Opioid Overdoses in Midwestern States in Relation to State Medicaid

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The Situation

Millions of Americans suffer from unmanaged acute and chronic pain and are often prescribed opioids to treat their conditions. However, the dangers of prescription misuse, opioid use disorder, and overdose have been growing problems throughout the United States for the past few decades. For our project, we analyzed the number of opioids, synthetic opioids, and methadone overdose deaths from 2015 to 2017 to determine which Midwestern states have the highest and lowest number of deaths due to opioid overdose. In addition, we analyzed Medicaid expenses as overall percentage of state budget from 2015 to 2017. The extracted data provides information on State ID, State, Year, and Percentage, which was then merged via a for loop to get a more substantial data source on each Midwestern state.

To address our areas of interest, we used data from the Center of Disease Control and Prevention, the official Medicaid website, and the State Health Access Data Assistance Center (SHADAC), an affiliated program of Health Policy and Management at the University of Minnesota.

Answering the Question

The data was cleaned and transformed into a clean file to analyze the average number of deaths due to opioid overdose among Midwestern states from 2015 to 2017. This data was also used to produce Medicaid expense as a percentage of state budget to determine if a correlation exists between Medicaid spending and opioid overdoses in that state. In our initial proposal, we hypothesized Illinois had the average highest number of opioids overdose deaths and Iowa had the lowest average number. However, after further analysis we discovered that Ohio was the state with the highest average number of deaths due to opioids overdose from 2015 to 2017.

Additionally, there were no reported deaths due to opioids overdose in several Midwestern states (Figure 1– Average Number of Opioids Deaths). This is probably due to a lack of reporting of opioid overdose deaths and not due to the lack of occurring opioid overdose deaths.

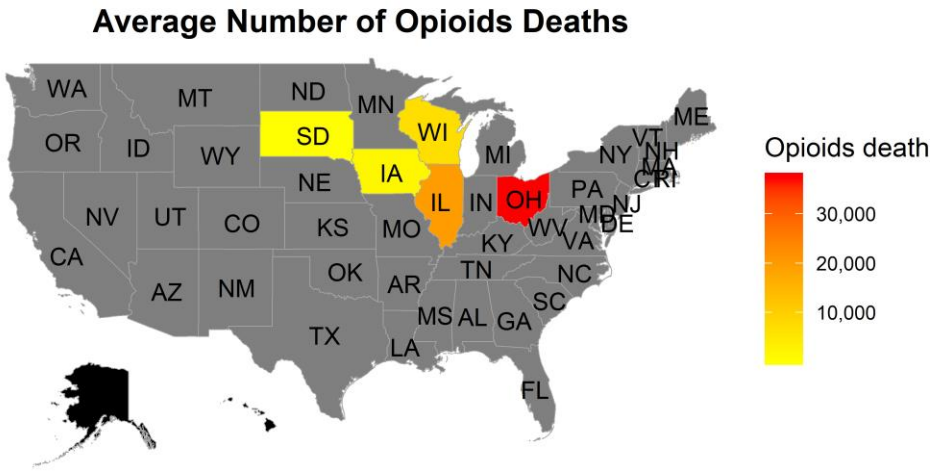


Figure 1

After determining Ohio as the leading Midwestern state in opioid related deaths, we examined how Medicaid as percentage of state budget factored (or did not factor) into opioid overdoses in that state. Our hope was to see a correlation among expenses and a lower number of deaths. If visible, this correlation may indicate that a high concentration of state budget dedicated towards Medicaid may be effective at curbing opioid related deaths. However, our analysis was inconclusive. States with high rates of death, such as Ohio and Illinois, dedicated moderately high to high amounts of their state budget towards Medicaid. Iowa and Nebraska, on the other hand, only dedicated a small amount of their budget towards Medicaid but still boast low amounts of opioid related deaths (Figure 2 – Medicaid as Percentage of State Budget).

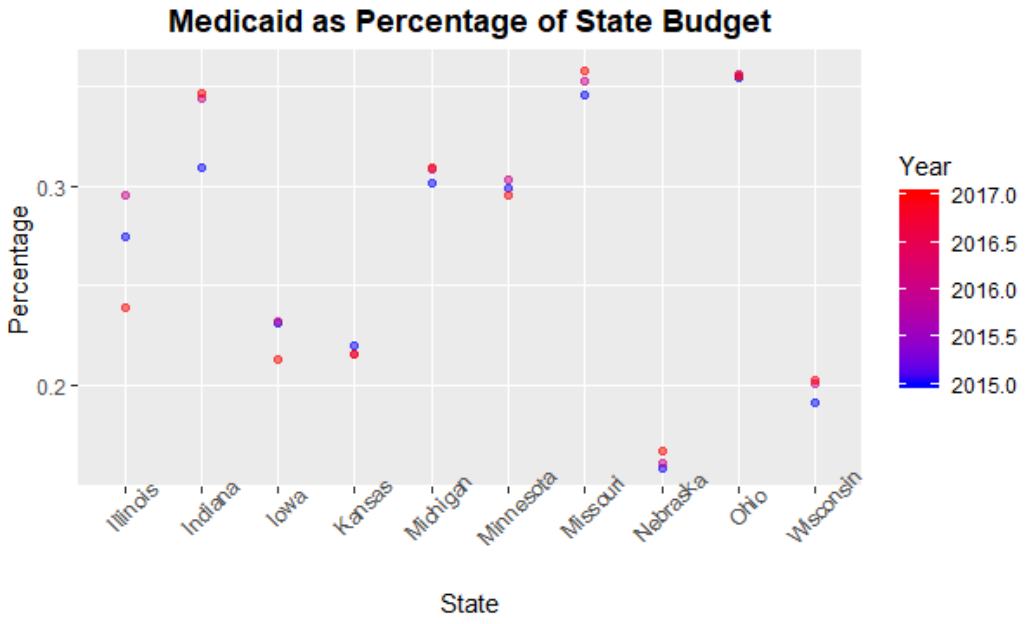


Figure 2

Further Analysis

In addition to our initial analysis, we looked extensively at the following:

- Average number of opioid related deaths in each state
- Percentage of opioid over total drug related overdose deaths
- Trends in Medicaid as % of state budgets

Before analyzing the average number of opioids overdose deaths from 2015 to 2017 among Midwestern states, we wanted to know which Midwestern state had the highest average number of drug overdose deaths from 2015 to 2017. We selected the states and year in which we were interested, averaged the number of drug overdose deaths from 2015 to 2017, and adjusted the data to meet the requirement for the function of choropleth map. Figure 3, "Average Number of Overdose Deaths", shows the average number of drug overdose deaths in each Midwestern states. From this map it can be shown, similar to our previous findings, that Ohio state had the highest average number of deaths due to drug overdose.

Figure 3

To address the main question of which states have the highest or lowest average number of opioids deaths, data was analyzed by making a choropleth map to see the average number of opioids deaths among Midwestern states from 2015 to 2017. Similar to the average number of overdose deaths, Figure 4 shows Ohio state had the highest average number of deaths due to opioids overdose. Interestingly, we also found that there were other midwestern states, such as North Dakota, Nebraska, Minnesota, Kansas, Michigan, Indiana, with no reports of opioid overdose deaths probably due to a lack of reporting.

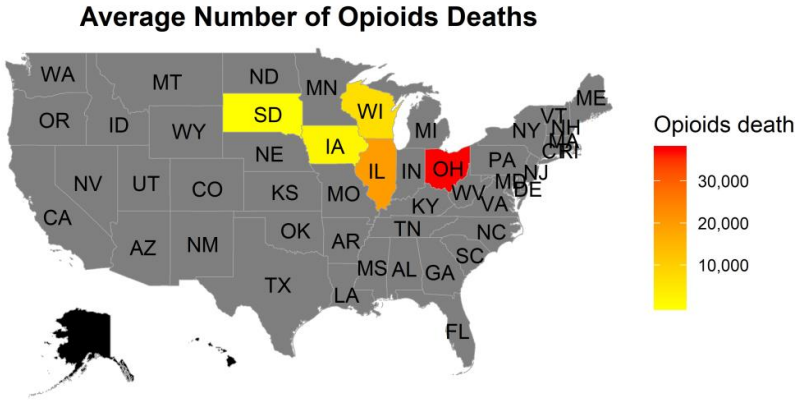


Figure 4

We further analyzed the percentage of opioids over total drug overdose deaths to determine how many cases of drug overdose are due to opioids overdose. Figure 5, “Average Opioids Deaths Percentage”, shows that among 10 cases of drug overdose deaths, there were 7 cases that were due to the opioids overdose in Ohio and Illinois state. Iowa and Wisconsin state had approximately 5 out of 10 cases that were due to opioids overdose. South Dakota had around 3 out 10 cases due to the opioids overdose. This is a similar pattern seen with average drug and opioid overdose deaths.

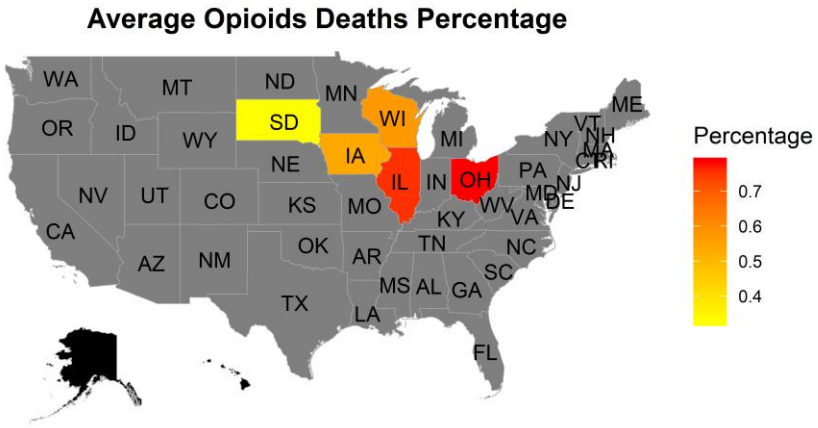
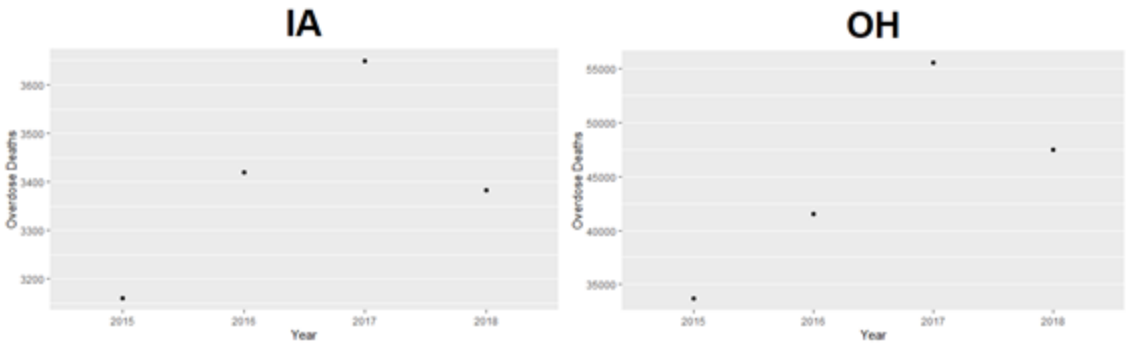


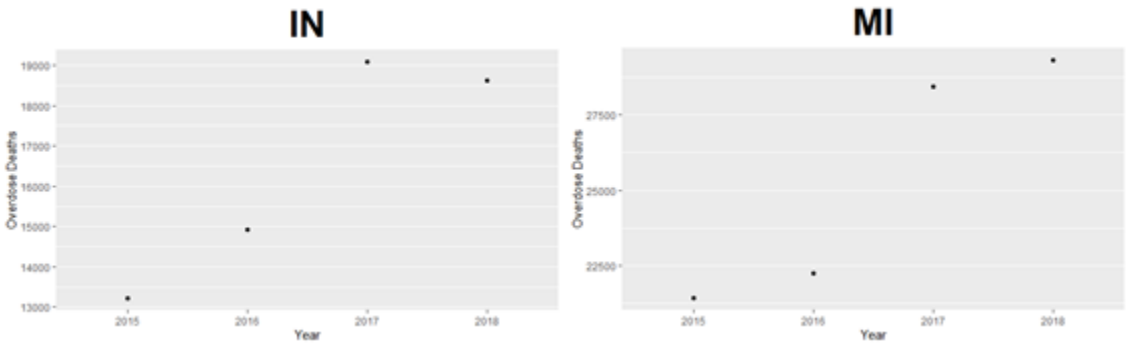
Figure 5

In addition, we also wanted to track the yearly overdose deaths for each state to see if there were any trends to look out for in the Midwest. We created the function state.deaths.year() for this purpose. After creating the plots, three main trends emerged among Midwestern state plots:

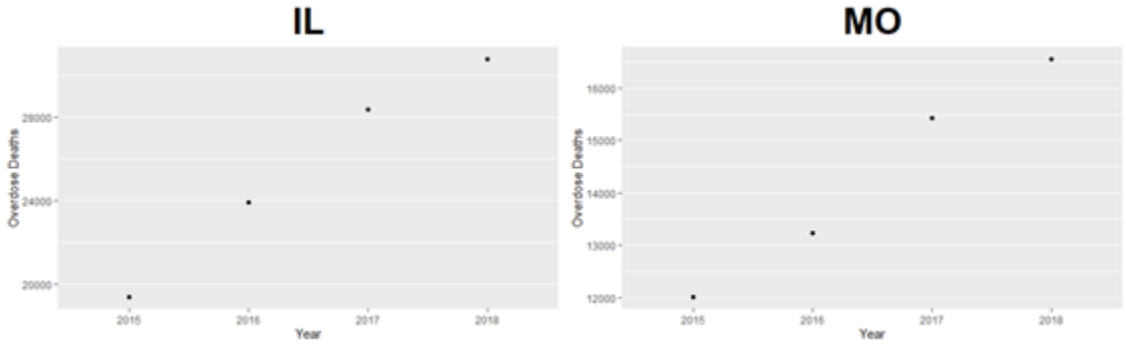
1. Drug overdose deaths increased, and substantially decreased (not pictured: ND, SD)



2. Drug overdose death increased, then remained relatively level (not pictured: MN, WI)



3. Drug overdose deaths show a steady increase



Among states with the highest amount of overdose deaths, Michigan, Indiana, and Minnesota have shown a decline in the amount of overdose deaths each year. Illinois overdose deaths have continued to increase at a steady rate. Although it still possesses the highest number of overdose deaths, Ohio had a large decrease in overdose deaths in 2018.

To document trends in Medicaid as a percentage of state budget, state budgetary data from 2015 to 2017 was extracted from SHADAC and merged via a for loop on R. The data was then displayed as a box plot, indicating the average and range for each year. According to the display (Figure 6), the average has remained relatively stagnant, with a slight decrease occurring

in 2017. The percentile range, however, accounting for the middle 25%-75%, has widened extensively. This indicates that many areas in the Midwest do not partition large portions of their budget to Medicaid services, and instead use their money elsewhere. This leaves little room for Medicaid programs to utilize their resources towards opioid use support and opioid misuse prevention.

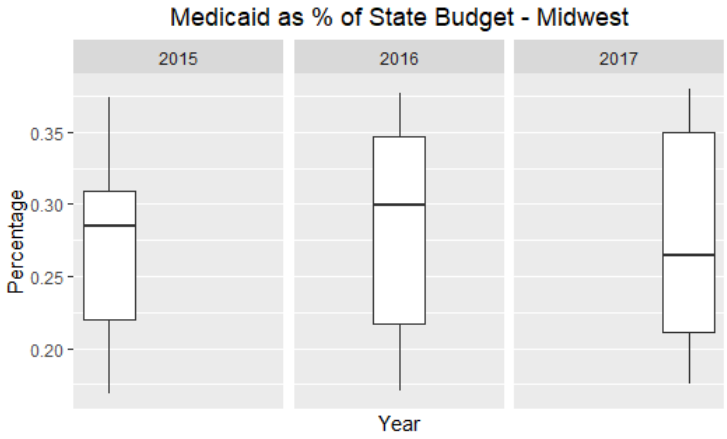


Figure 6

In a separate display, a density plot was created to provide an alternative view on the trend in Medicaid as percentage of state budget (Figure 7). Broken down into facets based on year, there is a clear shift occurring in 2017. In previous years, the density plots are skewed right, indicating most states in the Midwest dedicated a higher percentage of their overall budget towards Medicaid. The sudden shift in 2017, which shows many states lowering their percentage into the 15% to 25% range, indicates a shift in priorities and move away from reliance on Medicaid.

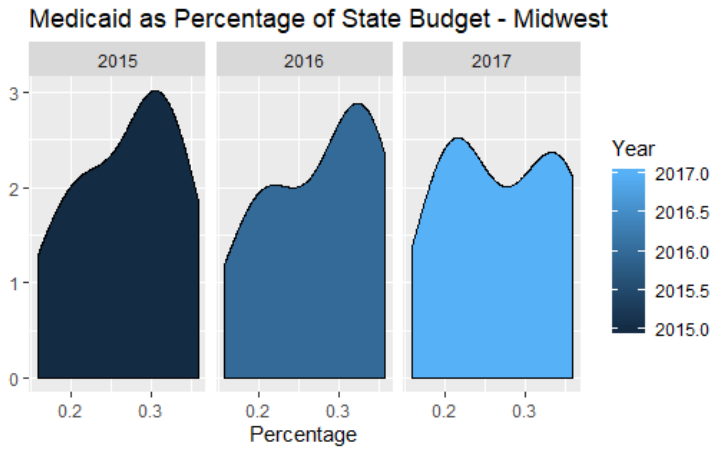


Figure 7

Getting the Data

The number of drug overdose deaths data is publicly available from Center for Disease Control and Prevention website (https://www.cdc.gov/nchs/nvss/vsrr/drug-overdose-data.htm), in the form of one Excel spreadsheet. This spreadsheet includes basic variables such as state, year, month, drug name, the actual number of deaths, and the predicted number of deaths. Other variables that we are not interested in were eliminated from the datasets. We read this "csv" file into data frames, cleaned, and extracted relevant data for analysis. To analyze state funding, we extracted data from (http://statehealthcompare.shadac.org/Data). This information enabled us to draw on financial statistics between the Midwestern states. Similar to the data on drug overdose deaths, the data on Medicaid funding was loaded into R as a "csv" file and merged using a for loop. Additionally, Medicaid prescription drug claims data was used to analyze Medicaid's potential role in the opioid crisis (https://www.medicaid.gov/medicaid/prescription-drugs/state-drug-utilization-data/index.html).

Obstacles Faced

The first obstacle we faced was understanding the drug overdose data we found on the Center for Disease Control and Prevention website and to select the necessary information. The original data contained 50 states, year from 2015 to 2019, and different types of drugs overdose

information. We spent majority of the time cleaning and extracting the data we would like to concentrate. We chose not to use 2019 data due to the year not being over. Also, we formatted the data to meet the requirement of the choropleth map's function. An additional obstacle we faced was combining information from several different data sources into a useable format to answer our project questions. Finally, there were difficulties while creating the graph visuals for "Medicaid as a Percentage of State Budget – Comparison" and the yearly plots from the state.deaths.year function. We would have liked to create bar graphs for these visuals but encountered the following error message: Error: stat_count() must not be used with a y aesthetic. Finally, the opioid crisis is very complicated. There are many factors to consider and we couldn't possible consider all of them for the purposes of this project. Additionally, the move from prescription opioid misuse to illicit synthetic opioid use (such as heroin) in the past decade complicates our research and results even further.

Function Documentation

The function written for this project is designed to make a choropleth map at state level to compare the average number of drug overdose deaths among Midwestern states from 2015 to 2017. Our function (choropleth_map) takes the data frame's name as an input and returns a choropleth map for the average number of drug overdose deaths, the average number of opioids overdose deaths, and the percentage of opioids over drug overdose deaths at state level. We also use the function to set the font size and characteristics and format the map's title.

```
#Create a function to make a customized choropleth map
choropleth_map <- function(data){
  p_data <- state_choropleth(data, num_colors = 1)
  p_data <- p_data + theme(title = element_text(size = 12))
  p_data <- p_data + theme(plot.title = element_text(face = "bold",hjust=0.5))
  print(p_data)
}
```

We also wrote the state.deaths.year function to create a plot of yearly overdose deaths for a specified state within a specified year range. The function first cleans and reduces our data set to rows containing drug overdose numbers for the specified state and year range. The cleaned

table is then summarized to show the total overdose deaths each year for the specified state. Finally, the function utilizes qplot to create a graph:

```
state.deaths.year <- function(state = "", year1 = 2015, year2 = 2018){
  df1 <- df_od[grepl(state, df_od$State, fixed = TRUE), ]
  df1 <- subset(df1, Year >= year1)
  df1 <- subset(df1, Year <= year2)
  df1 <- subset(df1, Indicator == "Number of Drug Overdose Deaths")
  df1 <- group_by(df1, Year)
  df1$`Data Value` <- as.integer(df1$`Data Value`)
  df1$Year <- factor(df1$Year)
  df1 <- df1[complete.cases(df1),]
  df1 <- summarize(df1, `Overdose Deaths` = sum(`Data Value`))
  p <- qplot(Year,
             `Overdose Deaths`,
             data = df1,
             geom = "point")
  p <- p + ggtitle(state)
  p <- p + theme(plot.title = element_text(size = 32, face = "bold", hjust = .5))
  p <- p + theme(panel.grid.major.x = element_blank(), panel.grid.minor.x = element_blank())
  p
}
```

Appendix