R Term Project – 0693126

I. Introduction

Opioids and drug abuse have become global issues in the last decade, the advent of COVID-19 significantly increase the impact. Drug abusers have been disproportionately affected by the "twindemic," with the CDC reporting that over 40 states in the USA have drastic increases in opioid-related mortality, particularly from fentanyl or fentanyl-like substances.

The (CDC) estimates that the economic impact of legally obtained opioid use in the United States is $78.5 billion a year, which also covers the costs of healthcare and criminal justice involvement. Some of the states lost almost $13 billion from 2000 to 2018 due to unemployment because of drug addiction. Child welfare costs as a result of the opioid epidemic were approximated at almost $2.8 billion between 2011 and 2016. According to the HHS, drug overdose deaths continue to increase in the US among all demographics. The epidemic had been declared a national emergency as it has almost reached plague-like proportions.

Some of the opioids are illegally obtained and manufactured under very poor conditions. These are sold on the dark web where people purchase them without any knowledge of the dosage and end up overdosing to death. This also makes it harder for the government to track as it struggles to make the connection between the disproportionate overdose deaths and prescribers. A lot of drug abusers turn to assault, battery, theft, and murders to get money for buying drugs. Many rehabilitation centers have come up around the world to help drug addicts but the issue largely remains unaddressed.

II. Literature Review

Minnes et Al. talk extensively about adolescent abuse of drugs and alcohol causing the victim to become dependent on them. Melissa et Al. talk about the increase in drug overdose deaths involving Fentanyl which is one of the most consumed drugs. Baird talks about patients with substance abuse disorders and how they affect the emergency settings in hospitals. There were three waves of opioids in the years from 1990 with natural prescription opioids or methadone. The second wave was in 2010 with the rapid increase in heroin abuse and related deaths. The

most recent wave occurred in 2013 with illicitly manufactured fentanyl abuse, cocaine, and counterfeit pills. The addiction center highlights that there have been 100,000+ American deaths due to overdose between the period of April 2020 and April 2021.

Merianne R. et Al. talk about the timeliness of death certificates in their 2016 paper to highlight the lag time between the week of death and when information on death certificates became available for mortality reports. They also found that the lag was significant when it was an injury-related death. Benedict Fisher et Al. talk about the opioid crisis in Canada where it was observed that British Columbia had significant drug-related deaths nearly 30 years back which have only increased as the years progressed. One of the key insights learned was that Canada was the second highest after the US in terms of prescription opioids which led to many people becoming addicted and dependent on its use rendering them incapable of functioning without it. While the government tried to regulate opioid consumption, this led to people purchasing them illicitly leading to increased opioid fatalities. Existing procedures and policies have tried to curb the use but the issue is still sadly largely at hand. All references are cited in the last section of this article.

III. Problems addressed and Purpose of the Application

Drug overdose deaths often require lengthy analysis, investigations, and death certificates based on the cause of death. Due to these protocols that need to be followed, there is a significant delay in the estimation of the provincial count of deaths. These vary by the jurisdiction, time, and place of death which means some of the deaths aren't reported accurately due to the lag. The Government is responsible to save the lives of citizens by dealing with the opioid crisis in an urgent manner. However, the magnitude of the problem is gargantuan. It can be very hard for governmental agencies to allocate their exhaustible resources.

Data analytics is the key to overcoming this problem. By using data analytics, government agencies can understand where to allocate their resources judiciously to fight the opioid crisis efficiently. Analytical tools can help these organizations study prescription information, and pharmacy fill rates, identify how social groups may be enabling the transfer of prescribed substances from one member to another, and monitor opioid use enablers in society.

Formal information management and data analysis can provide a gamut of consolidated solutions like enabling pharmacies to associate anomalies and develop better treatment

methods. Thus, public healthcare providers, hospitals, and governmental agencies can leverage analytics to better analyze the possible outcomes of well-intentioned initiatives.

Fighting this epidemic is a highly complex challenge that requires a variety of players to collaborate in order to fully understand and solve the problem. Some include the Public Health Agency of Canada, as well as local substance abuse and mental health service groups, Insurance companies, physicians, treatment centers, and law enforcement.

All parties in the healthcare system need to leverage analytics. From physicians to rehabilitation centers to healthcare providers, these groups must make data-driven decisions. Finally, data analysis can help public health groups, community coalitions, and substance abuse treatment improve their operations, measure their results, and contribute valuable data of their own to the larger cause of saving lives.

Given the importance of monitoring trends, aggregating data, analysing different demographics and notable lags in the provisional number of deaths and lack of integrated monitoring, this app was designed to provide a single source of truth that can provide the big picture view to help monitor the specific analysis of drug and drug-related deaths in addition to overdose mortality. These insights will allow the government to make informed policy decisions. The government will get the requisite information to marshal their resources and proactively treat a disease that has been decimating our communities for far too long.

The Interactive Opioid Crisis App will allow users to explore historical opioid-related morbidity and mortality data. The R shiny application can uncover insights like what was the main reason for these deaths and what was the proportion of the different groups of individuals who were involved. Data for the application was sourced from drug-related deaths in the US by the Center for Disease Control. Drug usage by age group along with the percentage of people using them. Significant differences in drug use by different genders have also been analyzed. The most popular drugs that lead to deaths are visualized in a wordcloud format to understand which drugs need to be monitored more stringently. The cause of death is also analyzed by gender. The analysis is supplemented by a geospatial component to the analysis to view drug-related deaths in the different states of the US. The results of this analysis can help us uncover some key insights and statistics on these fatal deaths. One thing to note is that the potency varies by drug, for example, fentanyl is synthetic opioid-like morphine, however, it is 50 to 100 times more potent.

IV. Operational Instructions to use the Application

The application consists of the home screen and five tabs. The first tab is called the 'Overview' tab where the Opioid Overdose phenomenon is described with some history and statistics along with an image of some opioids. There is also a hyperlink attached that will take you to the CDC page to learn more information and view statistics on the Center of Disease Control website.

The first tab is called 'Gender-wise breakdown', where we note that males are significantly higher in proportion with the number of overdose deaths at 74% at almost 3800 deaths while women constitute 26% with around 1450 deaths.

The second tab describes the age-group breakdown of deaths where we change the gender of the population to see a pie chart distribution of deaths by age and gender. Among men and women, it is observed that drug usage is quite high among people in the age group of 30-49 who constitute the majority of the death population at 47.3% and 43.8%. It is also seen that kids from the age of 14 are consuming these fatal drugs, especially among women aged 14-20 who form 2.2% of the population while men in the same age group are at 1.6%. This raises the need to be vigilant about drug abuse among children. People aged in their twenties constitute around 20% of the drug abuse deaths and this is where people get habituated to drugs in the long run. It is also observed that people above 65 consume drugs with deaths related to women double the number of deaths related to men at 2% of the population.

The third tab talks about the most common drugs leading to death and the visual can be dynamically changed based on the ethnicity of the population. The results of top drugs consumed by ethnicities are depicted in the world cloud where the larger the size of the word the higher the frequency of drug usage or intoxication is. It can be observed that among all ethnicities in this word cloud, Heroin and Fentanyl are the most consumed drugs which show that these need to be monitored more stringently.

The fourth tab reports the cause of death for different opioids by gender such as acute fentanyl intoxication which was the cause of death for most men at 149 while heroin intoxication led to nearly 104 deaths while women died the most due to multiple drug toxicity at 42 deaths. The data is represented in a horizontal bar chart with the male being highlighted in the lighter blue shade while women in the darker blue shade.

The fifth tab demonstrates how the opioid crisis in the US has progressed over time. One may select the type of opioid overdoses like heroin, and synthetic narcotics, as well as statistics like total deaths, death percentage, and death rate. The year can be changed using the slider button from 2000 to 2015. A time sequence can be viewed by pressing the play button which changes the years from the currently selected year until 2015. Users may see the data being mapped for each state by hovering over the state. The darker blue shade signifies a higher proportion of deaths with Ohio, California, and Florida having the highest death counts.

V. Conclusion

A single source of truth dashboard can provide timely information about the drug overdose mortality rates and address the problems of delays in reporting the breakdown of deaths. The R shiny Opioid Crisis Application has helped us understand the trends of consumption behind different proportions of the population.

Bringing together data from disparate sources like pharmacies, governmental agencies, hospitals, and physicians will help local government agencies work more effectively together. This can assist in identifying areas for improvement in order to put actions in place that will make a real impact in the fight against opioid abuse. Forming partnerships among these stakeholders will set the stage for a collaborative approach to analytics which can provide a dynamic view of how individuals are abusing the system, identify high-risk individuals, and inform the best strategies for addressing the problem. The manner of death plays an important role in the analysis and it is vital to note that some of the data could be underreported due to the significant delay and hamper public healthcare efforts.

The insights discovered can provide analytically driven decisions on whether healthcare providers and investigative resources are warranted by identifying overdose spikes and their magnitude. It can also help in identifying and triaging crucial resources. Leveraging AI and machine learning can help allocate resources by identifying drug trends and anomalies. Using transaction information and purchase logs, one can also monitor for third-party organizations and people providing opioids that lead to fatal overdoses. This gives an understanding of the presence and prevalence of drugs, and the impact of drug abuse on specific demographics in specific locations.

VI. References

1. Gibbons C, Mangen M, Plass D, Havelaar A, Brooke R, Kramarz P et al. Measuring underreporting and under-ascertainment in infectious disease datasets: a comparison of methods.

2. Minnes, S et. Al.(2017). The association of prenatal cocaine exposure, externalizing behavior and adolescent substance use. Drug and Alcohol Dependence 176 (Complete), 33 43. doi: 10.1016/j.drugalcdep.2017.01.027

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4. Spencer M, Ahmad FB. Timeliness of death certificate data for mortality surveillance and provisional estimates. Vital Statistics Rapid Release Special Report, No. 001, 2016

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6. Center for Disease Control and Prevention (https://www.cdc.gov/drugoverdose/epidemic/index.html)

8. Ahmad F, Rossen LM, Spencer MR, Warner M, Sutton P. Provisional drug overdose death counts. National Center for Health Statistics. 2018. Available from: https://www.cdc.gov/nchs/nvss/vsrr/drug-overdose-data.htm.

9. Addiction Center (https://www.addictioncenter.com/drugs/overdose/)

10. John Hopkins Medicine (https://www.hopkinsmedicine.org/opioids/what-are-opioids.html)

Link to R Shiny Application

https://jj97.shinyapps.io/Opad/

Link to Github Repo

https://github.com/jeffyhaspeople/Opioider