regional strike forces to deal with the problem.

The Texas Medical Board approved rules on the use of restricted substances in the treatment of pain in 2007. The recommendations call for conducting a thorough patient evaluation before prescribing opioids, reviewing prescription data and the patient's medical history from the state's prescription drug monitoring program (PDMP), getting the patient's informed consent, conducting periodic reviews of the opioid treatment, and keeping a thorough medical record of the patient's treatment. A law took effect September 1, 2019, and required prescribers to limit opioid prescriptions for acute pain to a ten-day supply, as well as prohibiting refill of opioid prescriptions.

The state of Washington has adopted new rules relating to pain management, which were scheduled to become effective January 2, 2012. The rules govern the use of opioids for the treatment of chronic pain in the non-cancer setting. It involves patient evaluation, monitoring patient conduct, detailed periodic review, special Requirements for Opioid Prescribing, and requirement of Consultation With a Pain Specialist.

Data

To conduct our study, three separate datasets will be used to give us statistics on state population, prescription opioid drug shipments, and death caused by opioid overdose. We obtained the data on opioid shipments from the *Washington Post* (<https://www.washingtonpost.com/graphics/2019/investigations/dea-pain-pill-database/>). It provided us with the total number of opioid prescriptions at a monthly level from 2006 to 2012. We received data on overdose mortality for each county in each state from the *US Vital Statistics* (https://www.cdc.gov/nchs/data_access/vitalstatsonline.htm). The *National Historical Geographic Information System* (<https://www.nhgis.org/>), which provided census population data broken down by county, was the third source we used to extract population data. Since county names were inconsistent throughout the three datasets, we applied FIPS numbers to all of them to ensure that the counties from the population data and the other two datasets were consistent.

Analysis & Interpretation

Florida:

Shipment Rate

Reference States: South Carolina, Louisiana, Arizona

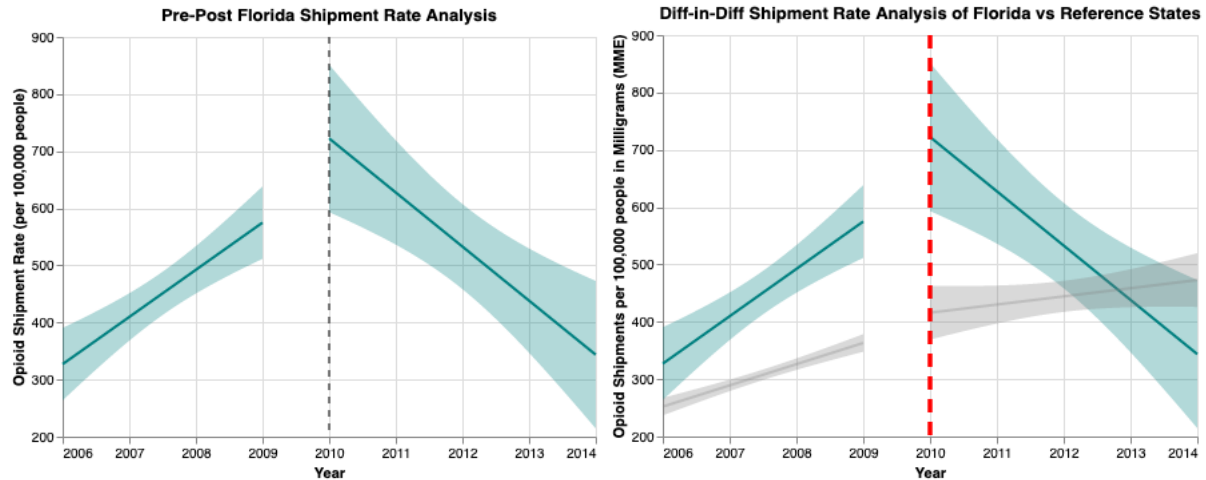


Figure 3.1: Overview of opioid shipments in Florida. Left: pre-post shipment rate analysis for Florida. Right: diff-in-diff shipment rate analysis for Florida and its reference states (South Carolina, Louisiana, Arizona)

We can see from the left graph that opioid shipments per capita increased steadily up to the policy's implementation in 2010. However, as soon as opioid shipments were controlled, the number of prescriptions per capita immediately decreased. Comparing Florida with other reference states (SC, LA, AZ), the fact that opioid shipments to the control states are still rising suggests that the policy was successful in reducing the volume of opioids sent into Florida. Therefore, we can attribute the shift observed in Florida to the regulations implemented in 2010.

Mortality Rate:

Reference States: Louisiana, Nevada, Colorado

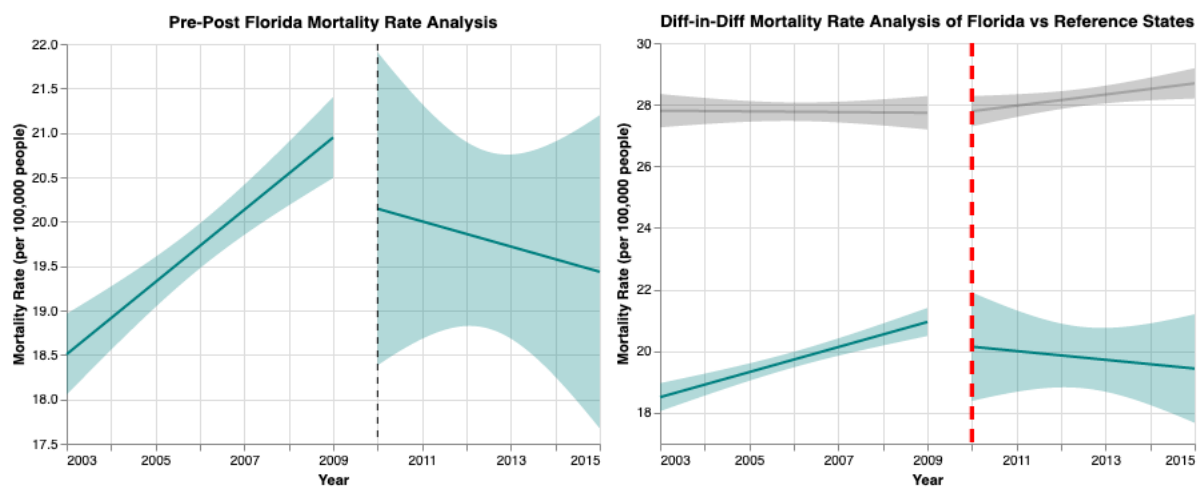


Figure 3.2: Overview of opioid mortality in Florida. Left: pre-post mortality rate analysis for Florida. Right: diff-in-diff mortality rate analysis for Florida and its reference states (Louisiana, Nevada, Colorado)

Prior to the implementation of the policy, the death rate increased steadily from 18.5 to 21 per 100,000 people, as shown in the graph on the left. The mortality decreases right away after the law was implemented. In order to further establish whether this was a result of the rules imposed by state legislators, we compare the pattern with the control states (LA, NV, CO). From the graph on the right, the control states show an increase in mortality rate after 2010, which demonstrates that the restrictions on opioid prescriptions had a positive effect on Florida in reducing the number of overdose deaths.

Washington

Shipment:

Reference States: Colorado, New York and Arizona

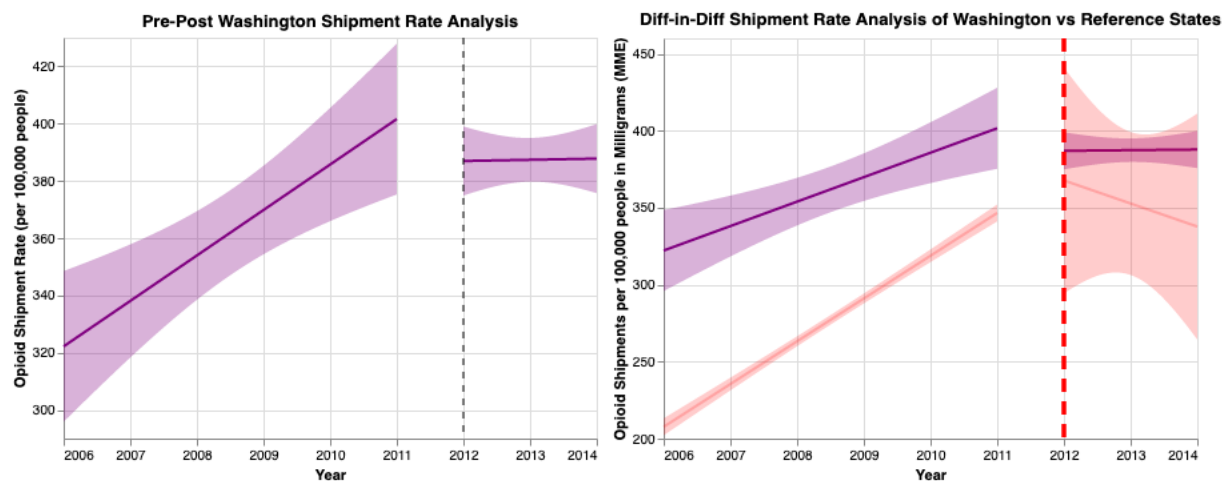


Figure 3.3: Overview of opioid shipments in Washington. Left: pre-post shipment rate analysis for Washington. Right: diff-in-diff shipment rate analysis for Washington and its reference states (Colorado, New York and Arizona). In the left figure, we detect a rising trend in opioid shipments per capita from 320 to 400 mg from 2006 to 2011. Following the implementation of policy in 2012, this slope is maintained continuously with no signs of a rise or fall in rate. Compared to reference states which are Colorado, New York and Arizona, we can see that the control states show a decrease in opioid shipment per capita. This suggests that the change in opioid shipment rate per capita cannot be attributed to the state of Washington's own enforcement of opioid prescription regulations.

Mortality:

Reference States: Oregon, Oklahoma, Hawaii

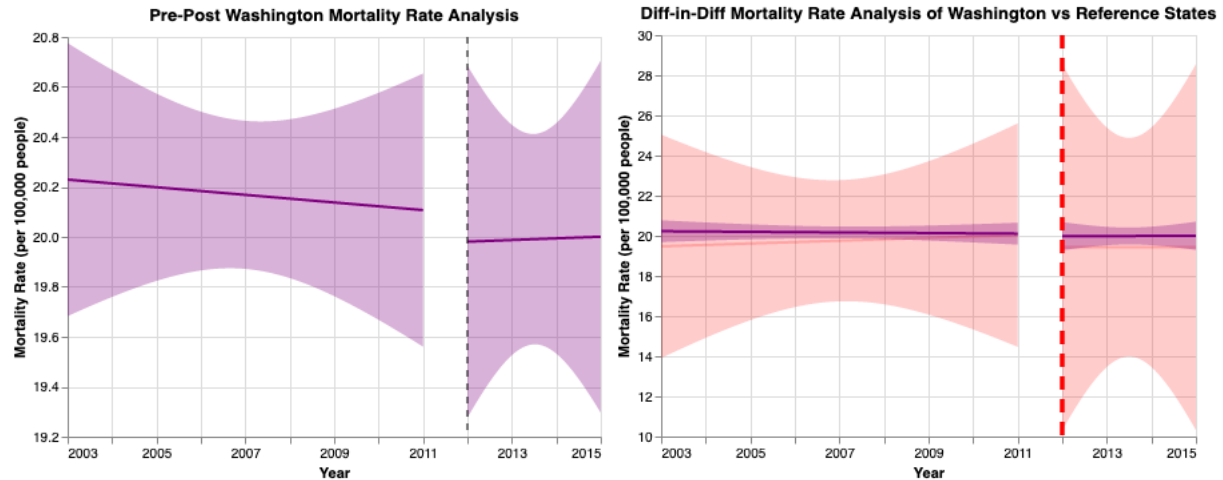


Figure 3.4: Overview of opioid mortality in Washington. Left: pre-post mortality rate analysis for Washington. Right: diff-in-diff mortality rate analysis for Washington and its reference states (Oregon, Oklahoma, Hawaii)

From 2003 to 2011, there was a decreasing trend in mortality rate per capita in Washington even before the policy was put into place in 2012. After the rule regulating the prescribing of opioids was put in place, mortality rate per capita began to follow a steady pattern. Without taking into account external variables, it appears that the policy did not have its desired effect. In order to validate our hypothesis, we ran the difference-in-difference analysis comparing Washington with Oregon, Oklahoma, and Hawaii. The right figure shows that they all show a similar constant trend regardless of the policy implication. Therefore, we were unable to draw the conclusion that the policy had any impact on the state of Washington, as shown by both types of study we performed.

Texas

Mortality:

Wisconsin, New York, Oregon

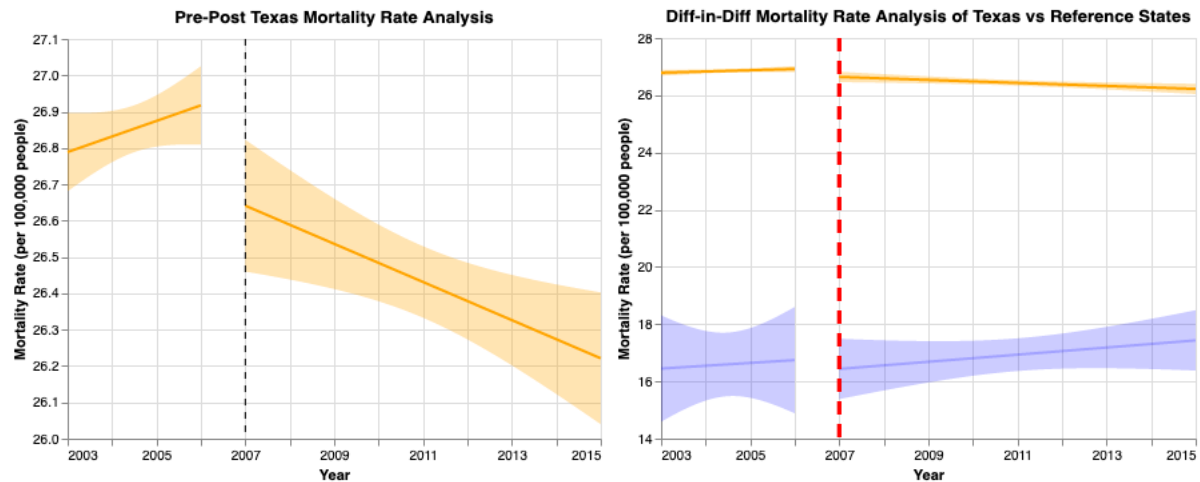


Figure 3.5: Overview of opioid mortality in Texas. Left: pre-post mortality rate analysis for Texas. Right: diff-in-diff mortality rate analysis for Texas and its reference states (Wisconsin, New York, Oregon)

The graph on the left shows that, up until the policy's implementation in 2010, the average mortality rate from drug overdose rises and reaches a peak of approximately 26.9 deaths per 100,000 people. The death rate decreases and maintains a declining trend after the policy is put into place, which might not have been the case had the policy not been implemented. The graph on the right indicates that those of the reference states (WI, NY, and OR) continue to climb both before and after 2007 while Texas' average death rates are falling. This demonstrates that the opioid limitations had a positive impact on Texas' mortality rate.

Conclusion

According to our pre-post and difference-in-difference analyses for three states, drug policy in Florida shows a positive effect in reducing both opioid shipment rate and mortality rate. The policy in Texas is potentially successful since the death rate decreased after the state legislature is implemented. However, we cannot draw any conclusions about how the rules affected the entry of opioids into the state since we could only examine mortality data for this state, but the decline in overdose deaths does allow us to draw the inference that the overuse of opioids was constrained. But the policy to regulate drug overdose in Washington does not seem to be effective compared to the reference states. We chose the control states of Oregon, Oklahoma,

and Hawaii based on their population and whether they have adopted their own opioid regulatory legislation. However, if any of the control states had implemented their own opioid regulation policies prior to 2012, resulting in the stability of mortality rate, we would need to re-analyze the impact with new control states.

Citations

Opioid Epidemic: <https://www.hhs.gov/opioids/about-the-epidemic/index.html>

US Share of Opioids:

<https://www.health.state.mn.us/communities/opioids/prevention/painperception.html>

Drug overdose CDC: <https://www.cdc.gov/drugoverdose/deaths/prescription/practices.html>