Estimate the Impact of Opioid Control Policies

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National survey estimates indicate that in 2018 nearly 10 million people misused prescription opioids, approximately 800,000 used heroin, and 2 million people had an opioid use disorder(OUD). Additionally, initial evidence suggests the COVID-19 pandemic may have increased opioid misuse and mortality. Preliminary data released by the Centers for Disease Control and Prevention (CDC) indicates overdose deaths rose 28.5ongoing crisis, state governments have enacted a broad array of policies. With the opioid crisis being an important health, economic and societal burden for the US, this project analyzes the effectiveness of policies that intended to control the opioid epidemic Three policies analyzed here were enacted in Florida in 2010, Texas in 2007, and Washington in 2012. To analyse the effect of the policy interventions, a *Pre-Post Comparison* and a *Difference-in-Difference* quasi-experimental design is specified. Findings indicate the success of the policies enforced in Florida and Texas in altering the rate of increase for both prescription opioid shipments and opioid mortality. In Washington, this analysis did not provide evidence to suggest that the policies were successful in reducing mortality or shipment of opioids.

1 Introduction

In 2017, the US Department of Health and Human Services declared the Opioid epidemic facing the nation as a public health emergency. The epidemic began in the 1990s, when pharmaceutical manufacturers assured medical professionals that opioid pain relievers were not addictive, and as a result their prescription rates rapidly rose in numbers (Affairs (ASPA) 2017). Unfortunately, opioids are in reality highly addictive, with 8-12 percent of people using opioids to treat chronic pain eventually developing an opioid addiction (Abuse 2021). In 2019 alone, 10.1 million people in the US misused prescription medications (Affairs (ASPA) 2017). The misuse of prescription medication often leads to a search for cheaper, more readily available drugs, such as heroin or fentanyl. People with a history of using prescription opiates are 13 times more likely to start using heroin (DeWeerdt 2019). As the number of prescriptions and addictions rose, so did the number of overdoses. This is especially of concern for the more potent opioids, fentanyl and heroin (JD 2021).

While the national state of emergency did not occur until 2017, several states were on the forefront of opioid regulation and legislation. This report will focus on 3 different policies in Texas, Florida, and Washington. In 2007, Texas' Medical Board adopted new regulations for the prescription of opiates; specifically, they required a more thorough patient history, informed consent from the patient, and regular reviews and records of a patients' treatment. In 2010, Florida enacted *Operation Pill Nation*, which required pain clinics using opioids to register with the state, prohibited physicians from dispensing schedule II or III drugs from their offices, and established a prescription drug monitoring program. In 2011, Washington State implemented more thorough management of opioid prescriptions, including mandatory consultations for adults taking 120 mgMED/day and periodic reviews for those taking 40 mg MED/day (Abuse 2021).

In order to determine the effectiveness of these policies on inhibiting the opioid crisis, this study examines the rates of overdoses per county in the years before and after each state's policy was implemented in comparison to national trends (Alaska was excluded from the national trends due to county re-configurations that made population difficult to process). This comparison is to ensure that changes seen are an effect of the policy itself, and not other outside factors (such as national policy changes, opioid shortages, etc.) (DeWeerdt 2019).

Additionally, an examination of the prescription rates in Florida before and after its 2011 policy will be performed. Because the death data was not available on a national scale, three control states are chosen: Kentucky, Georgia, and North Carolina. These states were chosen on the basis of geographic proximity, population demographic similarities, size, political landscape, and its high rates of opioid prescriptions. None of the states chosen for the "control" group had policies for opioids control during the time period of our analysis, which was a key factor in selecting the comparison states (Affairs (ASPA) 2017).

2 Data

For this project, three different data sources are used:

1. Opiate prescription data: contains all prescription opiate drug shipments in the United States from 2006 to 2014. The data was released (in mid-2019) by the Washington Post, which obtained the data through a *Freedom of Information Act (FOIA)* request to the US Drug Enforcement Agency (The Washingtin Post 2019)

2. Mortality data: obtained from the US Vital Statistics records, which include data on every death in the United States.

3. US population data: taken from the US Census, with exact values for every 10 years (e.g. 2010) and the Census' estimates of population for the intermediate years(United States Cenus Bureau 2018).

For Florida, both prescription and mortality data allows to look at the effect of the policy from two perspectives. For example, does the decrease in opiate shipments and decrease in deaths both happen after the policy implementation. For Washington and Texas, only the mortality data is used to analyze policy effectiveness.

3 Methods

The data pre-processing steps consisted of validation checks for county and State name consistency across datasets. A join is performed on both Mortality and Prescription datasets to augment with Population features at the county level. More validation checks are run to make sure the newly merged data included information from both data sets.

3.1 Mortality Rate

In the mortality data, this study calculates the opioid-related mortality rate per 100,000 residents for each county each year. For this calculation, all opiate related deaths were considered and counted into the rates, whether intentional or not. The deaths categories included in the calculation of the mortality rate were: `Drug poisonings (overdose) Unintentional (X40-X44), All other` `drug-induced causes, Drug poisonings (overdose) Suicide (X60-X64), Drug poisonings (overdose) Undetermined (Y10-Y14).`

3.2 Opiate Prescription Rate

Using the opioid shipments dataset, observations are represented as the quantity of opioid shipments in a given county in a specific month, measured in morphine milligram equivalents (MME) per resident. Only Florida opiate shipments are analyzed using the following features: County of entity receiving shipments, the date of the shipment, Morphine Milligram Equivalent factor and the total amount of active weight of the opiate in the transaction. With some missing County values, information from other columns such as city, buyer's address were used to impute the actual names. The total amount of opiates were in each shipment was calculated multiplying the total active weight of the drug in the transaction, in milligrams, by the Morphine Milligram Equivalent (MME) factor. Finally, the metric of interest, the Morphine Milligram Equivalent rate, is calculated by dividing the Morphine Milligram Equivalent total weight by population for each unit of observation. For better scaling, the Morphine gram Equivalent rate is multiplied by 1000.

3.3 Imputation of Mortality Values

After making sure datasets merged completely at the right level, a linear regression model is used to impute mortality rate for each unit of observation with placeholder death values. Prior to this step, for the data without missing values, mortality rate is calculated by dividing total opiate related deaths by population. For each treatment state, using population and year as predictors, a linear regression is used to estimate mortality rate. This model is used to predict the mortality rate for the missing values. Given that counties with less than 10 deaths were unreported, the newly imputed mortality rate multiplied by population is used to ensure death counts are less than 10. If they are over 10, we impute 10 instead. From there, this newly updated death counts are divided by population count for the final imputed mortality rate. This procedure ensures the imputed values account for the trend in each state and how large the population is. For control states, no missing values are kept, since the study is intends to find trends against the treatment states.

3.4 Summary Statistics

Table 1 and Table 2 below give summary statistics on the mortality rate.

In table 1 it is observed that the average amount of opiates (equivalent to morphine) available in Florida counties per capita was about 5 times the amount purchased in the control states together, which justifies the urgency of implementing a control policy for opiates.

Table 1: Equivalent grams of Morphine available per capita per year in counties

	Morphine in Florida	Morphine in Control States
mean	15,098.42	2,888.25
min	4.9	0.95
max	283,016.20	54,395.28

In Table 2, it is observed that the average mortality rates of the counties across states and compared to the control group are different, which we will observe in the next section where we plot trend for these variable by year. In most states, there is at least one county where there have not been any deaths by opioid overdose, which explains why the minimum value is 0 for the rate in Florida, Texas and Washington.

Again, because this study is interested in how these rates are changing in the period before and after the policy, it will not use the mean values to determine the policy effectiveness.

Table 2: Death rates per 100K people per year (from 2003 to 2015) in U.S. counties caused by opioid overdose

	Florida	Texas	Washington	Control States
mean	18.7	103.3	28.60	16.23
min	0.00	0.00	0.00	0.80
max	113.0	17,777.7	430.42	126.85

4 Discussion

Two methodologies were employed to investigate the effect of opioid drug prescription regulations on opioid shipment and drug overdose deaths. Firstly, the trend of opioid shipment or mortality before the policy took effect was directly compared to the trend after the policy went into effect– this method is known as a pre-post comparison. Following this, the change in the trend of the metrics before and after the regulations are computed and compared with the change in similar counties – this method is known as difference-in-difference. Table 3 summarizes the analyses discussed in the next subsections:

4.1 Pre-Post Policy Comparison

The first approach to estimate the effectiveness of the opioid control policies is to compare the trend slope of our two variables of interest: `population rates of opioids available for prescriptions` and `overdose deaths`.

For this analysis, counties are treated as equally-weighted units of study. Each county is considered a single "community", and opioid control is governed at the level of communities (particularly when community division is related to administrative boundaries that impact government law enforcement).

Figure 1 clearly indicates an inflexion point in the trend for Florida counties in 2010, the year the policy was made effective. The change in slope of the trend means the quantity of opioid available in Florida counties started to decrease after 2010, thus, if no other factor could have caused such decrease, the policy appears to be effective.

Table 3: Analysis Summary

State	**Analysis**	**Regulation Date**	**Pre-Period**	**Post-Period**
Florida	Opioid Shipment Rate	February, 2010	2006 - 2009	2010 - 2012
Florida	Mortality Rate	February, 2010	2003 - 2009	2010 - 2015
Texas	Opioid Shipment Rate	January, 2007	2006	2007 - 2012
Texas	Mortality Rate	January, 2007	2003 - 2006	2007 - 2015
Washington	Opioid Shipment Rate	January, 2012	2006 - 2011	2012
Washington	Mortality Rate	January, 2012	2003 - 2011	2012 - 2015

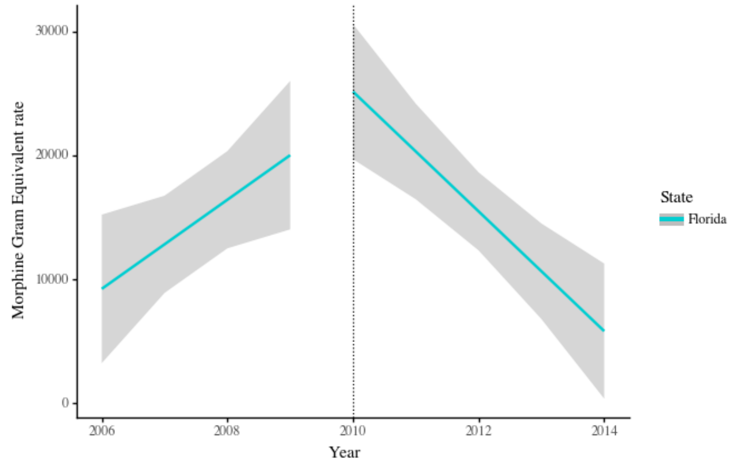

Figure 1: Morphine Gram Equivalent rate in Florida before and after 2010 with a 95% CI

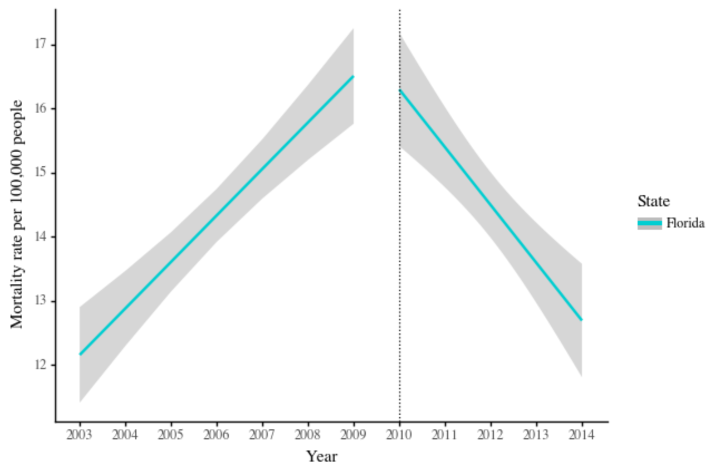

Figure 2: Morphine rate per 100,000 in Florida before and after 2010 with a 95% CI

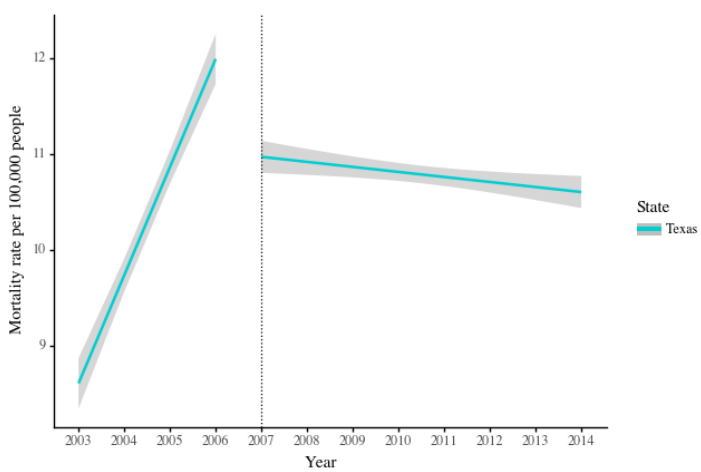

Figure 3: Morphine Gram Equivalent rate per 100,000 in Texas before and after 2007 with a 95% CI

In terms of opioid overdose deaths, the change in slope in Florida again seems to demonstrate most effectiveness of the control policy implemented (Figure 1). For counties in Texas, in Figure

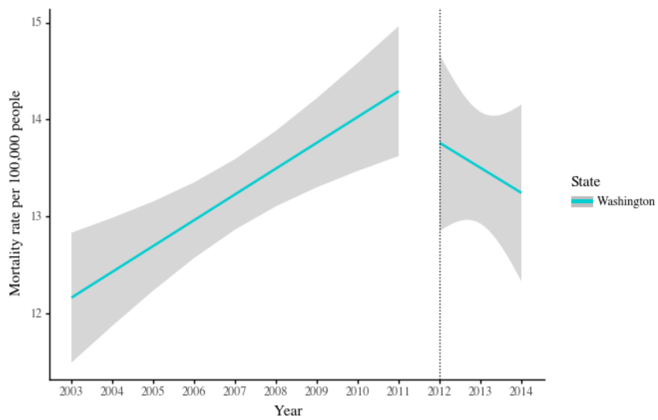

Figure 4: Morphine rate per 100,000 in Washington before and after 2012 with a 95% CI

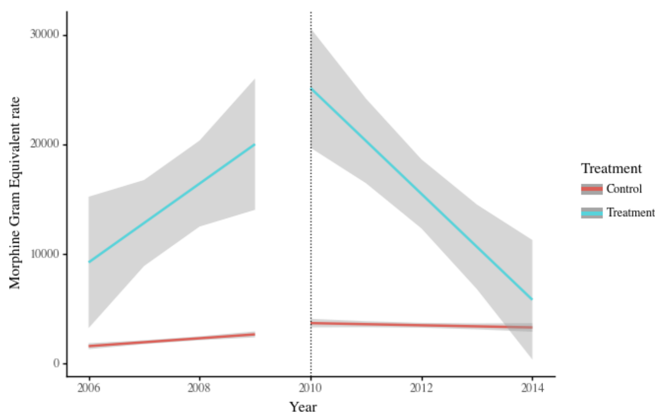

Figure 5: Morphine Gram Equivalent rate in Florida vs. Control States before and after 2010 with a 95% CI

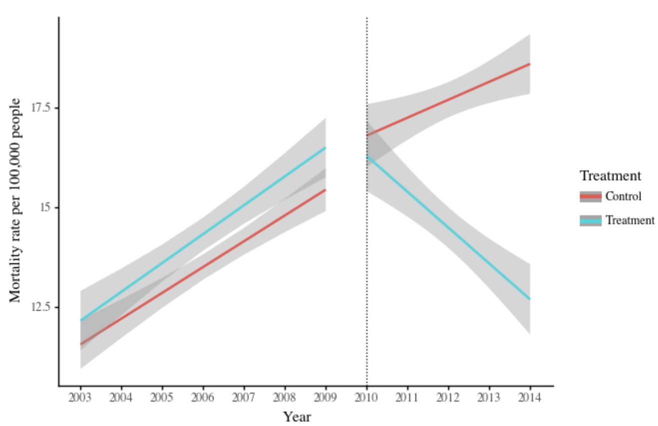

Figure 6: Mortality rate per 100,000 people in Florida vs. Control States before and after 2010 with a 95% CI

3, the regression trend of opioid-related mortality rates seem to also be negative after 2007, the year the control policy was implemented. The mortality rate in Texas had an increasing slope until the year the opioid regulations were made effective, meaning the policy could have been effective in Texas. Similarly, for Washington counties, mortality rates due to opioid overdose seem to be

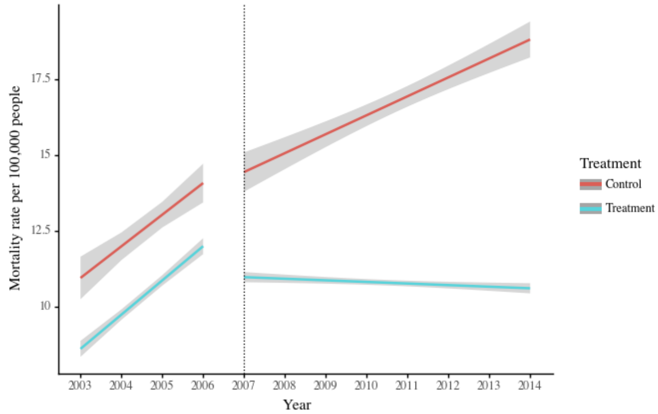

Figure 7: Mortality rate per 100,000 people in Texas vs. Control States before and after 2007 with a 95% CI

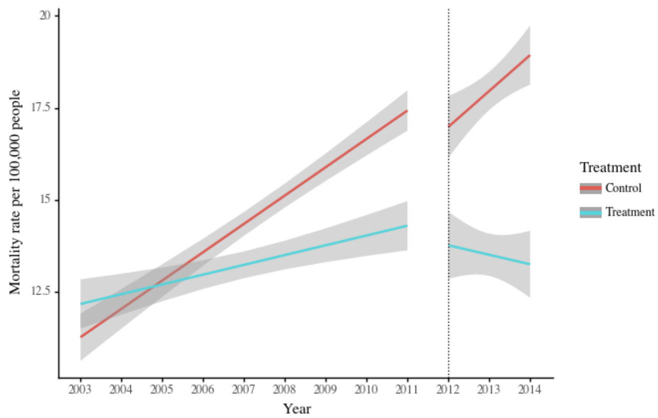

Figure 8: Mortality rate per 100,000 people in Washington vs. Control States before and after 2012 with a 95% CI

increasing before opioid regulations were implemented, and started to decrease right after the policy implementation in 2012.

4.2 Difference in Difference

For the second part of the analysis, a difference in difference design was used to compare the trends seen regarding opioid abuse outcomes in our policy-treated states. Assuming that comparison states as similar enough to the with-policy states, they must follow the same trend of overdose mortality rate and opioid purchase rate before the implementation of the policy. If the control group in is a good enough counterfactual to accounts for all the possible unobserved differences between treatment and control groups, they must behave similarly before the intervention, and if that is true, it could safely be assumed that if we see a difference when comparing post-policy intervention period between the states intervened by policies and control groups, it could only be attributed to the regulations and not to other potential causes.

The difference-in-difference results indicate policy-treated states (Florida, Texas, Washington) do not have the same levels of prescription and mortality rates as our non-policy-change states (Control states) before the policy implementation year, but they do have similar slopes in the trends. In Florida, in Figures 6 and 5 it is observed that the trends of both overdose death rates and purchase rates are increasing each year prior to the policy implementation as it is the case for the control groups. As expected, after the policy year, the trend becomes negative for Florida, but continues to be positive for the control groups. Having effectively controlled for other factors that could have influenced the trend in Florida with our control group of States, this study can affirm the policy in Florida was indeed effective.

For Texas and Washington counties, Figures 7 and 8 show a difference in the trends when comparing to the control (National) group of states. For Washington and Texas, the trend post-policy intervention is decreasing compared to the increasing mortality rate of the national average (the control group of counties). Therefore, again, if it is assumed that the only factor that was different for Texas and Washington compared to the national average are their respective opioid regulations, their opioid control efforts were effective.

5 Conclusion

Findings suggest that Florida's policy is likely the most effective. While the national overdose trend and Florida's trend coincided before 2010, after the implementation of Operation Pill Nation there was a sharp decline in the mortality rate. It became lower than the national average, despite being slightly above in the years before 2010. Additionally, the level of opiate shipments also had a sharp decline, while the trends in the control states of Kentucky, North Carolina, and Georgia remained stagnant.

The success seen by Florida was achieved to a lesser extent in Washington and Texas. Both of these states had lower opiate mortality rates than the national trends in the years before their opiate policies, and saw a decline following their implementation.

The data from Florida suggests that limiting access to opiates decreases the likelihood of overdose. It also suggests that stricter policies may lead to stronger decline. That being said, there are additional factors that were not considered in our analysis that may be influencing the trends seen in our different treatment states. For example, Texas saw a very slow rate of decline for its opiate mortality rates following 2007. But, opiates do not just consist of prescriptions, but also recreational drugs such as heroin or fentanyl. It has been estimated that over 90 percent of the heroin in the United States comes from Mexico, so it stands to reason that a border state, like Texas, may have more access to these recreational opiates. For future, more in depth, analysis dividing the opiate mortality's based on specific species of drugs may tell us more about how well the policies affect moralities related to prescription opiates.

It is also important to address other limitations of this analysis. For privacy protection, counties with yearly deaths of less than 10 in a specific category are suppressed. Using the data available, the death rates for these counties were imputed, but it is possible that this imputation could skew the data. Continually, with the goal of evaluating the effectiveness of policies, it would be beneficial to include more policy changes, as well as different metrics for effectiveness. An important caveat to keep in mind while considering future policy changes is that the COVID-19 pandemic may very well have changed the opioid landscape, and the factors that influence the epidemic. Finally, access to healthcare was not considered in this analysis but may give more insight into the nature of addiction in certain areas. Not all overdoses are fatal, some may result in hospitalizations instead. In the future, analysis looking at how healthcare can protect opiate related fatalities could have potentially life-saving consequences.

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