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## **ANALYSIS ON ADDICTION AND OPIOID CRISIS: IMPLICATIONS AND SOLUTIONS**

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ANALYSIS ON ADDICTION AND OPIOID CRISIS:  
IMPLICATIONS AND SOLUTIONS

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A Project  
Presented to the  
Faculty of  
California State University,  
San Bernardino

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In Partial Fulfillment  
of the Requirements for the Degree  
Master of Science  
in  
Information Systems and Technology

---

by  
Bhavika Korat  
March 2020

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March 2020

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## ABSTRACT

Opioids have become a popular way of pain management treatment over the past decades and although they have proven to be very successful to treat pain, they require serious attention as they have become the cause of addiction and overdose deaths. Opioid overdose costs the US government \$78.5 billion each year. This project exhibits the background on opioids, the different types of opioids and their role in the addiction and overdose epidemic. The objective behind this project was to demonstrate what kind of people are more vulnerable to addiction and overdose.

This project shows the statistics of opioid overdose deaths in the United States which analyze a detailed comparison of the deaths caused by opioid overdose in various states, within certain age groups, ethnicity, and the types of opioids causing these issues using Tableau and IBM Cognos. It also involves what types of providers produce most of the opioid prescriptions.

West Virginia has highest death rate caused by overdose in the United States. Males and age group of 24 to 35 are more prompt to have addiction problem and the death rate is high in almost all the states. The white community also have high death rate in most of the states.

This paper also provides information on what systems are already in place to minimize the addiction and overdose problem and what is still needed to be done. Foremost, it will give an overview of what future work can be done in this

field to reduce the addiction and overdose occurrences. Implementation of future work provides the basic framework of the system needed to accommodate the needs of patients and providers. This can potentially help the government to reduce the cost of drug abuse treatment and will also assist patients to get a better understanding of opioid treatment.

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## CHAPTER ONE: PROJECT BACKGROUND

### Introduction

In the 1990s, pharmaceutical companies started manufacturing opioid-based painkillers on a large scale and assured the healthcare providers that it will not lead to addiction. As a result, doctors have started prescribing painkillers as an effective treatment to relieve pain. This ultimately led to a widespread movement of drug diversion and misuse. By the time the government realized the serious consequences of misuse, more than 1.7 million people were addicted to opioids by 2017 and 47,000 Americans died due to an overdose (NIDA, 2019).

The American Society of Addiction Medicine (ASAM) recognizes addiction as a chronic condition of the brain in which a person is dependent on a particular substance, thing or activity which results in serious health problems (Tyler, 2016). Addiction is considered a genetic issue which means an individual with a family history of addiction is more likely to end up with the same condition if proper measures are not taken. People with substance abuse history may exhibit lowered self-confidence and self-efficacy. An addicted person can show signs of compulsivity and may make poorer choices in regards to obtaining a substance, with less focus on potential health effects, effect on finances, etc. (Hazelden, 2019).

Addiction doesn't develop over a short period of time. The process of addiction takes place in the part of the brain called the reward center. Reward center is part of body's basic survival system. Body needs food for survival, this reward center leads the body for the desire of food, in such way it ensures the survival of the body (Horvard, Misra, Epner, & Cooper, 2018). This center regulates the natural rewards that are necessary to sustain our existence. In other simple words, when we take food or water, the reward center identifies these ingredients as vital substances for our bodies to function efficiently (Hazelden, 2019).

Repetitive use of harmful substances leads the brain to identify them as vital ingredients that are necessary to sustain a normal and natural body functionality. The brain thinks these substances are required for our continued existence. On top of that when a person uses these products, it also gives them a feeling of joy and fulfillment. Because of this behavioral feeling and urge of the brain, the person becomes more susceptible to use these products routinely and prioritizes these substances over other basic necessities. Scientists are still trying to understand the biology of addiction, it is a long lasting brain condition and very complex to understand. It is very much possible that person who successfully quit the addiction, may develop it again in future and that is called relapse (Wein, 2017). Studies have also shown that a variety of other factors like genetics, social and emotional environments also play an important role in making people more vulnerable to addiction. Due to these other factors that affect addiction, a

situation in which two people start using addictive substances together, only one may develop an addiction (Hazelden, 2019).

The following substances have been identified in addiction cases: alcohol, opioids, tobacco, heroin, cocaine, marijuana, etc (Bradbury, 2020).

Among all of these substances, tobacco, alcohol and opioids are responsible for almost 90% of addiction cases. Considering the users of tobacco and alcohol are more prominent than opioid users, comparative cases of addiction are more significant in the case of opioid users. What this means is, out of 100 users of alcohol or tobacco merely a few of them get addicted to those substances and an even fewer number of people die because of its overdose (Lopez, 2019). While in the case of opioid users, a significant number of people develop dependence and addiction, which can lead to death from overdose (Bradbury, 2020).

### Problem Statement

Every day more than 130 people die from opioid overdose in America. The misuse of these substances affects social and economic welfare. Prescription drug misuse costs the United States more than \$78.5 billion every year (NIDA, 2019). Several regulatory bodies such as Drug Enforcement Administration (DEA), the Centers for Disease Control and Prevention (CDC) and the National Institute on Drug Abuse (NIDA) are created to keep a watch on opioid misuse but still, the problem persists (NIDA, 2019). However, it can be unclear regarding

which specific groups are disproportionately suffering from opioid addiction and increased death rates due to overdose. In addition, some organizations may show differences in the opioid addiction-related outcomes that they encounter.

### Purpose of the Study

This project will attempt to summarize the view of the opioid crisis through a data analytics approach. By analyzing the data obtained from secondary data sources (The Henry J. Kaiser Foundation), the research will aim to illustrate the more susceptible and exposed areas where drugs are being misused.

We will also analyze the drug misuse trends according to sex, ethnicity and race, and age in different states. The research will endeavor to identify the type of prescribers and their specialty field who prescribes more opioids.

The study will identify the current measures taken by the regulatory authorities and what the potential flaws in the current system are. The study will also show what possible solutions could be considered in the future.

### Research Questions

1. What kinds of people are more vulnerable to opioid overdose death?
2. What types of doctors are prescribing more opioids?
3. In which age group the addiction problem is more persistence?
4. What kind of opioid is more responsible for overdose and death?

5. Which states are at the highest in drug overdose death?

6. What are the steps the government is taking to keep the situation under control?

7. What can be the future possible solutions which can be helpful to spread addiction awareness?



## CHAPTER TWO: LITERATURE REVIEW

### Background

After drug manufacturing companies started manufacturing opioids in the 1990's, it has become the most successful treatment for pain management. Soon, it has become the most accepted way of painkiller treatment by patients and doctors. This ultimately led to widespread drug misuse and overdose due to its habit-forming nature. In 2017, more than 1.7 million people were addicted to opioids (NIDA, 2019). Along with opioids, there are several other substances which cause addiction after repetitive use, such as alcohol, tobacco, marijuana, cocaine, etc. From all these substances, opioids are more dangerous because initially they are used in various disease management treatments but users can gradually develop dependence and lead to overdose and death (Bradbury, 2020).

Opioids are most widely used as painkillers, especially for the more painful diseases like cancer, kidney stones, and rheumatoid arthritis. They also work very well as a temporary pain reliever in cases of labor or menstrual pain. Due to its versatility and effectiveness, it has become so popular over a short period of time (Højsted & Sjøgren, 2012). This chapter includes an overview of the different types of opioids, addiction, how opioid and addiction works, its effects on the body, overdose, overdose symptoms, etc.

## Opioids

Opioids, also known as narcotics, are substances that bind to the opioid receptors which are located primarily in the central nervous system and the gastrointestinal tract to relieve pain by blocking the pain signals between the body and the brain. Opioids are more widely used as a painkiller and anesthesia (ASA, 2019).

Types of opioids: Opioids occur naturally and can also be synthesized artificially.

There are main 3 types of opioids (Bellum, 2014):

- Natural- These are naturally occurring substances that contain nitrogen as a base compound. It is obtained from plants like opium poppy.

Ex: Codeine, Narceine, Morphine, Thebaine, etc.

- Semi-synthetic- These types of opioids are derivatives of natural opioids created in labs.

Ex: Hydrocodone, Oxycodone, Heroin, Hydromorphone, etc.

- Synthetic- These are completely produced artificially by humans.

Ex: Fentanyl, Methadone, Tramadol, etc.

Some of these are legal prescription drugs such as hydrocodone, oxycodone, morphine, tramadol, etc. People start receiving these medications as part of their treatment and after a continuous use of these medications, the brain adapts them as a vital ingredient for the normal functioning of the body. This is when the addiction starts developing. If proper measures are not taken at this point, it may lead to addiction. Best practice to avoid this situation is to regularly

consult a doctor to taper down the dose of painkillers as treatment comes to an end or to use suitable alternatives (Bellum, 2014).

Mechanism of Action (Chahl, 1996). Opioids exert their effect by inhibiting the release of neurotransmitters by acting on neural cell membrane receptors located on the central and peripheral nervous systems as well as the gastrointestinal tract. There are three major types of opioid receptors:

1.  $\mu$  (mu)
2.  $\Delta$  (delta)
3.  $\kappa$  (kappa)

A sensation of pain is triggered by stimuli caused by chemicals produced due to inflammation or damage to the body parts. Neurons are activated by these chemicals and release the neurotransmitters and the individual feels pain. Opioids block the production of these transmitters to react with pain stimuli and prevent the feeling of pain. Different kinds of opioids react differently with  $\mu$ ,  $\Delta$ , and  $\kappa$  opioid receptors to produce its effects (Chahl, 1996).

Effects of Opioids. The continuous use of opioids has some immediate and gradual effects on the body. These include (Short and Long, 2006):

- Constipation
- Palpitation
- Sweating
- Stomach upset
- Nausea and vomiting

- Drowsiness
- Insomnia
- Diarrhea

## Addiction

Addiction is a disorder of the brain in which a person becomes dependent on a certain substance or habit. Even though the substance is known to be harmful to the body, the person cannot resist the urge to consume it. Prolonged use of specific substances results in dependence and that is called addiction. People can sacrifice a healthy lifestyle, money, relationships or even life to get what they are urging for (ASA, 2019).

### How to Identify Addiction and its Symptoms (ARS, 2020):

- Consistent change in mood or behavior
- Avoid contact with friends or family
- Become more aggressive or cranky
- Sleep pattern change
- Violent behavior
- The drastic change in food intake
- The person denies the use of drugs or medication
- A person lacking motivation or being in a depression
- Mental and emotional instability
- Loss of concentration
- Lose control over the body or responsiveness

## Overdose and its Symptoms

Uncontrolled use of opioids often results in an overdose. It is extremely important to use prescription drugs as directed by professionals. In most overdose cases, the patient overdoses because they intentionally take in more drugs than prescribed with the hope of getting better and faster effects. Addicted people try to obtain multiple prescriptions of narcotics from different providers and pharmacies simultaneously. They consume more than they are supposed to and become the victim of an overdose (ASA, 2019).

### Overdose Symptoms (ASA, 2019):

- Breathing problems
- Seizures and tremors
- Confusion
- Inability to speak properly
- Extreme sleepiness
- Muscle cramps
- Sweating
- Paranoia
- Restlessness
- Discoloration of skin and lips
- Abnormally dilated or constricted pupils

How to help someone with Addiction or Overdose:

As soon as you know that someone is an addict, the first thing you should do is to take them to a doctor. Consult with the doctor to prescribe medication that helps with addiction and withdrawal symptoms. If the doctor is not a specialist, ask them for the referral to an addiction doctor. The American Society of Addiction Medicine has a list of facilities to help addicts on their website. You can access their website to find the closest location to you and have the addicted individual admitted. The Substance Abuse and Mental Health Service Administration (SAMHSA) has a toll free 24/7 national helpline: 1-800-662-4357, for information and referral for anyone who has a substance abuse disorder. It is available in English and Spanish (ASA, 2019).

If you see someone overdosing, keep talking to the person and keep them conscious until help arrives. The goal is to keep the individual engaged through either conversation or movement in case it is difficult to determine whether they are really physically. If a person is having difficulty breathing, rub gently on their back or try to clear the person's airways if you think it is blocked. Call 911 and stay with the person (ASA, 2019).

### Prescription Drug Monitoring Systems

Controlled substances are mainly classified into 5 different categories (DPVR, 2019):

- Schedule -I

These are the substances that have a high potential for abuse. This category is strictly prohibited in medical use.

Ex: Heroin, marijuana, LSD

- Schedule -II

These are the substances that are accepted to be used for medical treatment, but they also have a high potential of abuse but lower than Schedule-I.

Ex: Hydrocodone, oxycodone, morphine, amphetamine, etc.

- Schedule- III to V

This category has a lower potential of abuse than above 2 categories

Ex: Codeine, tramadol, zolpidem, lorazepam, diazepam, alprazolam, etc.

Control Substance Utilization Review and Evaluation System (CURES) (DOJ, 2019)

CURES is the national database to monitor the use of controlled substances. It observes various controlled substance prescriptions dispensed to any particular patient for at least 12 months from the current date. It serves various parts of the healthcare system such as hospitals, physicians and pharmacists, regulatory bodies and law enforcement agencies to obtain vital data about the patient's control substance usage. When a person walks into a medical clinic and consults a doctor seeking for pain management medication, the physician can check the CURES data to identify if the patient is already using any narcotic, the dates of previous fills, day supply and the quantity prescribed in

previous prescriptions. It also shows which doctor issued the previous prescription and which pharmacy filled it. This helps the physician identify the patient's authenticity regarding narcotic usage. If a patient has a broad history of different kinds of opioids, changing patterns of usage, overlapping dates of prescription fills, multiple prescribers for the same medication, multiple pharmacy usage, etc. it raises a flag for potential misuse of opioids. In such cases, a physician can deny the new prescription or advise patients to go for a non-controlled pain killer. Similarly, pharmacists also have access to CURES in the pharmacy setting. They can also check the history of the particular patient to understand the opioid usage history and determine potential misuse (DOJ, 2019).

It is compulsory for all licensed physicians and pharmacists to register with CURES. For prescribers and pharmacists, it is mandatory to check the CURES profile of a patient before writing or dispensing controlled prescriptions (CSBP, 2016).

All the dispensers are required to submit dispensing data to CURES every week. Most of the software utilized by clinics or pharmacies automatically submit weekly dispensing reports to the CURES.

Limitation of CURES. The biggest limitation of CURES is that it takes one week for the latest data available to be updated on the CURES database. Therefore, if the patient has obtained the controlled substance in the past 3 to 5



days from any other location, it is not possible for the clinic or pharmacy to obtain that prescription history. This could result in duplication of prescription fill (DOJ, 2019).

### Drug Enforcement Agency (DEA)

DEA is the federal agency that monitors drug trafficking and usage of prescription drugs across the country. DEA has set specific standards for prescribers and dispensers of opioids to become licensed providers. It is mandatory for any healthcare organization to obtain a DEA certificate in order to get a professional license. DEA provides a unique identification number to all these compliant providers. It serves the purpose of monitoring the distribution of opioids between manufacturers, wholesalers, retailers, and consumers. It also regularly conducts audits of the healthcare facilities to ensure the governance of predetermined standards (DEA, 1973).

Despite its strict actions and agendas, DEA continues to attempt to maintain control of the distribution of illegal opioids and drugs on local streets.

In the United States hundreds of people die due to opioid overdose every day. This has economic, societal and governmental impacts (NIDA, 2019). Further work needs to be done to identify which specific groups are suffering from opioid addiction and increased death rates due to overdose.

The research data in this project summarizes the misuse of the opioids in various age groups, ethnicity, sex, states and types of opioids. By summarizing these data, it will help to identify most affected people who are at high risk in different regions. This will also guide various regulatory agencies to increase their efforts to high risk people which will increase the agencies' efficiency and effectiveness.

## CHAPTER THREE: DATA DESCRIPTION AND VISUALIZATION TOOLS

To find solutions to my research questions, I have obtained a few datasets freely available from The Henry J. Kaiser Foundation. I was able to find state-level data on opioid overdose. The datasets used in this research project are from 2017.

Here are some of the variables I will be using throughout my research for opioid overdose and deaths:

### Dataset Descriptions

#### State Population

- Total Population per States.
  - Includes total population for the 50 US states; federal district of Washington D.C and the territory of Puerto Rico
  - Male population per states
  - Female population per states
  - Age 18 year population per states
  - Age 18 to 24 years population per states
  - Age 25 to 34 years population per states

- Age 35 to 44 years population per states
- Age 45 to 54 years population per states
- Age 55+ years population per states

### Opioid Death Datasets

- States
  - Includes the 50 US states; federal district of Washington D.C and the territory of Puerto Rico
- Age
  - 0 to 24 years
  - 25 to 34 years
  - 35 to 44 years
  - 45 to 54 years
  - 55+ years
- Sex
  - Female or male
- Ethnicity
  - White not Hispanic, Black not Hispanic, and Hispanic
- Past Year Opioid Misuse
  - Misuse of opioid from 2016 to 2017
- All Drug Overdose Deaths
  - All drug overdose deaths in 2017

- Opioid Overdose Deaths
  - Out of all drug overdose deaths in 2017, how many were opioid related
- Past Year Opioid Use Disorder
- Opioid Overdose Deaths as a Percent of All Drug Overdose Deaths
- Teens Ages 12-17 (did not get treatment)
  - Teenager who had an addiction problem but did not get a treatment
- Adults Ages 18+ (did not get the treatment)
  - Adults who had an addiction problem but did not get a treatment

#### Characteristics of Each Prescriber Datasets

- Sex
  - Female or male
- State
  - Includes the 50 US states; federal district of Washington D.C and the territory of Puerto Rico
- Specialty
  - Description of what type of medical practice

These datasets also include the list of medicines provided by each individual specialties.

### Visualization Tools

To analyze my datasets, I have used Tableau and IBM Cognos visualization tools. Tableau is considered as one of the fastest-growing business intelligence and visualization tool. It is easy to explore, learn and create user-friendly dashboards. Tableau can visualize huge amounts of data. You can also combine two different datasets with the foreign key. In that case, you can analyze two data sets at the same time. It also has a drag and drop interface and Tableau will place the variables where they go. However, you can always undo this and place the variable anywhere you want.

IBM Cognos Business Intelligence is another great web based analytic tool. The website provides different types of tool sets which include analytics, reporting, and monitor events. This tool also has the drop and drag interface. It works similarly like tableau where you can combine two datasets and also create a dashboard which can be exported to PowerPoint.

## CHAPTER FOUR: ANALYSIS

### Population by States in United States

Population by States

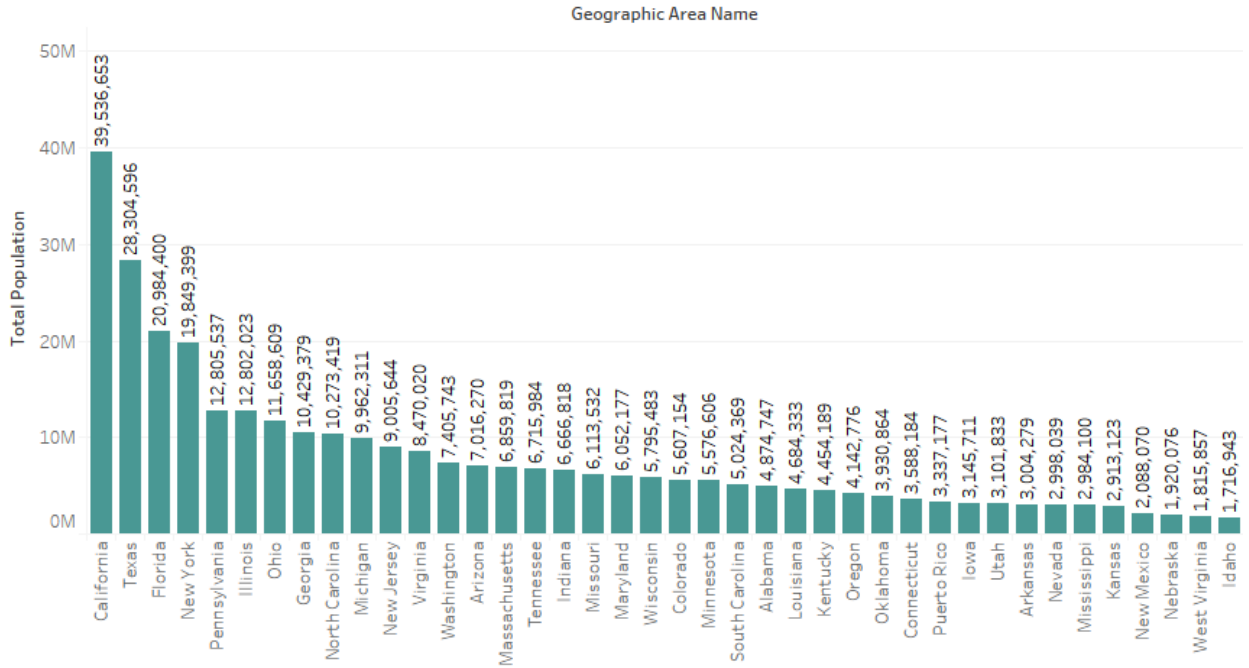


Figure 4.1: States in the US vs. Total Population

Figure 4.1 shows the population in each state of the United States.

California has the highest population followed by Texas, Florida, New York, etc.

## Percentage of Opioid Deaths Distributed by State

Total % of Death Distributed by State

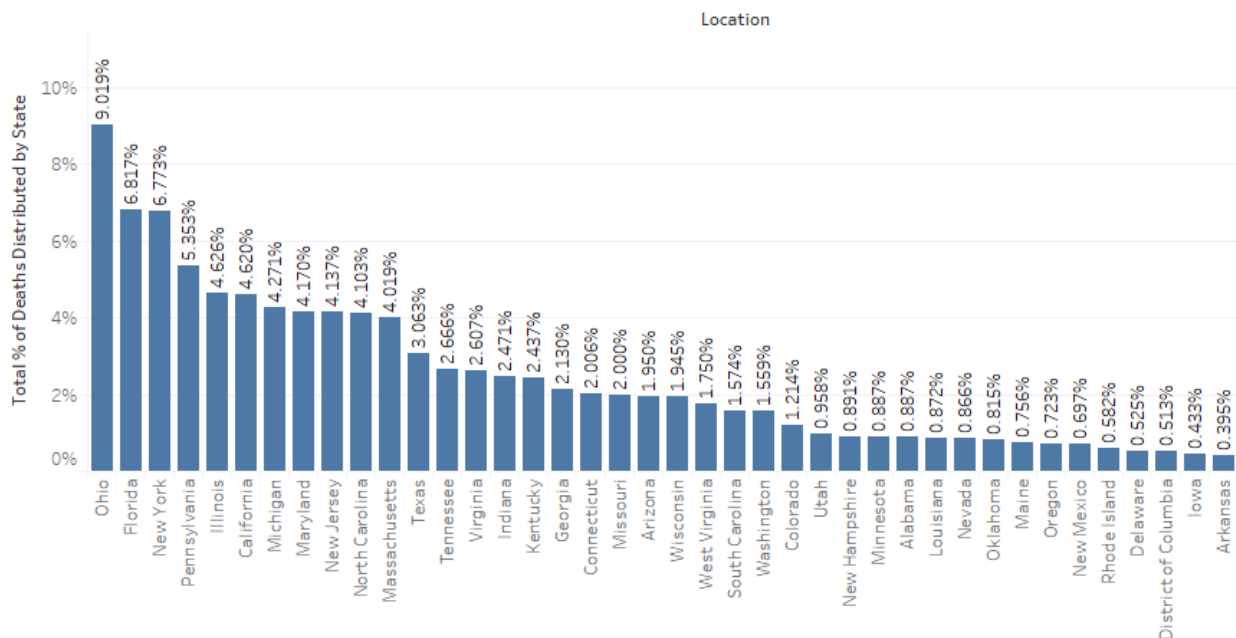


Figure 4.2: States in the US vs. Total % of Deaths

Figure 4.2 shows percent of deaths distributed by states caused by opioid overdose in the year of 2017. The data was analyzed to illustrate the comparison of opioid overdose deaths in each of the 50 US states. As we can see, Ohio has the highest death rate. Based on the populations of the US states, Ohio has the seventh largest yet has the maximum percentage of deaths due to overdose. That means the problem of overdose death is very severe in this state. Comparatively, California has the highest population and it stands far behind Ohio, Florida and New York. The death rate is less than half than Ohio. The same goes for Texas, despite being the second largest in population, it stands



quite far from Ohio, Florida and New York. According to the chart, Kansas, Mississippi and Arkansas have the lowest death rates of opioid overdose.

### Opioid Deaths by Age

Opioid Deaths by Age Normalized by State Population

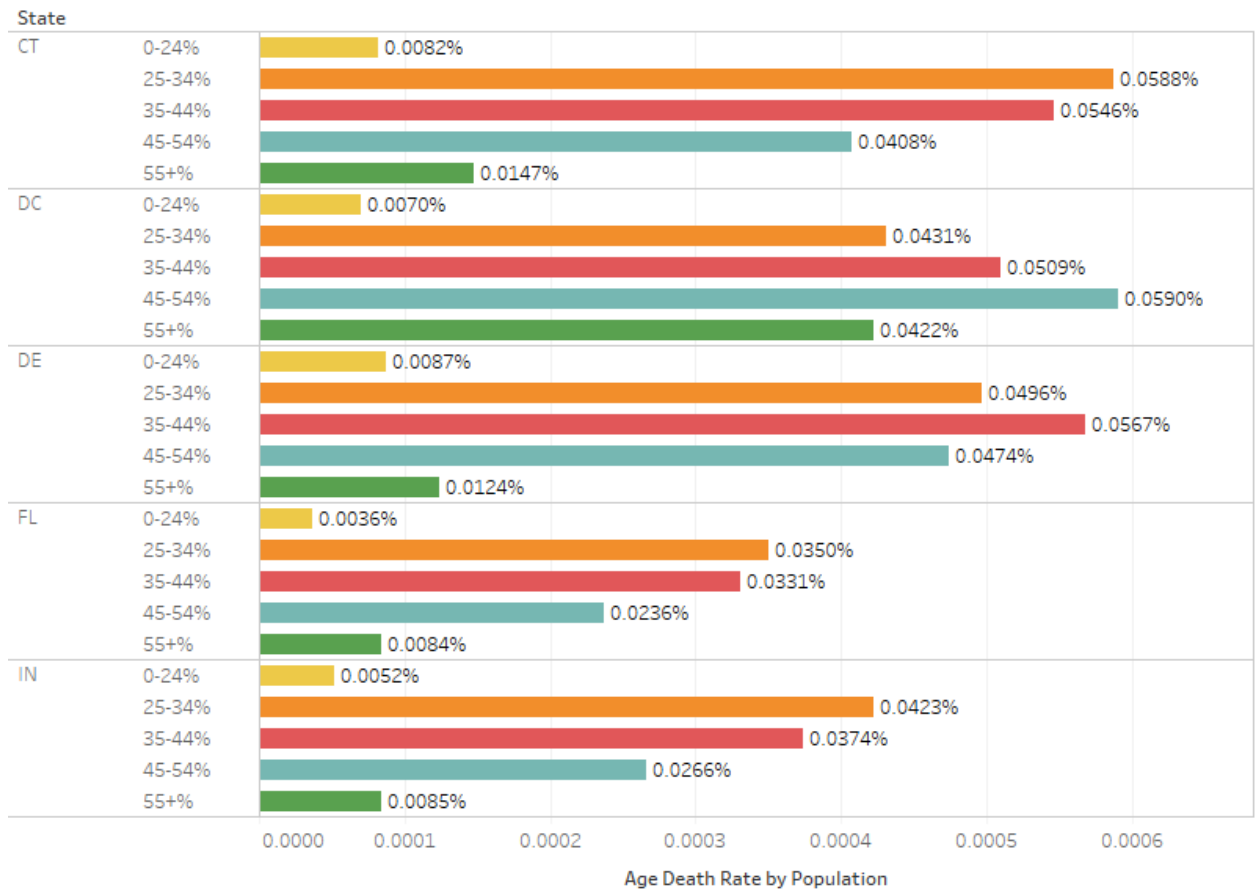


Figure 4.3a: Age Death Rate by Population vs. States in the US

## Opioid Deaths by Age

Opioid Deaths by Age Normalized by State Population

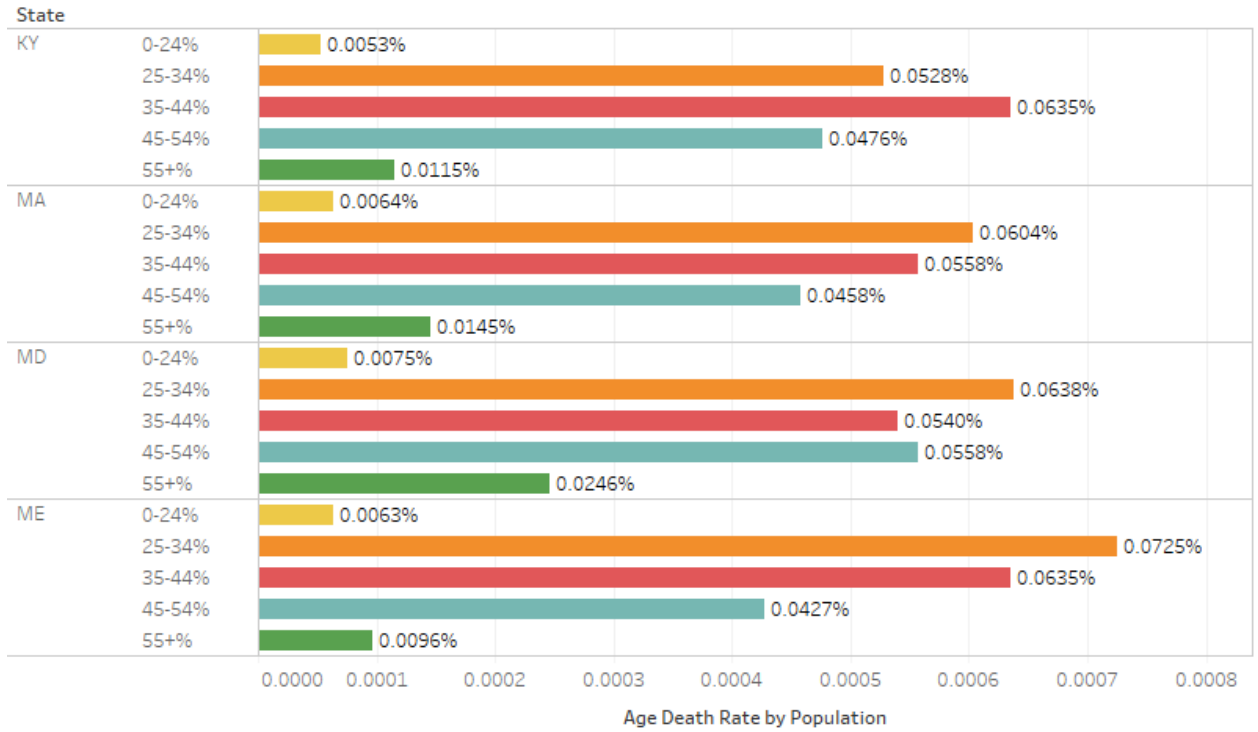


Figure 4.3b: Age Death Rate by Population vs. States in the US

## Opioid Deaths by Age

### Opioid Deaths by Age Normalized by State Population

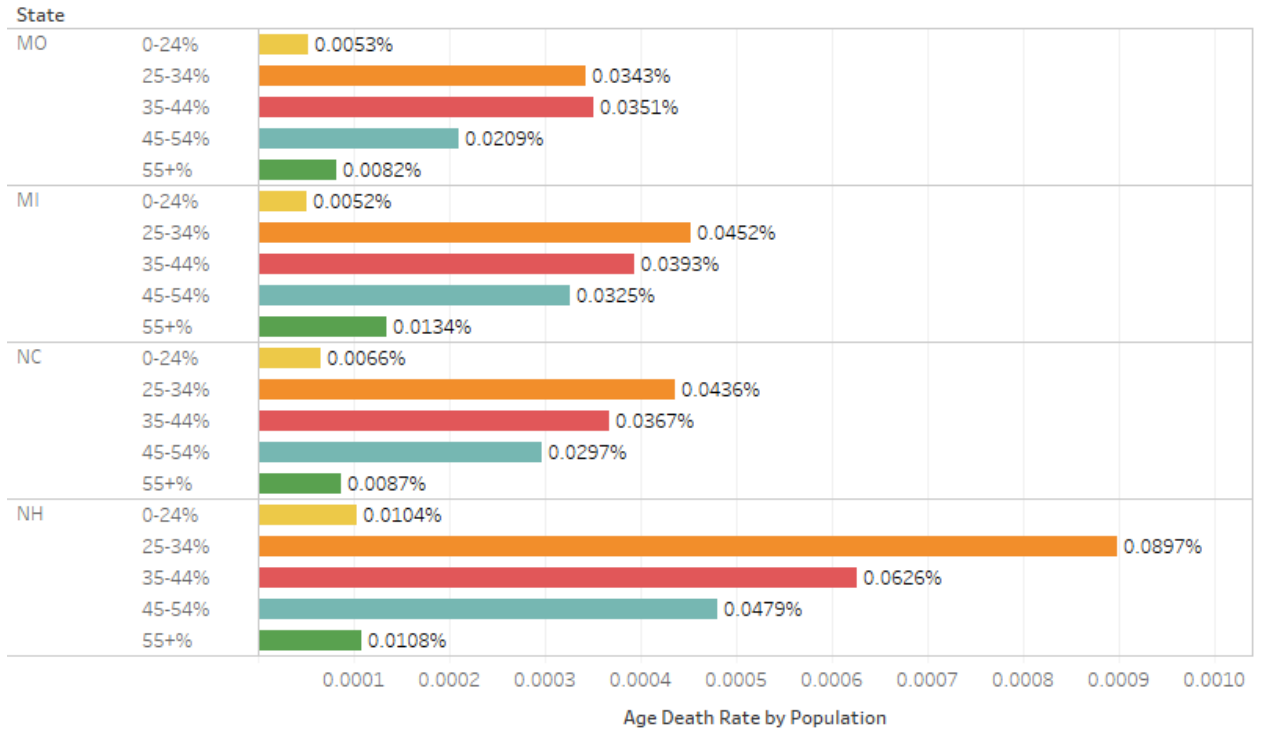


Figure 4.3c: Age Death Rate by Population vs. States in the US

## Death Rate per 10000

Death Rate per 10000

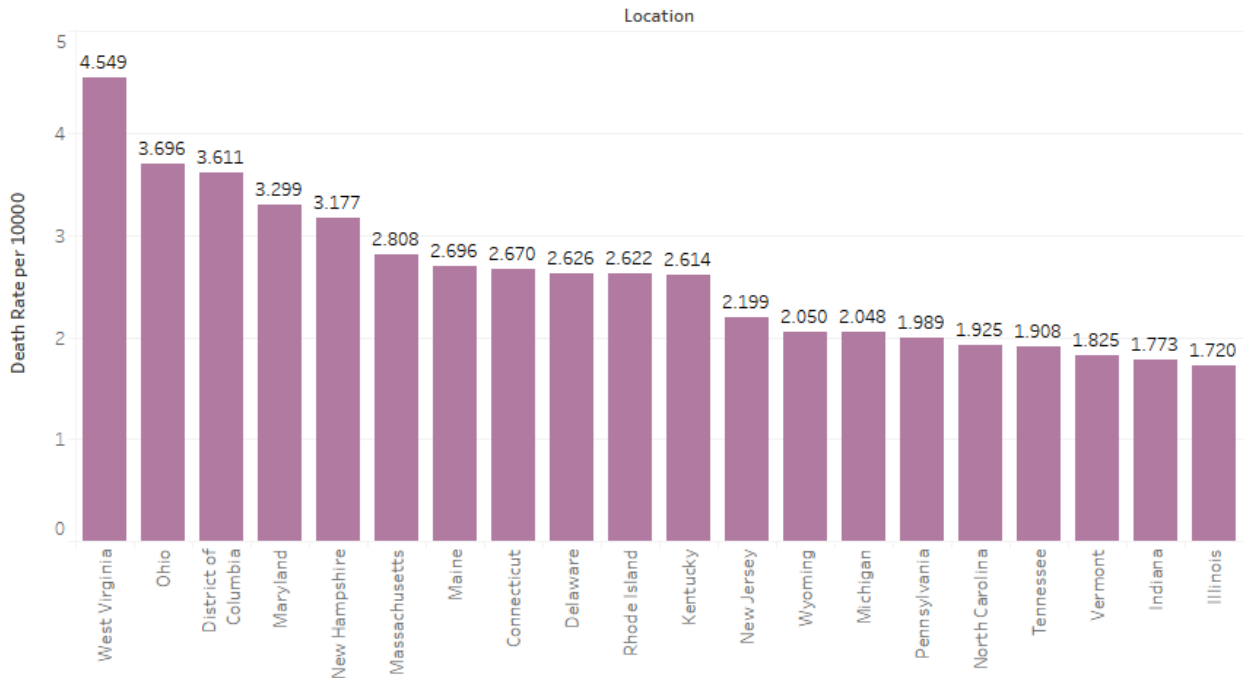


Figure 4.3d: States in the US vs. Death Rate per 10000

In figure 4.3a, 4.3b, 4.3c, I have analyzed the statistics on opioid deaths in various categories from the few states with the largest number of opioid deaths according to age. In most of the states, overdose deaths are more common in the age group of 25 to 34. In fact, except for California and West Virginia, in all other states the problem is more prominent within this age group. Deaths in the age group below 24 are at the lowest in almost all states. After the age of 35, the number of deaths caused by opioids varies from state to state. As per the pattern in the state of Texas, the number of deaths in the age group of 35 and up is similar to the age group of 25 to 34 shown in Appendix A1. In California,

surprisingly the number of deaths is more severe in the people of age 55 and above compared to other states shown in Appendix A2.

### Opioid Deaths by Ethnicity

#### Death Rate by Ethnicity in top States

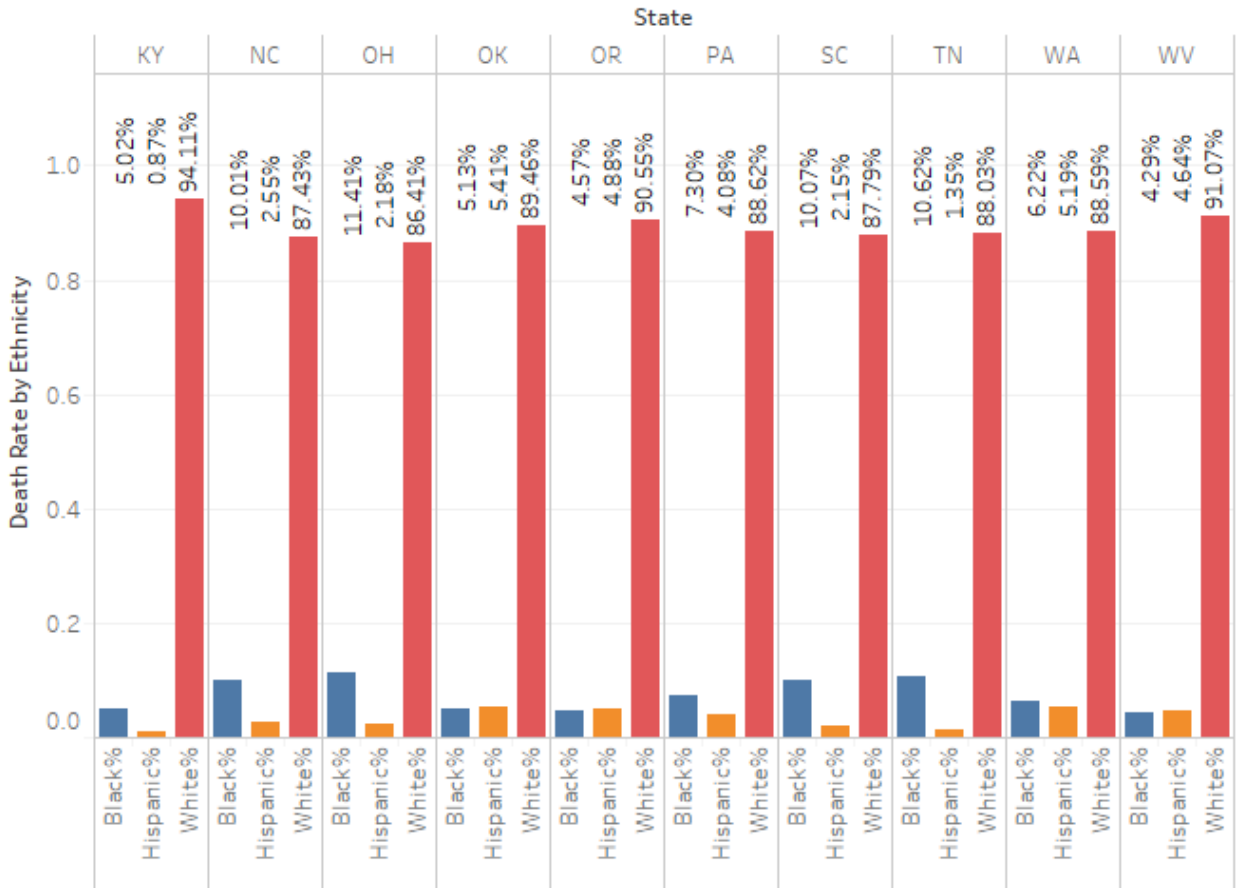


Figure 4.4: Top 10 States in the US vs. Death Rate by Ethnicity

Figure 4.4 shows death rates caused by opioid overdose based on ethnicity. The majority of America’s population is White and Non-Hispanic and that is likely why the number of deaths in this group is so predominant. However,

the Hispanic population is ranked second followed by the white population in most of the states. Black and Non-Hispanic people rank the lowest in these charts.

### Opioid Deaths by Sex

#### Opioid Overdose Deaths in Top 10 States by Sex

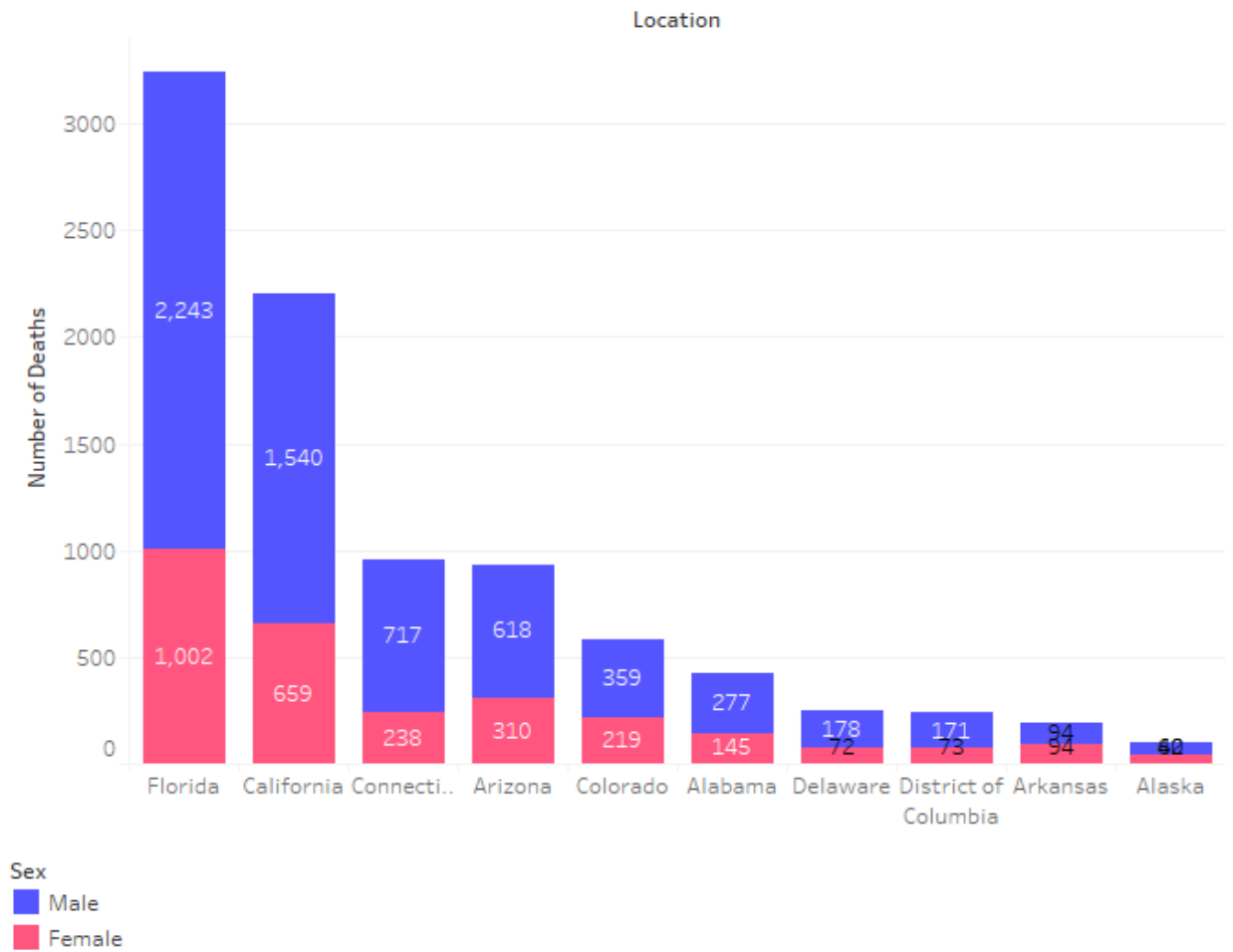


Figure 4.5a: Top 10 States in the US vs. Number of Deaths by Sex

## Death Rate by Sex Normalized by State Population

Death Rate by Sex Normalized by State Population



Figure 4.5b: States vs. Number of Deaths by Sex

## Death Rate by Sex Normalized by State Population

Death Rate by Sex Normalized by State Population

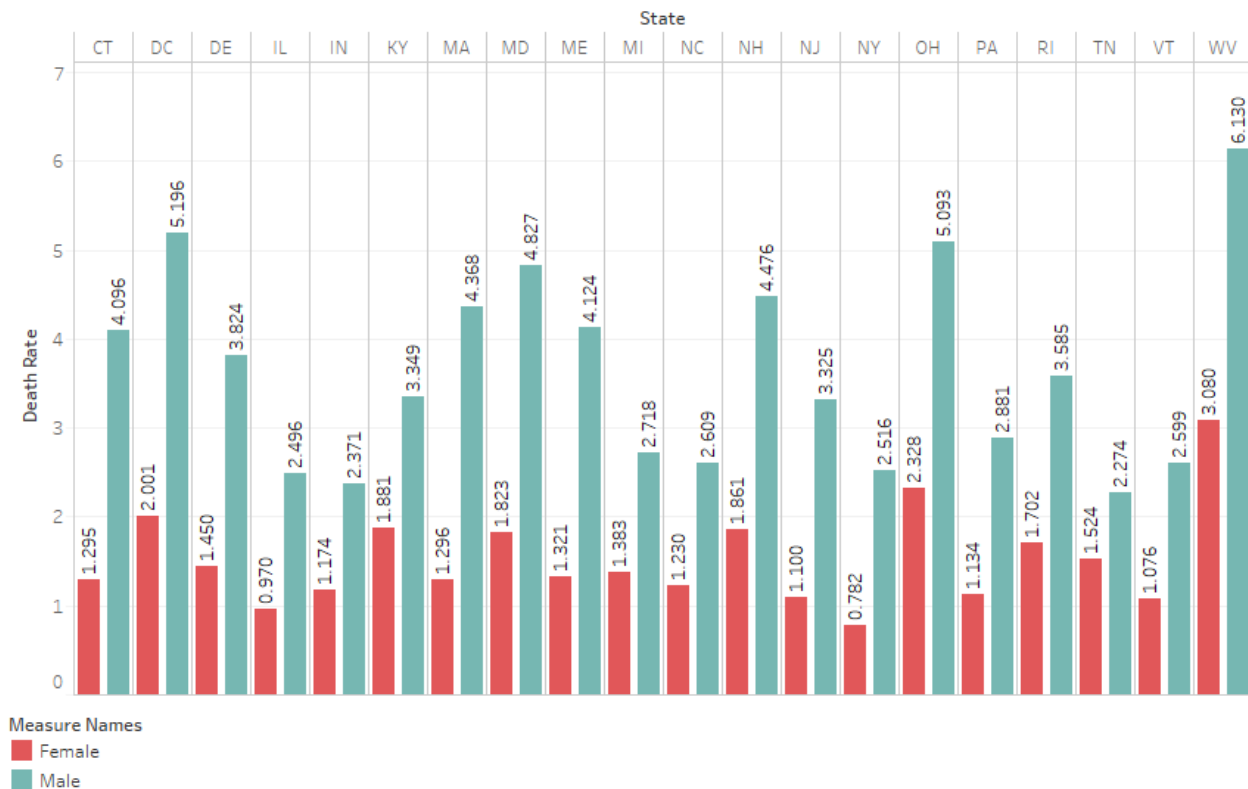


Figure 4.5c: States vs. Number of Deaths by Sex

Figure 4.5 shows the number of deaths based on sex in top. In figure 4.5.1 and 4.5.2 shows the death rate by sex normalized by state population. In all the states, it is clear that males are at the greater risk of opioid overdose death. Only in Arkansas, the male and female statistics are similar, but in other states, the female number is considerably lower than the male. Males are more likely to be opioid users than females.



### Average Opioid Prescribing Rate in Top 10 States

#### Avg. Opioid Prescribing Rate

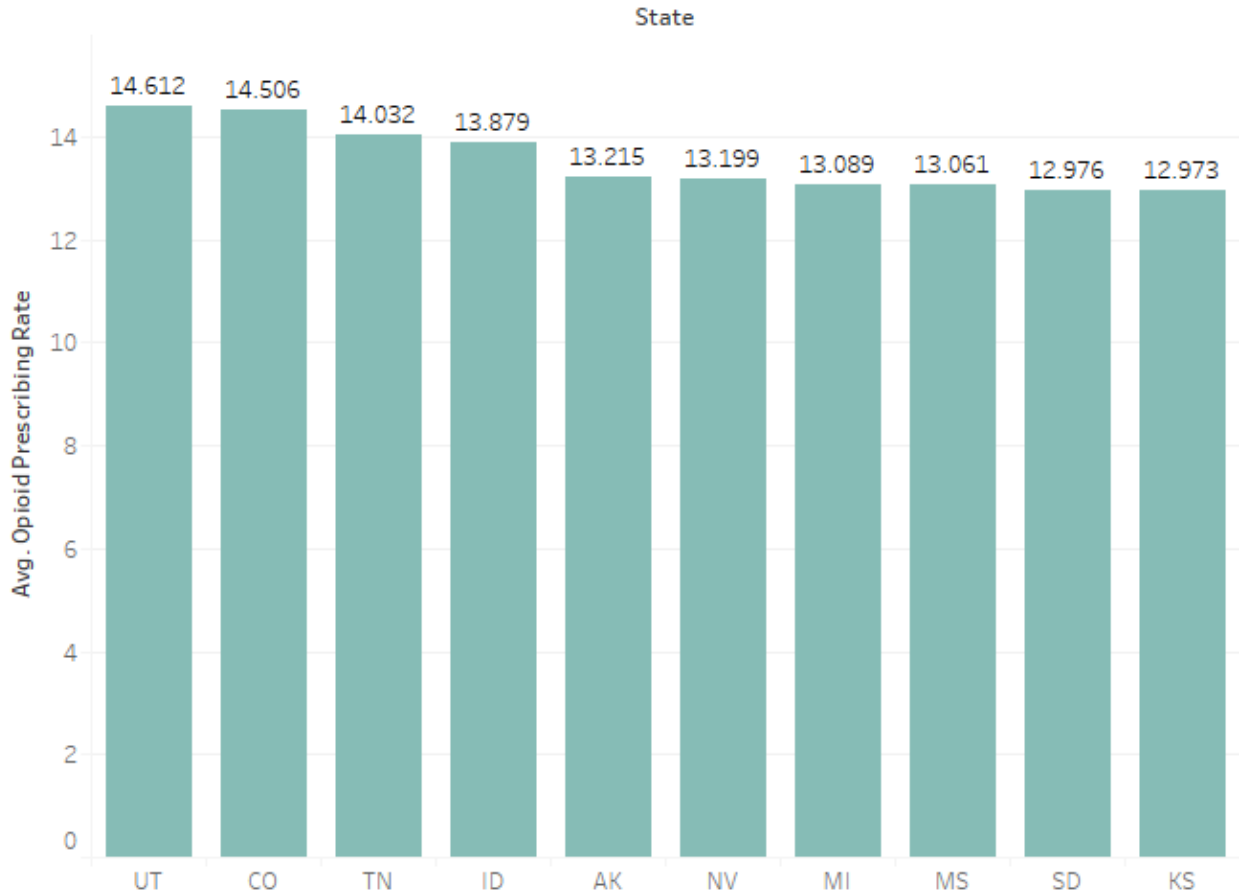


Figure 4.6: States vs. Avg. Opioid Prescribing Rate

Figure 4.6 shows the top 10 states where avg. opioid prescribing rate was high. It shows the percentage of opioid claims out of the total claims. Based on this rate, Utah has the highest opioid prescribing rate. However, it is not the state which has the higher opioid overdose death rate.

## Specialty Total Claims Normalized by State Population in Top 9 States

### Specialty Total Claims Normalized by State Population

Specialties	States								
	CA	FL	GA	MI	NC	NY	OH	TN	TX
Internal Medicine	109.3	155.8	127.3	143.6	123.1	171.1	147.3	144.3	79.8
Family Practice	84.2	110.7	115.8	135.1	146.1	68.9	168.1	155.3	93.2
Nurse Practitioner	15.1	31.1	27.6	28.3	52.0	41.3	47.3	111.6	19.7
Physician Assistant	14.6	14.2	13.5	27.9	48.5	26.3	10.9	23.3	11.6
Emergency Medicine	3.5	4.4	10.6	5.7	4.2	2.9	4.3	8.8	4.1
Physical Medicine and Re..	1.4	3.1	3.0	3.1	3.0	1.8	2.0	1.9	1.9
Orthopedic Surgery	1.3	2.9	3.2	2.1	2.4	1.2	2.5	2.8	1.9
Anesthesiology	0.8	2.8	3.8	1.8	1.7	0.9	1.8	1.3	2.0
Pain Management	0.6	2.6	1.9	1.7	0.6	0.8	2.2	1.0	1.6
Interventional Pain Mana..	0.6	3.7	2.8	1.0	0.9	0.7	1.1	0.9	1.5

Figure 4.7: Total Claims by Specialties vs. States

Figure 4.7 shows the total number of claims for all medication in the year 2017 from different providers as per their practice specialty. Most of the prescriptions are produced by family practice and internal medicine. The number of providers in these two specialties and the number of prescriptions written by them are the highest in America. People tend to go to their primary care doctor for their initial visit as well as for maintenance care visits which fall under these two categories. The total number of claims also include opioid prescriptions. An interventional pain management produces a lower number of prescriptions compared to other specialties.

## Specialty Opioid Claims Normalized by State Population in Top 9 States

### Specialty Opioid Claims Normalized by State Population

Specialties	States								
	CA	FL	GA	MI	NC	NY	OH	TN	TX
Family Practice	4.23	4.69	5.43	8.67	6.28	2.03	6.71	7.51	4.07
Internal Medicine	4.39	5.75	5.07	8.48	4.55	3.34	5.22	6.42	3.17
Nurse Practitioner	1.06	0.04	0.46	0.70	4.21	1.98	3.25	12.91	0.53
Physician Assistant	1.56	0.09	0.31	2.43	5.53	1.61	1.33	3.15	0.38
Anesthesiology	0.40	1.66	2.19	1.05	1.02	0.38	0.84	0.71	1.16
Orthopedic Surgery	0.52	1.26	1.45	1.09	1.04	0.36	1.16	1.20	0.84
Physical Medicine and Re..	0.59	1.46	1.63	1.40	0.99	0.56	0.80	0.64	0.82
Interventional Pain Mana..	0.27	2.32	1.64	0.64	0.51	0.27	0.50	0.51	0.96
Pain Management	0.33	1.61	1.13	0.95	0.35	0.35	1.18	0.56	1.03
Emergency Medicine	0.45	0.82	1.23	1.01	0.69	0.30	0.72	1.01	0.54

Figure 4.8: Total Opioid Claims by Specialties vs. States

Figure 4.8 shows the number of opioid claims according to the practice specialty of the doctors. Family practice and internal medicine have the highest number of opioid claims in almost all states.

## Adults Ages 18 + (Addiction but Did Not Get Treatment)

Rate of Adults 18 + by Population State (did not get treatment despite of having an addiction)

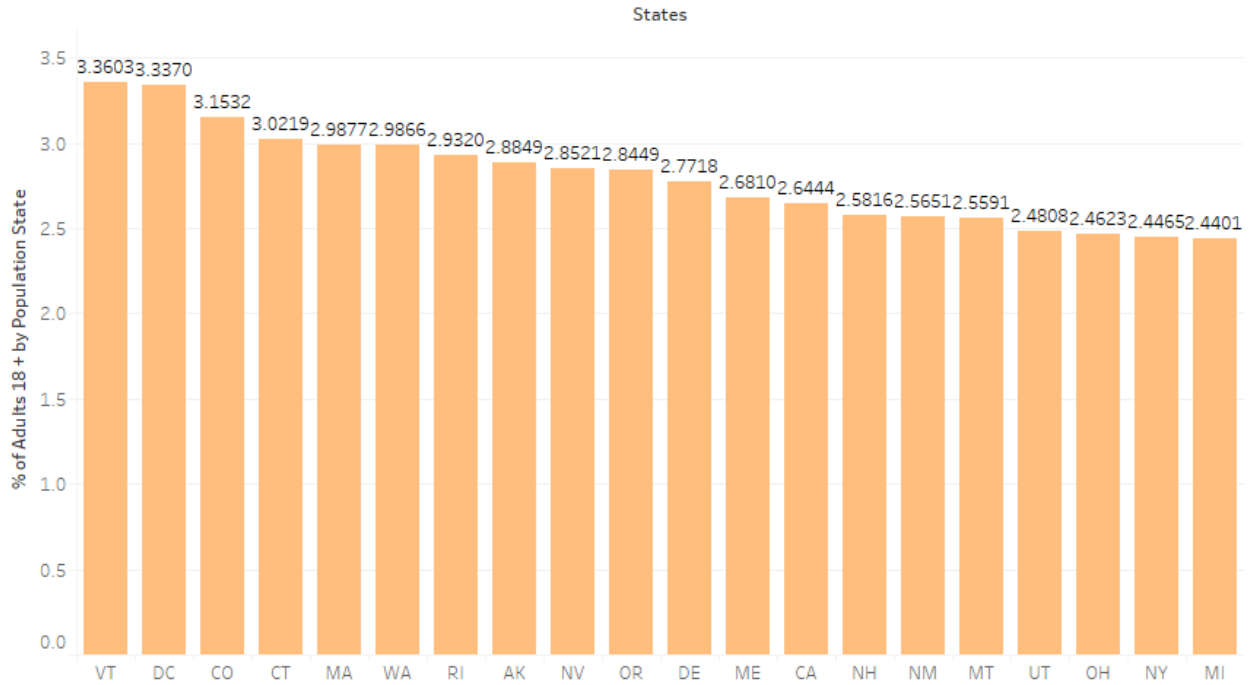


Figure 4.9: States in the US vs. Adults 18+ Population

Figure 4.9 shows the addiction data for those that reported addiction but did not receive any professional treatment in the age group of Adults 18+. In this age group, Vermont and the District of Columbus are at the highest position.

## All Drug Overdose Death Vs. Opioids Overdose Deaths in Top 10 States

### All Drug Overdose Death Vs Opioids Overdose Deaths in Top 10 States



Figure 4.10: All Drug Overdose Deaths vs. Opioid Overdose Deaths

Figure 4.10 shows the statistics of overdose deaths caused by all drugs compared to those caused only by opioids. From the graph, it is pretty clear that opioids play a very important role in overdose deaths, as they are the reason for more than half of the total deaths in all states.

## Opioid Misused Normalized by State Population

### Top States - Opioid Misuse

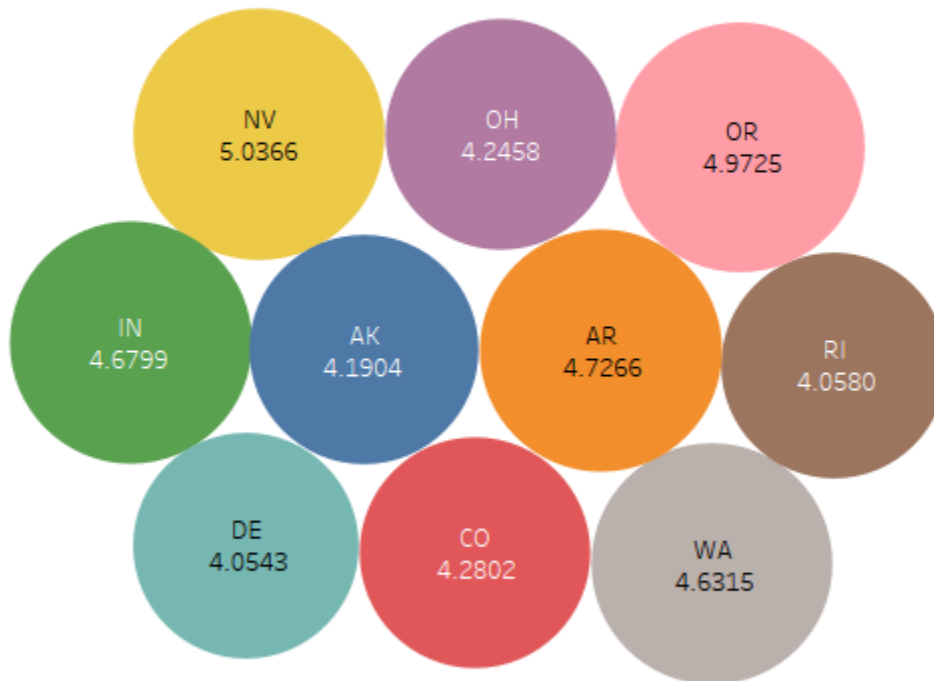


Figure 4.11: States in the US vs. Opioid Misuse

Figure 4.11 illustrates the cases of opioid misuse recorded in top 10 states normalized by state population. Nevada, Orlando and Arkansas are the top three states with an opioid misuse issue. Preventive measures are necessary in these states to control this situation.

## Opioid Overdose Deaths by Type of Opioid (2016)

Opioid Overdose Death by type of Opioid 2016

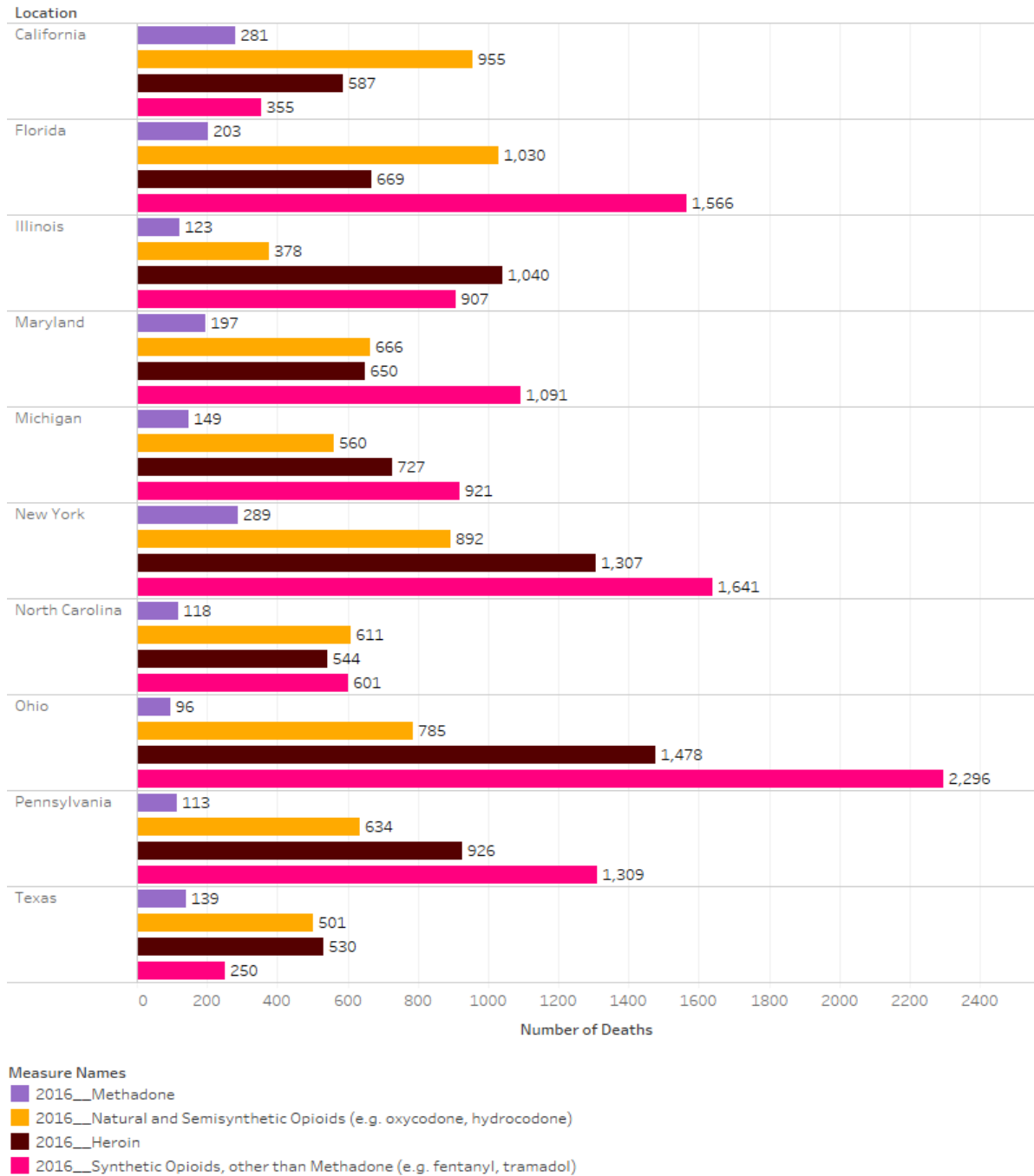


Figure 4.12a: States in the US vs. Death by Opioid Types (2016)

## Opioid Overdose Deaths by Type of Opioid (2017)

Opioids Overdose Death by type of Opioid 2017

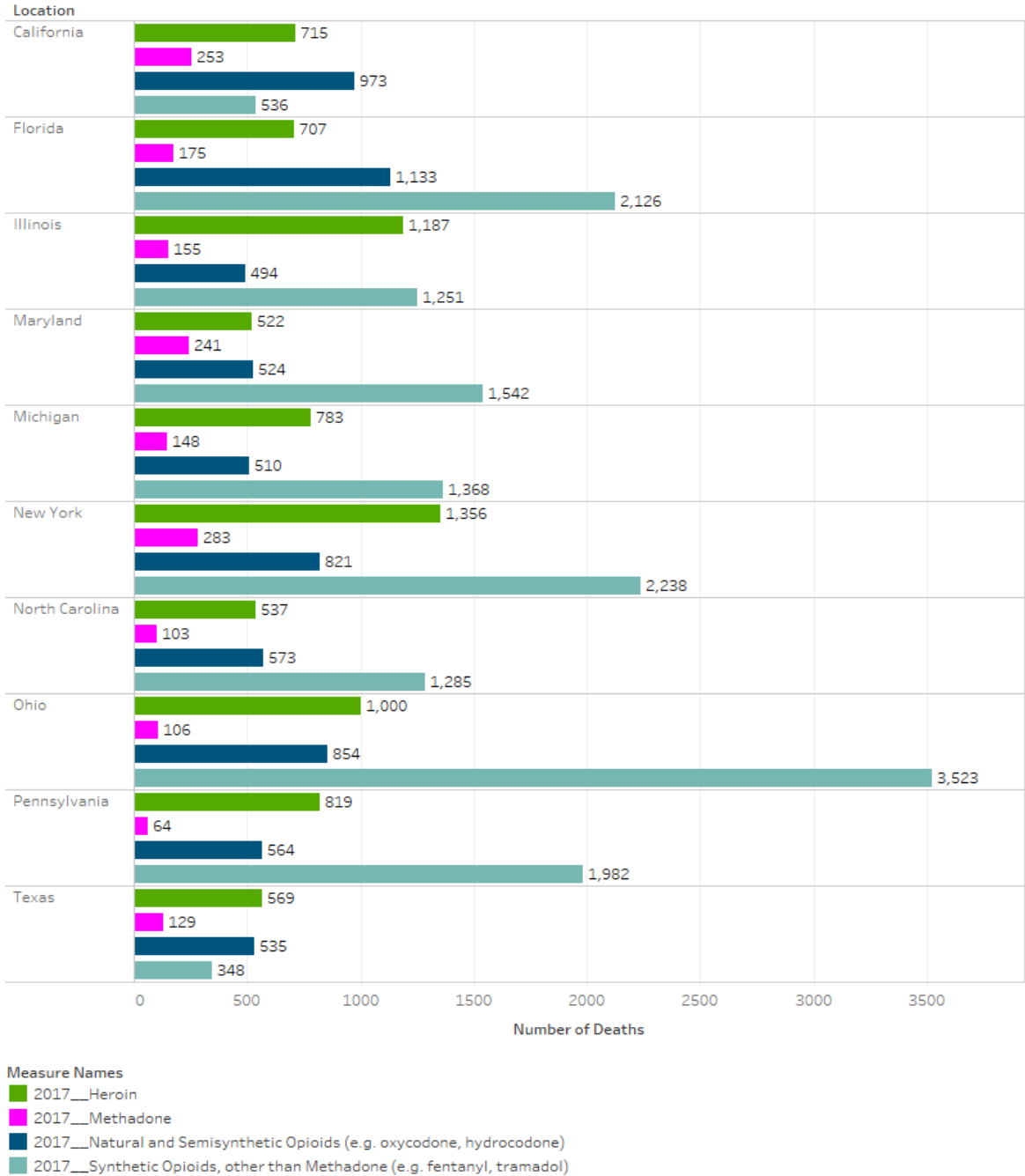


Figure 4.12b: States in the US vs. Death by Opioid Types (2017)



Figure 4.12a and 4.12b shows the comparison of deaths caused by different kinds of opioids in 2016 and 2017. In both years, synthetic opioids like Methadone, Fentanyl, etc. are more responsible for the overdose deaths than natural opioids. This pattern is similar in most of the states. It is also interesting to see a significant number of deaths caused by heroin even though illegal. Heroin alone has caused half the total number of deaths that were caused by synthetic opioids.

By looking at the statistics, it is very clear that the number of overdose deaths have increased from 2016 to 2017.

## CHAPTER FIVE: MINIMIZING TECHNIQUES

By analyzing the above data, it is shown that certain states and communities are highly affected by addiction problems. We should enhance education and awareness to high risk areas about opioids and its side effects. Most of the users of opioids are not aware of its short term and long term effects on their body. They think of these medications just like any other medication. These people need to be educated first before initiating the opioid therapy (HHP, 2019). Doctors and other healthcare facilities should provide detailed information about medication. The patient should be educated about the mechanism of action of drugs, how it works on the body, what are the usage of the medication and its side effects, and its interaction with other medication and its side effects. It is very common that patients are unaware of the adverse drug reaction or allergic reaction caused by the medication (Staff, 2019). In this case if a patient gets any reaction after taking the opioid medication, it is possible that they do not know the reason behind it which could be due to use of that particular medication. To prevent this situation, the patient must be aware of the effects of the opioid medication.

Any opioid prescription must be dispensed with the overdose countering medication such as Narcan Nasal Spray. Sometimes, patients accidentally ingest more than prescribed dose and may end up in an emergency due to overdose.

Narcan nasal spray is very easy to use in such conditions to avoid hospitalization. Narcan is an opioid antagonist which is used to quickly reverse effects of opioids.

It should be mandatory to check the CURES profile before dispensing any control substance prescription. Many doctors and pharmacies do not follow the guidelines to safely dispense opioids and abusers take advantage of this situation to obtain opioids from multiple locations. Any healthcare facilities should be closely monitored to ensure safe dispensing practices (CSBP, 2016).

Data shows that the age group from 24 to 35 is more susceptible to opioid overdose. There could be a possible explanation for this condition because individuals within the age group of 25 to 34 are often those trying to build their career professionally and personally. They are likely to be more stressed during this time and hence more vulnerable to get opioids to relieve stress or even to enhance their performance. Lack of education and awareness at this age may also be the cause of overdoses. These people should be closely monitored and followed up after each opioid prescription. Below age 24, the opioid death rate is low in most states. This is due to the time it takes most individuals to develop an addiction and therefore by the time that an individual is addicted they have passed the age of 25. Also, it is rare to get an opioid prescription below the age of 18. No more than one month supply of opioids should be given at a time to avoid large quantities and risk of overdose.

The data also shows that there are a huge number of people who reported to get opioid overdose but did not receive treatment. This may be because they are unable to reach the correctional facilities for such reasons: lack of transport, financial outage, lack of knowledge, low inspiration or motivation, or lack of family support, etc. (Kelley, 2020).

More rehabilitation centers should be created with endless support to the ones who need it. There are several different programs available to the addicts who help and support them to fight back with addiction problems, but to some extent they are not efficient enough to control the problems. The programs should be expanded to reach more and more people who are in need to fight back with addiction (Kelley, 2020).

Family practice and Internal medicine has prescribed more opioid claims compared to other specialties. Looking at these facts, the Drug Enforcement Agency (DEA) has recently notified these practitioners to provide a maximum of 7 days' supply of narcotics or opioids as a part of initial pain management therapy. If patients need more than that they need to be referred to pain management specialists for further treatment.

In Vermont and the District of Columbus were reported highest for adults 18+ who did not receive treatment after being addicted. This can be a serious problem. If a person is reported to have an addiction problem, they should be given immediate attention and treatment. If treatment is not pursued, addiction

can lead to misuse and overdose (NIDA, 2019). Sometimes because of social pressure and stigma, a person is hesitant to go to the rehabilitation center. They may think if they go to a rehabilitation center, they may forever be labeled as an addict and lose their pride and respect. Some reasons for not getting treatment also include lack of knowledge, financial burden or unreachable treatment facilities (Kelley, 2020).

Based on the analyzed data, certain types of opioids such as Fentanyl and Methadone are more accountable for overdose deaths. Synthetic opioids are proven to be more effective for the pain management treatment. Therefore, most people prefer to have synthetic opioids over natural or semi-synthetic. These classes of drugs cause a high level of dependence and by the end of treatment a person is very likely to become addicted to them. After prolonged usage, it becomes really hard for them to avoid using synthetic opioids or to navigate to other mild opioids like hydrocodone and oxycodone (Bellum, 2014). Doctors should minimize use of these opioids and focus on safer options like oxycodone and hydrocodone. Patients should be encouraged to use alternate ways of treatment instead of using opioids by physicians and pharmacists. Most of the patients develop dependence after repetitive use of opioids. To avoid this situation, patients should be gradually weaned off the use of opioids to ensure the end of opioid treatment. This way, a person will not crave for the opioid medication unnecessarily. It would be helpful to refer the patients to skilled nursing facilities if they are using high risk opioids. The healthcare professionals

will monitor the dosing of the opioids for disabled or aged patients (Dineen & DuBois, 2016).

#### Limitation

Data used for the analysis in this project are derived from one source. It is possible that other sources may have slightly different information and facts. Suggestions made in this project are based upon the market situation of the 2017 opioid crisis. There is scope of changes in death rate and addiction pattern in the past two years. Factors considered during this research are limited to age, sex, ethnicity, prescriber type and types of opioids. There are a number of other factors such as social and mental state of patient, type of disease they are treating, duration of opioid use, etc. which can possibly make difference in the conclusion of this project.

## CHAPTER SIX: FUTURE WORK

Pain is a subjective matter. The problem with the pain is that it cannot be measured. When a person visits a doctor and complains about having pain, there is not a way that doctor can analyze if the patient is actually in pain. In that case, the treatment starts with simple pain medication. However, a constant complaint of having pain by a patient leads to a treatment with opioids. As per CDC, opioid users can get prescription for themselves, from their family and buy them on the streets illegally. Therefore, it is almost impossible for a physician to know that the patient is a legitimate opioid user or has an addict (Media, 2014). In that case, if we can find some ways for a doctor to know the patient more efficiently that patient is not abusing the pain medication. It would help to limit the misuse of opioid prescription.

After doing some research, one method to prevent the misuse of opioid medicine is by creating an application (Opioid Intake Measurement System) which can constantly observe a patient's blood concentration for a certain high risk opioids. The science behind this process is to create a sensor which can be applied on the skin which measures the level of different opioids in a person's blood stream and send the signals to the application. Veracious kinds of opioids have their threshold which determines the minimum amount of drug concentration needed in blood for them to produce therapeutic effects. The dose

of the medication is determined by this threshold. Also, there is a maximum limit to this concentration which can be safely tolerated by the body with minimum or no side effects. If the blood concentration goes beyond this limit, it could cause a very serious reaction or side effects (“Keep Track of Taking your Medicine,” 2019).

### Sensor

It can be a biologically made sensor which can be worn on the skin. It can stick to a body with adhesive material. This sensor should check the blood stream below the skin without any pricking or pain. The time interval between each measurement can be adjusted as per the need. The sensor should have an inbuilt battery and necessary components to perform its job. The sensor should be good for one week to one month depending on the size and capacity. The measurement data can be transmitted to the application downloaded in patients' as well as physicians' cell phone devices.

### Application

Application should collect the data provided by the sensor. This data can be classified in the application in various categories such as Date, Time, Type of opioids, Minimum and Maximum concentration of particular opioid in blood, etc. Physicians should analyze this data to determine the patient's legitimacy of opioid use. This application should also send notification to physician or patient's relative in case blood levels go beyond accepted limits. This application should



also be helpful to monitor patient compliance of oral opioids. The access to the application should be provided to patients, physician, hospital and acute care agencies as well as police.

## Modules and their Descriptions

### Doctor and Healthcare Facilities.

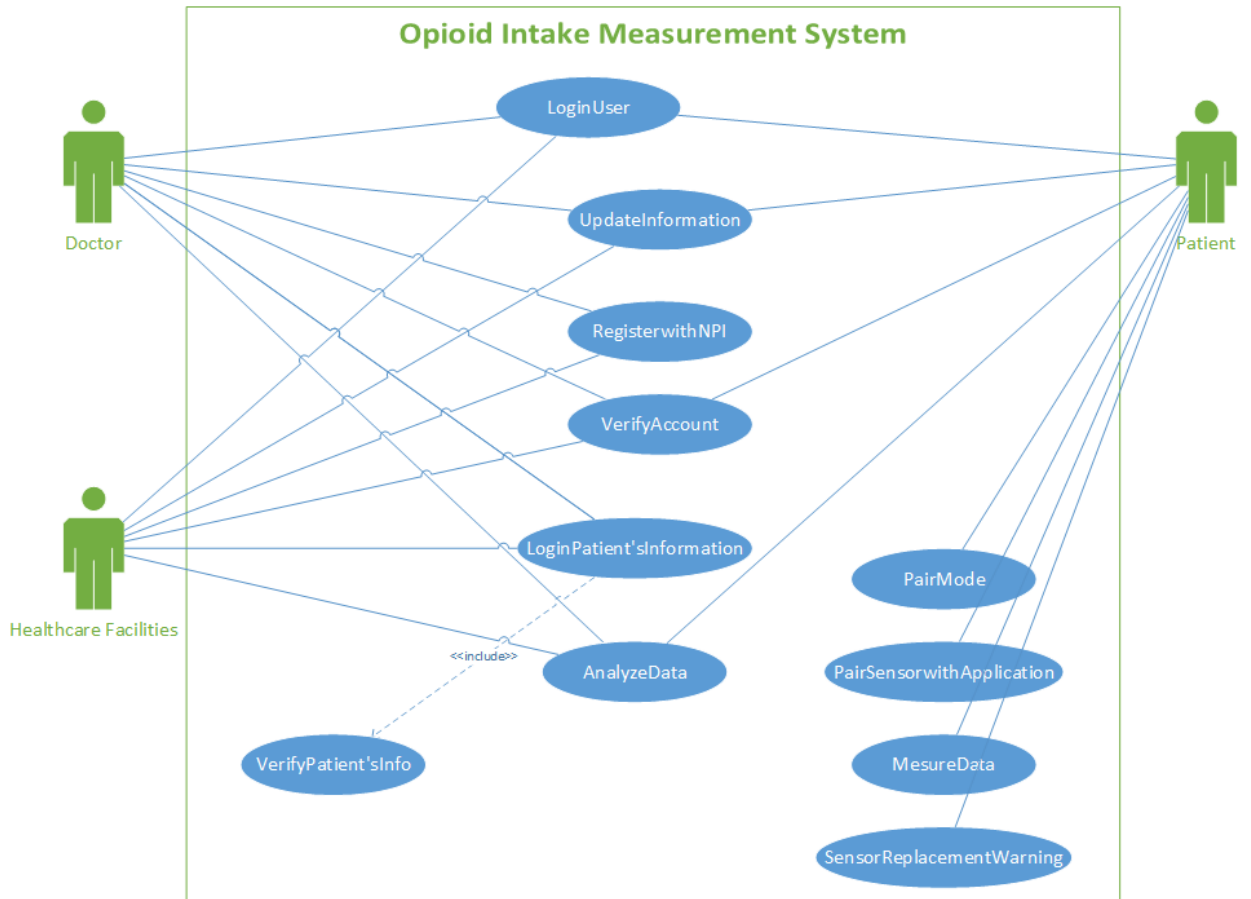
- Create an account: Doctors and healthcare facilities will create an account with their name and title and register with their National Provider Identifier (NPI) number.
- Login: Doctors and healthcare facilities will login to the system using their ID and Password.
- Search patient's information: Doctors and healthcare facilities will search the patient's information: last name, first name, and date of birth
- Analyze the Data: Doctors and healthcare facilities will analyze the patient's data regarding the intake of opioids.

### Patients.

- Create an account: Patient will create an account with their first and last name, date of birth and social security number.
- Login: Patient will login to the system using their ID and Password.
- Pair mode: Patient will pair their sensor with the application.
- Measurement and Analyze Data: Patients will be able to see their intake of opioids via the application.

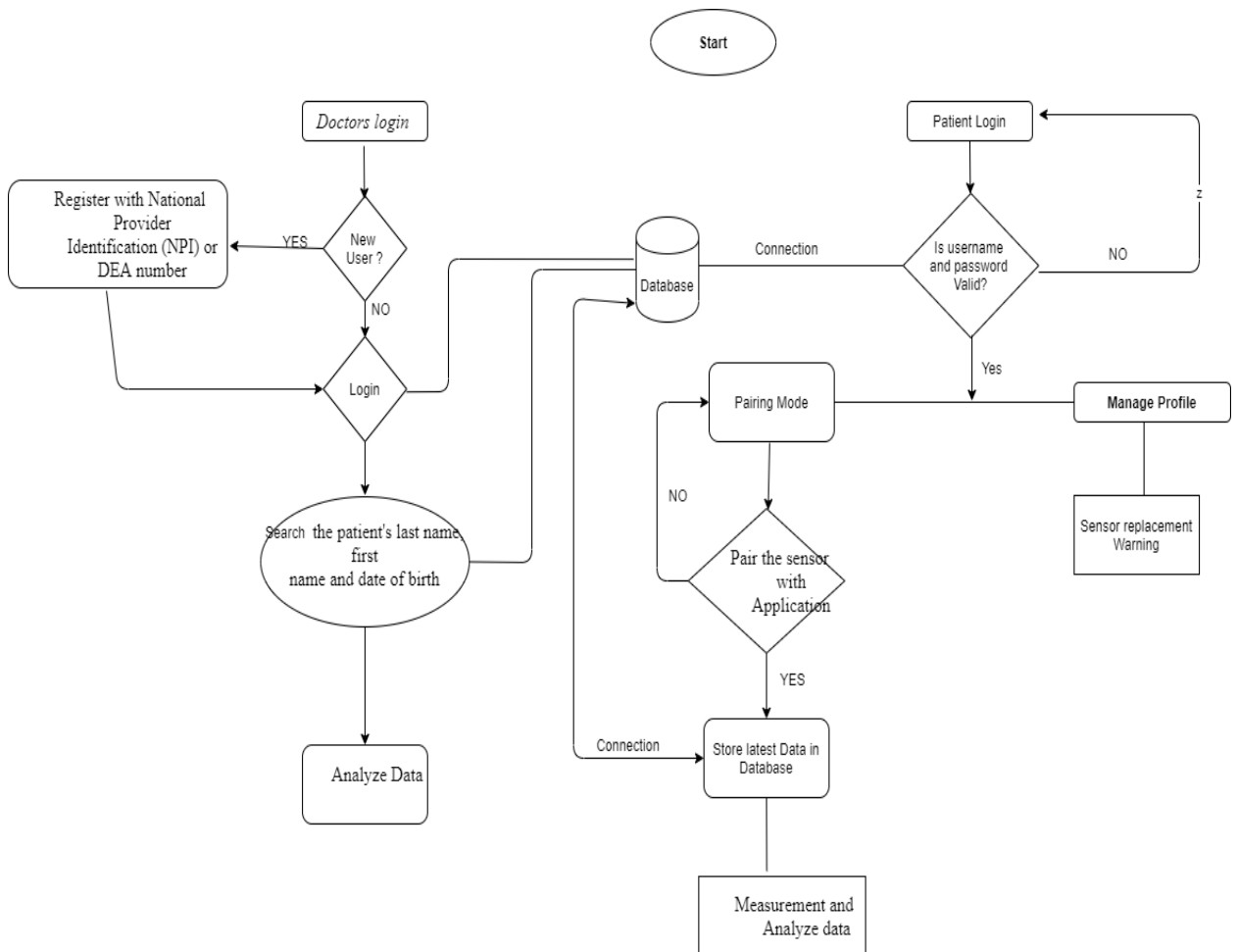
## Application Interface

### Use Case diagram



Use case diagrams representation of the user's system with the system in which shows the relationship between the users and the use cases who are involved. In this application, the end users will be patients, doctors and healthcare facilities.

## Data Flow Diagram (DFD)



Data flow diagram is a graphical implement which use to describe and analyze movement of data through the system. DFD can be divided into two parts: logical and physical. The logical part shows the flow of data through the system to perform certain functionalities. The physical data flow describes how logical data flow are implemented.

## CHAPTER SEVEN: CONCLUSION

On the whole, the current policy and programs to regulate the use of opioids are not efficient enough to reduce the overdose crisis. Despite spending millions of dollars, drug abuse and overdose death are increasing.

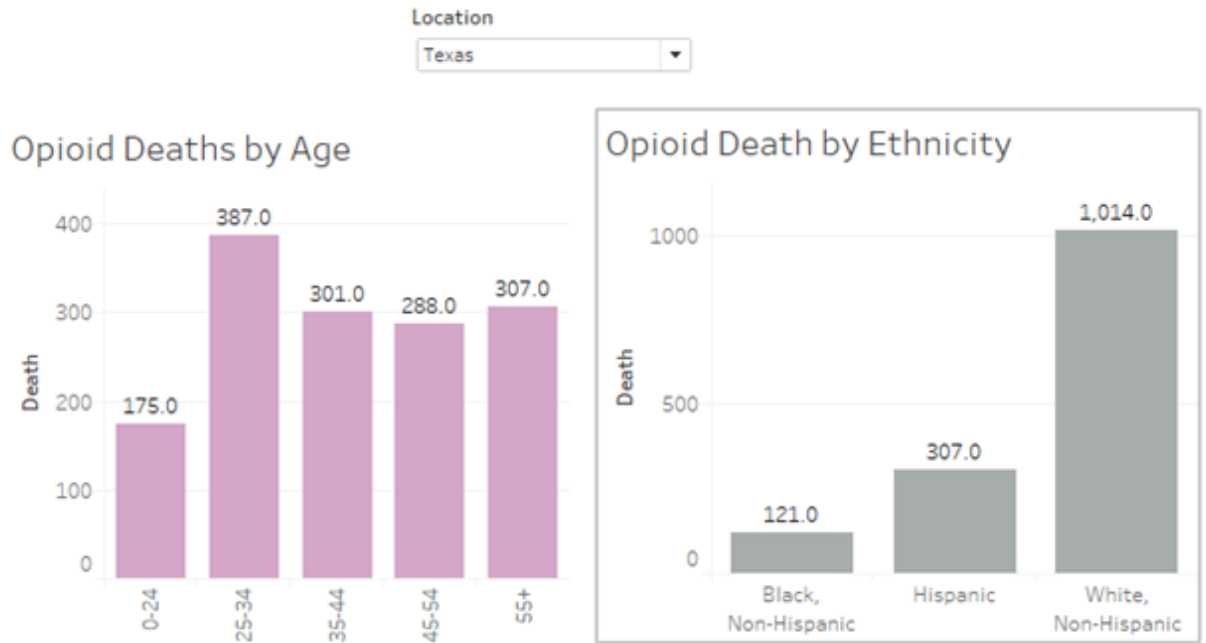
This project shows the statistics of opioid overdose deaths in the United States which concludes that the most opioid overdose death rate is in West Virginia State, within the age of 25 to 34 in mostly all states, in the white community. Synthetic opioids among all other opioids are shown to be worse. The research also gathered that family practice and internal medicine doctors produce most of the opioid prescriptions which is the group that should be focused on in the future in order to decrease the number of opioid prescriptions given out.

To minimize the opioid overdose, alternative pain management therapy should be used. Also, limit the use of synthetic opioids and try to divert patients towards safer opioids. Pain management treatment should be ended with the use of withdrawal management drugs such as Narcan and Suboxone to help the withdrawal symptoms. The number of rehab facilities should be increased to reach out to every affected area and should increase awareness of their centers. Also, addicted people should be encouraged to use them. In the future, digital

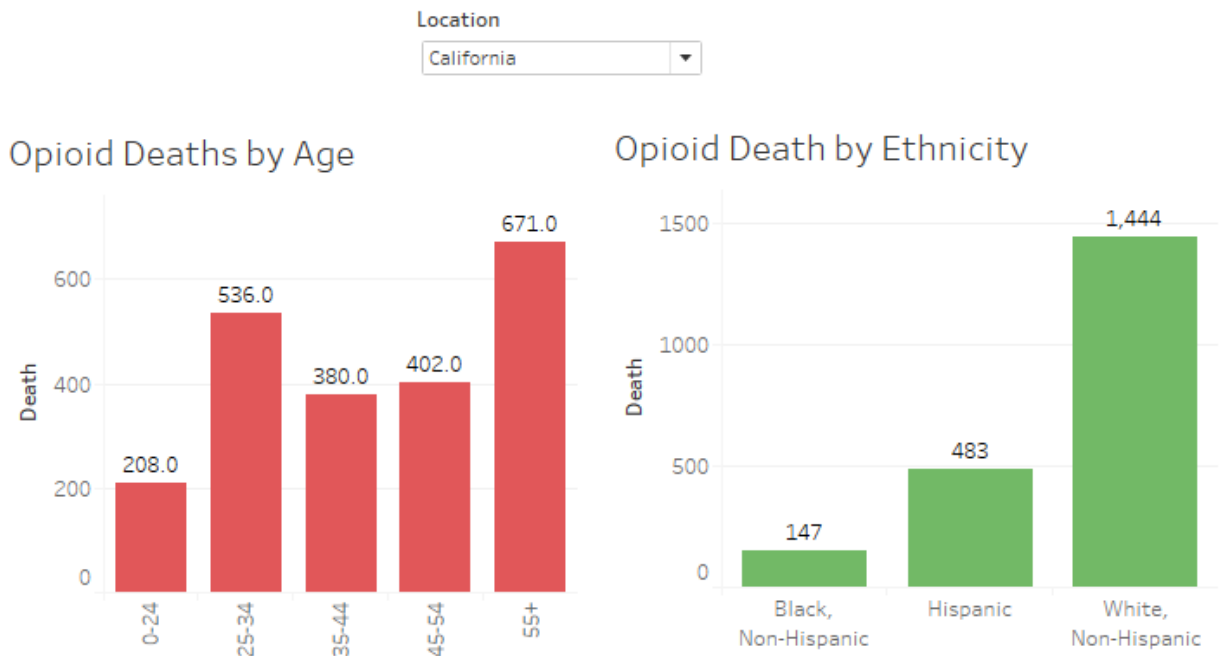
approaches should be established to monitor controlled substance usage in patients such as auto-read sensor and application technology.

## APPENDIX A

### Appendix A1: Opioid Death in Texas by Age and Ethnicity

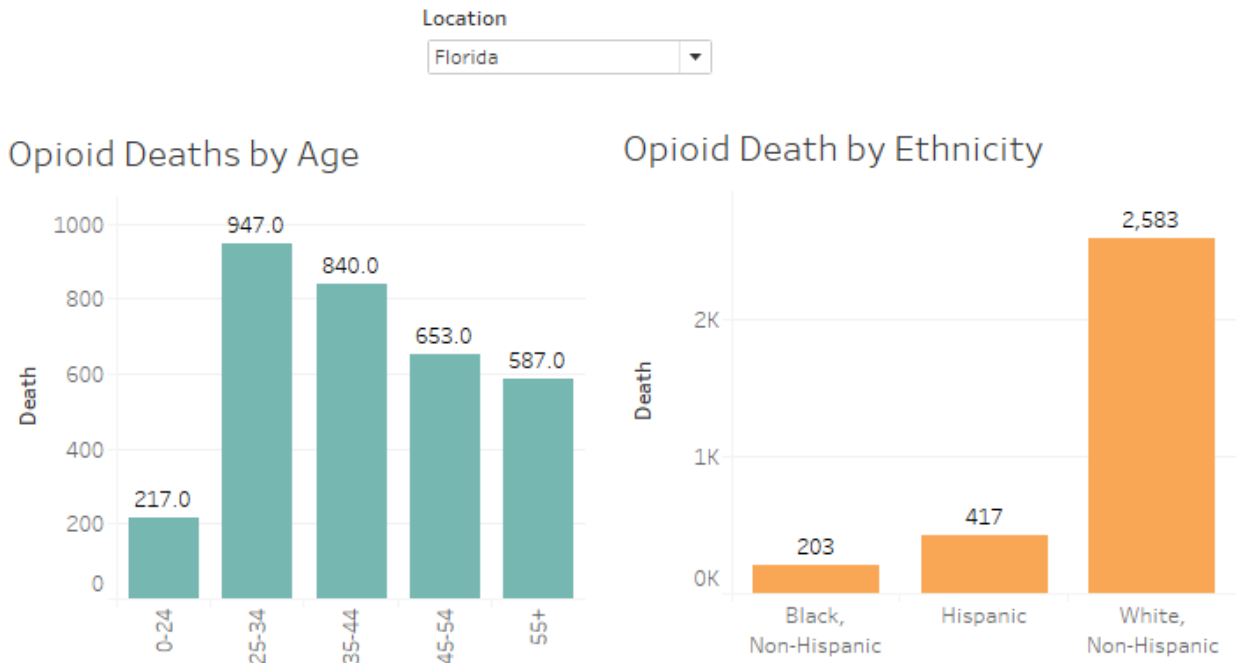


### Appendix A2: Opioid Death in California by Age and Ethnicity

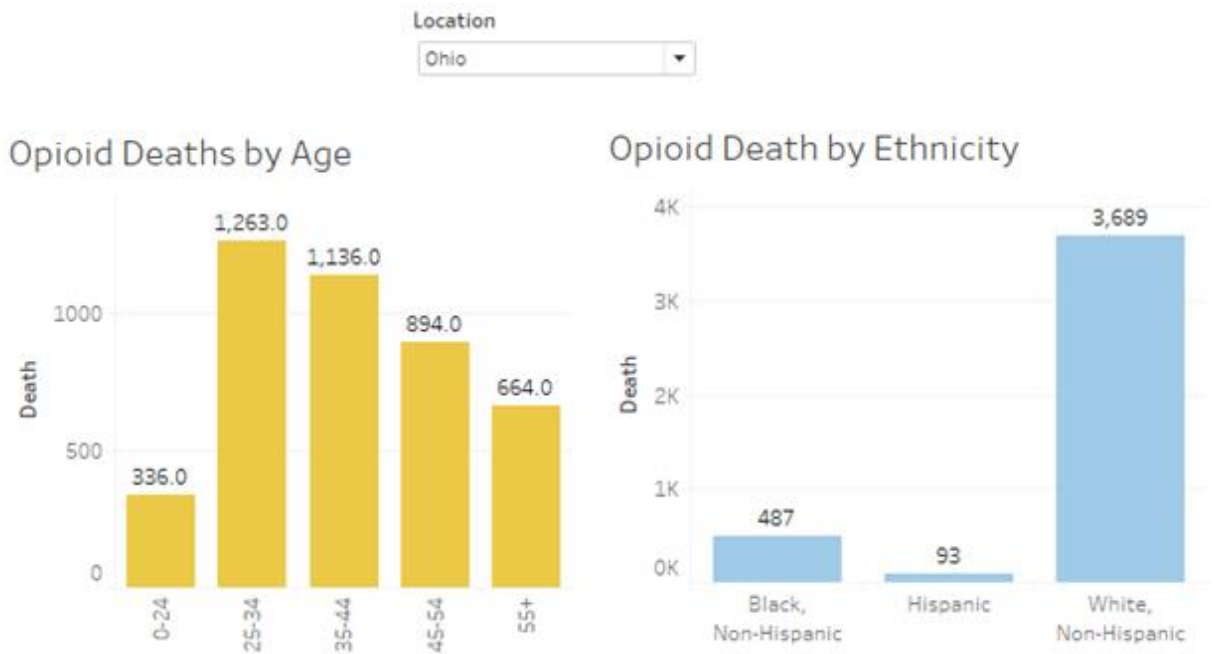




### Appendix A3: Opioid Death in Florida by Age and Ethnicity



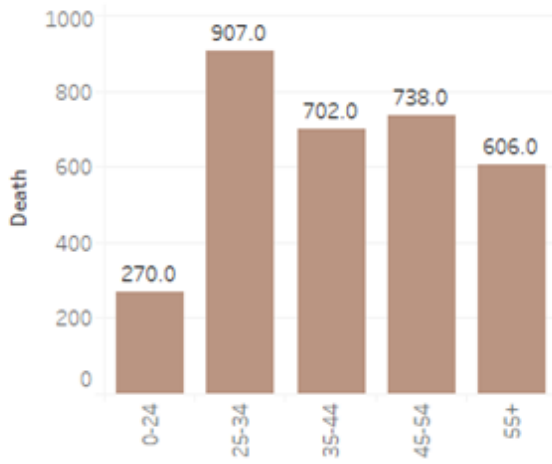
### Appendix A4: Opioid Death in Ohio by Age and Ethnicity



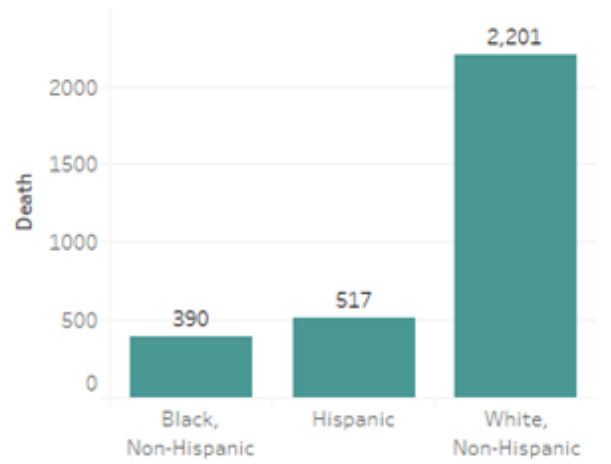
## Appendix A5: Opioid Death in New York by Age and Ethnicity

Location  
New York

### Opioid Deaths by Age



### Opioid Death by Ethnicity



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