Distribution Agreement

In presenting this thesis or dissertation as a partial fulfillment of the requirements for an advanced degree from Emory University, I hereby grant to Emory University and its agents the non-exclusive license to archive, make accessible, and display my thesis or dissertation in whole or in part in all forms of media, now or hereafter known, including display on the world wide web. I understand that I may select some access restrictions as part of the online submission of this thesis or dissertation. I retain all ownership rights to the copyright of the thesis or dissertation. I also retain the right to use in future works (such as articles or books) all or part of this thesis or dissertation.

Signature:

_______________________________ ______________

Taylor Guidry Date

The Association between Educational Attainment as a Socioeconomic Determinant and Opioid-Related Deaths in Georgia

By

Taylor Guidry
MSPH

Environmental Health and Epidemiology

Kyle Steenland, PhD
Committee Chair

Paige Tolbert, PhD
Committee Member

The Association between Educational Attainment as a Socioeconomic Determinant and Opioid-Related Deaths in Georgia

By

Taylor Guidry

B.S. in Neuroscience and Cognitive Science
The University of Arizona
2016

Kyle Steenland, PhD
Committee Chair

Paige Tolbert, PhD
Committee Member

An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Science in Public Health
in Environmental Health
2018

Abstract

The Association between Educational Attainment as a Socioeconomic Determinant and Opioid-Related Deaths in Georgia

By Taylor Guidry

The opioid epidemic has become one of the leading public health issues in the Unites States. Opioid related deaths have drastically increased in the past decade and are now the leading cause of unintentional death in the United States. In this study, I analyzed the association between educational attainment and death resulting from opioids in Georgia. I also examined the distribution of deaths resulting from opioids among racial, gender, and age groups in Georgia. A dataset provided by the Georgia Department of Public Health consisting of deaths due to opioids and fatal car accidents were used in this analysis. These types of deaths were determined according to the ICD-10 coding system. Educational attainment was categorized into three groups: no high school diploma or GED, and high school diploma or GED, and some college or more. When analyzing the distribution of opioid-related deaths, frequencies and percentages of deaths among each demographic group at each level of educational attainment. To analyze the association between educational attainment and death due to opioids, cases of opioid-related deaths were matched with fatalities in motor vehicle accidents on age group, gender, and race. A conditional logistic regression model was then used to determine the odds of death due to opioid compared to that of death due to fatal motor vehicle accident among different levels of educational attainment. This analysis showed that most opioid-related deaths were among white, middle-aged males. It also found that there is very little difference in the odds of death due to opioid-related causes compared to fatal motor vehicle accidents, regardless of levels of educational attainment.

The Association between Educational Attainment as a Socioeconomic Determinant and Opioid-Related Deaths in Georgia

By

Taylor Guidry

B.S. in Neuroscience and Cognitive Science
The University of Arizona
2016

Thesis Committee Chair: Kyle Steenland, PhD

A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Science in Public Health
in Environmental Health and Epidemiology
2018

Table of Contents

Background

Overview

Opioid abuse has risen as one of the top public health issues affecting the United States. The rate of opioid misuse in the United States has increased drastically in recent years. This epidemic has touched people in every community and caused thousands to lose their lives. Deaths and hospital admissions rates due to opioid overdose have considerably increased in the past decade. In 2015, the CDC reported a nearly 200% increase in opioid related deaths over the previous decade[1]. The rise in hospital visits for prescription opioid-related overdoses has also increased, especially in the South. A study found that the number of prescription opioid-related overdose hospitalizations was highest in the South when compared to other regions of the United States[2]. For many cases of opioid abuse, patients are initially prescribed these medications to treat legitimate medical conditions. Physicians often prescribe opioids for nonsurgical admissions and in high doses[3]. This study examines the association between socioeconomic status, specifically education attainment, and fatal opioid overdoses in the Georgia.

Opioids in the body

Opioids are drugs that affect opioid receptors in the body. These drugs are classified as natural, semi-synthetic, and synthetic. Natural opioids are those that occur naturally and are found in the resin of poppy or opium bulbs. Semi-synthetic opioids are opioids that are derived from natural opioids. These include hydrocodone, oxycodone, and diacetylmorphine (heroin), and benzylmorphine. Synthetic opioids are those that are synthesized from chemicals and include fentanyl, alfentanil, and sufentanil[4]. Opioid receptors are responsible for reducing pain in the body by inducing a chain reaction that reduces or inhibits the transmission of neurotransmitters responsible for signaling pain[5]. This inhibitory mechanism is coupled with the excitatory release of dopamine, an important neurotransmitter in the reward pathway in the brain. The activation of opioid receptors produces these two transmission pathways that work together to create the euphoria making opioids exceptionally addictive.

Opioid Abuse in the United States

Opioid abuse has become one of the leading public health issues in the United States. With the increased availability of opioid pain relievers, there has been increased use and overdose of opioids. Because these drugs are far more accessible and have more widespread use than what other drugs are perceived to have, nearly every community has been touched by these drugs. Fatal opioid-related overdoses take the lives of 115 people each day[6]. The number of reported overdoses nearly tripled between 1999 and 2014 and of these reported overdoses, 60.9% involved an opioid[7].

Many studies have linked this increase in opioid-related overdoses to the increase in opioid prescriptions. In the late 1990's, there was a large push from pharmaceutical companies for medical professionals to increase opioid prescriptions to treat pain in their patients[8]. The main reason for this increased rate of opioid use in the 1990's resulted from the introduction of OxyContin in 1995[9]. Prior to this, many physicians were not comfortable with prescribing opioids to their patients to treat non-cancer pain.

Although this epidemic has greatly impacted people from all backgrounds in the United States, it has had the largest effect on certain demographic groups. Opioid drug use and misuse is highest among white people[10]. In 2015, the mortality rate due to opioids was 3.6 times higher among white people compared to black individuals[11]. Between 1999 and 2014, the highest number of fatal opioid-related overdoses were reported in non-Hispanic white males and American Indian or Alaska Natives[12]. In terms of age, most opioid users are middle-aged individuals. People aged 25 to 54 represent the largest percentage of opioid users[11].

Opioid abuse has also been linked to socioeconomic factors. The opioid crisis has had the largest impact in the most poverty-stricken regions of the United States. In many studies, there is evidence that lower educational attainment is linked with higher risk of death due to opioids[10]. There are also more opioid prescriptions in areas with lower socioeconomic conditions[14].

Opioid abuse in Georgia

The rate of opioid use and deaths continues to escalate in the state of Georgia. There was a significant rise in deaths due to opioid-related drug overdose in recent years, tripling from 1999 to 2013[15]. In 2016, the rate of fatal opioid-related overdoses in Georgia was 8.8 per 100,000[16]. Opioids are in the lead for deaths due to drug overdose in Georgia, accounting for 68% of drug overdose-related deaths. The number of prescription opioid-related deaths in Georgia has increased to 549 between 1999 and 2014[15].

Many the areas most affected by the opioid epidemic in Georgia are in rural areas. 55 of the 159 counties in Georgia reported higher rates of drug overdoses compared to the national average. Socioeconomic factors have also been linked to higher rates of death due to drug overdose. Many people living in these areas who are affected by this epidemic do not have access to the resources needed to treat this addiction. Of counties reporting higher rates of drug overdoses compared to the national average, 60% have limited access to adequate treatment[15].

Similar to the national opioid epidemic's history in prescription pain relievers, the opioid crisis in Georgia has strong ties to opioid pain relievers prescribed in the state. In 2013 alone, there were approximately 8.99 million opioid prescriptions written in Georgia. That equates to about 90.7 opioid prescriptions for every 100 persons in the state of Georgia[16]. The national average was 79.3 per 100 persons. Efforts to lessen the opioid crisis have shown some success. There was a nearly 10% decrease in the number of opioid prescriptions written in Georgia from 2013 to 2015[15].

Opioid use beyond adults

Due to the rise of opioid use among adults, there has been an upsurge in babies born to drug-addicted mothers. According to a study conducted by the CDC, the incidence of neonatal abstinence syndrome, a postnatal drug withdrawal syndrome, increased 300% from 1999 to 2013[17]. There is also the issue of unintentional opioid poisonings in children who have access to drugs that are present in the home. In a study conducted by the Yale School of Medicine, researchers found that the incidence of hospitalizations for prescription opioid poisonings increased by 205% for children aged 0 to 4 and by 176% among adolescents age 15-19[18].

Just as there has been a rise in opioid prescriptions for adults, there has also been an increase in these prescriptions for children and adolescents for various injuries and non-cancer pain. One study found that there was a significant increase in the use of opioid analgesics in pediatric emergency department visits between 2001 and 2009[19]. In a study examining ambulatory reports of 1933 children found that of the 15% that were prescribed medication with potential dosing errors, more than 50% were potential overdoses[20]. Often, parents and children are not adequately educated on the possible risks of opioid usage which can lead to overdose or misuse.

Motor Vehicle Accidents in Georgia

Motor vehicle deaths have been a major concern in public health. Motor vehicle accidents are considered unintentional deaths, which is the fifth leading cause of death in the United States[21]. In the past, motor vehicle accidents accounted for the largest percentage of all unintentional deaths but in recent years that trend has changed. In recent years, death resulting from unintentional poisonings has taken over as the leading cause of unintentional deaths with fatal motor vehicle accidents falling into second place. There were 34,439 fatal motor vehicle accidents which resulted in 37,461 deaths in the United States in 2016[22]. In Georgia, there were 1,422 fatal motor vehicle accidents in 2016, accounting for 1,554 deaths[23]. Many of these fatal motor vehicle accidents involve drivers who are impaired by illicit drugs. In 2016 alone, there were 11.8 million people aged 16 and older who drove while under the influence of illicit drugs[24]. One nationwide study found that of those who tested positive for illicit drugs in deadly motor vehicle accidents, about 47% tested positive for prescription drugs. Of these drugs, prescription pain relievers were the most common[25].

There have been several studies that have found an association between socioeconomic status and motor vehicle accidents. Fatal motor vehicle accidents are more common than in poorer areas than in wealthier areas[26]. Studies that have analyzed the association between specific characteristics of socioeconomic status, such as income and education, and motor vehicle accidents have found that in those with lower educational status, there is an increased risk of death from motor vehicle accident compared to those with higher socioeconomic status[28, 29, 30].

This study is created to investigate the association between educational attainment and opioid-related deaths. It also analyzes the demographic distribution of opioid-related deaths in

Georgia between 2011 and 2016. I hypothesize that higher percentage of opioid-related deaths will be associated with middle-age, non-Hispanic, white males and in individuals with lower educational attainment. I also expect to see higher odds of death due to opioid-related causes compared to fatal motor vehicle accidents among those with lower levels of educational attainment.

Methods

Dataset

The dataset is comprised of information from death certificates collected by the Georgia Department of Public Health. The death certificates come from all hospitals across the state of Georgia. The date range is 01/01/2011-12/31/2016.

Variables

There were five variables analyzed in this study. The variable age describes the age at which a person died. In this study, age is categorized into groups with the first group consisting of individuals who were less than 15 years old at the time of death. The groups are then divided into ten-year increments. The last group includes all individuals who were 75 years old and older at the time of their death. Gender is a dichotomous variable that describes the sex listed on the death certificate. Males were coded as 1 and females were coded as 0. Race is a categorical variable that describes the race listed on an individual's death certificate. Death is a dichotomous variable that describes the manner in which a person died. This study codes death=1 as fatal opioid-related overdose and death=0 as a fatal motor vehicle accident. Level of education is a categorical variable that describes the highest level of education attained at the time of an individual's death. This analysis categorizes level of education into three categories: no high school diploma or GED, high school diploma or GED, and some college or more.

Inclusion criteria for cases

Cases are defined as men and women of all ages who have died from an opioid-related drug overdose according to the ICD-10 coding system as designated by the Georgia Department of Public Health. Fatal opioid poisonings in this analysis include suicides and unintentional deaths resulting from fatal poisonings of opioids and their derivatives. Suicidal deaths are those resulting from self-inflicted injury with evidence that supports the intention of death. Opioid poisonings are defined as poisonings when the opioid was taken unintentionally, an excess of the opioid was ingested, the incorrect opioid was taken, there was an incident involving the drug during surgical procedures. Georgia uses the ICD-10 coding system to code opioid overdoses, using the following underlying causes: mental and behavioral disorders due to psychoactive substance use (F11.0-F16.9, F-18.0-F19.9), unintentional death due to poisoning (X40-X44), intentional self-harm (suicide) via poisoning (X60-X64), assault (homicide) via poisoning(X85) and event of undetermined intent due to poisoning (Y10-Y14). The underlying cause of death describes the circumstances of the accident. It is the disease or injury that initiated the events resulting in death. Causes B and C are listed sequentially as the conditions contributing to the underlying cause of death (excluding the immediate cause, Cause A). In these cases of opioid-related deaths, causes B and C represent the specific opioid drug overdoses that contributed to the underlying cause of death. Contributing conditions A and B are other significant conditions that contributed to death were not direct contributory causes. Opioid drugs are broken down into subsets which include heroin (T40.1), opioid pain reliever (T40.2-T40.4), opioid (F11), opium (T40.0), multi-drug (F19), and other/unspecified narcotics (T40.6). This analysis included all deaths with an underlying cause of drug poisoning, unintentional death, suicide, homicide, or event of undetermined intent, and an opioid drug listed as cause B, cause C, contributing condition A, and/or contributing condition B.

Exclusion criteria for cases

Opioid-related deaths that did not occur in the state of Georgia were not included in this analysis. Entries that did not have an age, gender, race, or education level attained were also excluded from this study.

Inclusion criteria for controls

Controls in this study are defined as men and women of all ages who have died from a motor vehicle accident according to the ICD-10 coding system in the state of Georgia. Deaths from motor vehicle accidents are those resulting from accidents involving any motorized vehicle (car, truck, motorcycle, etc.) causing the unintentional deaths of a driver, passenger, bicyclists, or pedestrian on public roadways. ICD-10 codes these deaths as a pedestrian (V02-V04, V09.0, V09.2), a pedal cycle rider (V12-V14, V19.2, V19.4-V19.6), a motor cycle rider (V20-V29) an occupant of a three-wheeled motor vehicle (V30-V39), a car occupant (V40-V49), an occupant of a pick-up truck or van (V50-V59), an occupant of a heavy transport vehicle (V60-V69), a bus occupant (V70-V79), an animal rider or occupant of an animal-drawn vehicle (V80.3-V80.5), an occupant of a railway train or railway vehicle (V81.0-V81.1), an occupant of a powered streetcar (V82.0-V82.1), an occupant of a special vehicle (V83-V86) was injured in a collision with a motorized vehicle. These also include accidents where the mode of transport is unknown or unspecified (V87.0-V87.8, V88.0-V88.8, V89.0, V89.2).

Exclusion criteria for controls

Motor vehicle accidents that did not occur in the state of Georgia were excluded from this study. Entries that did not have age, gender, race, or highest education level attained were also excluded. Deaths that had an underlying cause of a motor vehicle accident but had opium or its derivatives listed as secondary causes or contributing causes were excluded from controls and instead categorized as cases.

Matching

To observe the association between exposure and outcome, a dataset containing matched cases and controls was created. To control for potential confounders in the analysis of the association between highest level of education obtained and outcome of death due to opioid related overdose, cases of death due to fatal opioid-related overdoses were matched to controls of fatal motor vehicle accidents. Cases and controls were matched on age, gender, and race. Due to the inadequacy of recording of ethnicity, it was not included in the analysis.

Analysis

For the analysis of exposure and outcome, a conditional logistic regression analysis was performed to obtain the odds ratio of death due to fatal opioid-related overdoses among different education levels compared to death to motor vehicle accidents. In this analysis, the exposure was defined as the highest level of education attained by the time of death. Cases were defined as deaths due to opioid-related causes and controls were defined as deaths due to motor vehicles accidents that did not involve opium or its derivatives.

Results

Opioid-Related Deaths

After the inclusion and exclusion criteria were applied to the dataset, there were 3,772 cases of deaths due to opioids in the state of Georgia between 2011 and 2016. There were 2,249 men and 1,523 women. The ages at time of death were categorized into groups of 10 year increments. The majority of the deaths in this study were in the 25-34, 35-44, and 45-54 age groups with 26.06%, 22.53%, and 23.49%, respectively. The majority of the cases were white (88.52%) with African Americans accounting for the second largest number of opioid-related deaths (10.68%).

On death certificates in the state of Georgia, level of educational attainment at time of death was categorized in four groups: than 9^{th} grade, 9^{th} through 11^{th} grade, high school diploma or GED, and some college or higher. For this analysis, these were collapsed into three categories: no high school diploma or GED, which included less than 9^{th} grade and 9^{th} through 11^{th} grade, high school diploma or GED, Some college or more. The majority of the deaths due to fatal opioid-related overdoses were found in people who had a high school diploma or GED at their time of death (42.71%). Observations who had some college or more at time of death had the second highest percentage of deaths due to fatal opioid related causes (35.17%) and no high school diploma or GED accounted for the lowest percentage of opioid-related deaths (22.13%).

When analyzing the contributing drugs to fatal opioid-related overdoses, the most common drugs involved are opioid pain relievers. Opioid pain relievers make up the largest percentage (71.83%) of opioids among all levels of contributing causes of death across all levels of education (Figure 2). When looking only at deaths in individuals with no high school diploma or GED, opioid pain relievers account for 80.94% of the deaths. The second largest percentage is heroin which accounted for 8.33% of the deaths at this level of education.

In opioid-related deaths among individuals with a high school diploma or GED, opioid pain relievers accounted for the largest percentage of deaths. Opioid pain relievers made up 72.53% of all secondary causes of deaths and the second most common drug, heroin, made up 18.64% of the deaths.

Among individuals with some college education or higher, opioid pain relievers make up the largest percentage of drugs contributing to death (67.63%). Heroin and opioids account for the second and third largest percentages of opioids contributing to death in individuals with this level of education at the time of death, 14.80% and 12.50% respectively.

Matched Case Control Analysis

Of the initial 3,772 cases of opioid-related deaths, 3,204 were matched with 3,204 controls of motor vehicle accidents (Figure 1). Of the 7,096 non-opioid related fatalities that resulted from motor vehicle accidents between 2011 and 2016, 3,892 were not matched to cases and therefore excluded from this analysis. In the dataset of 6.408 observations, cases and controls were matched on age group, race, and gender. The demographics of opioid related deaths in the matched dataset were similar to that of the all opioid-related deaths. The majority of the cases were males (66.64%) with females accounting for 32.36% of the cases. Most of the cases were also white (86.55%) with blacks and African Americans accounting for the second largest percentage of opioid-related deaths (12.58%). Age in the matched analysis was also categorized into the same groups as in the opioid-related deaths analysis. In the matched analysis, the majority of the cases were in the 25-34, 35-44, and 45-54 age groups with 26.69%, 21.07%, and 20.72%, respectively.

The highest level of education attained at time of death was categorized in the same groups as the initial opioid-related deaths. Most of the matched cases had a high school diploma or GED (45.01%). Cases with no high school diploma or GED accounted for 20.60% of the opioid related deaths and cases with some college or accounted for 34.39% of the deaths.

In terms of controls, most of the deaths had a high school diploma or GED (43.82%). Those with no high school diploma or GED accounted for 23.13% of deaths and those with some college education or higher accounted for 33.05% of deaths among motor vehicle accidents.

In order to analyze the association between the outcome of death and exposure of highest level of education attained at time of death, a conditional logistic regression analysis was performed on the matched cases control dataset. The following model was used in the analysis.

$$logit\left(P(X)\right) = \alpha + \beta_1 Level\ of\ Education + \sum_{i=1}^{4464} \gamma_i V_i$$

where V_i denotes variables for the matched pairs.

In the first analysis, I compared individuals with some college education to those with less than a high school diploma or GED. The odds ratio was 1.054 (p-value: 0.0234) with a 95% confidence interval of (1.007, 1.103).

The second model tested individuals with a high school diploma or GED to those with no high school diploma or GED. The odds ratio was 1.072 (p-value: 0.0303) with a 95% confidence interval of (1.007, 1.142).

Discussion

The purpose of this study was to look at demographic distribution of fatalities resulting from opioids in Georgia and to analyze the association between education attainment and opioid-related fatality. The results from this study show more opioid-related deaths among white, middle-age males. This analysis also shows there is very little difference in the odds of death due to opioid-related causes compared to motor vehicle accidents among different levels of educational attainment. The majority of the deaths due to opioid drugs and its derivatives were of people with at least a high school diploma or higher. Specifically, a large percentage of deaths were of people with some college education or higher. This is significant in that it shows that opioid-related fatalities are seen more in those with the highest educational attainment compared to those who do not have a high school diploma or GED.

Most of the cases of opioid-related deaths are found in white males. Within each educational category, white males made up the largest percentage of deaths due to opioid-related causes. This is in accordance with many studies that have found that the opioid epidemic has had the largest effect on non-Hispanic white males[10, 11, 27, 31].

In terms of age, the largest percentage of opioid-related deaths were found in the 45-54 age category. These results support previous studies that show middle-aged individuals represent the highest percentage of opioid abusers and the highest percentage of deaths due to opioids. This is most likely a result of the prescription trends seen in the United States which shows middle-aged Americans being prescribed opioids at a higher rate than other age groups.

When observing the most common drug contributing to opioid related deaths, opioid pain relievers made up the largest percentage among all contributing factors of death across all levels of education. When including all levels of education, opioid pain relievers accounted for 71.15% of all opioid-related deaths (Table 2). When looking at each individual educational attainment level, opioid pain relievers accounted for the largest percentage of contributing causes in opioid-related deaths. Among the lower levels of educational attainment, most of the opioids related to death were opioid pain relievers. As the level of educational attainment increased, the percentage of deaths due to opioid pain relievers decreased, showing other opioid derivatives causing a larger percentage of deaths.

When comparing the outcome of death to opioid-related causes and the exposure of education attainment in a matched case-control analysis, I found that there was not a large difference in the odds of death due to opioid-related causes compared to death due to motor vehicle accidents, regardless of level of education attainment. The odds of death due to opioid-related causes versus death due to motor vehicle accidents among those with at least some college education were 1.17 times the odds among people with no high school diploma or GED. The odds of death due to opioid-related causes versus death due to motor vehicle accidents among those with a high school diploma or GED were 1.15 times the odds among people with no high school diploma or GED. This shows that in the state of Georgia, the odds of death due to opioid related causes are slightly greater than the odds death due to motor vehicle accidents among those with more education. These results differ from previous studies in that it shows regardless of level of educational attainment, there is no difference in odds of death due to opioid related causes compared to fatal motor vehicle accidents. This difference could be contributed to the study design and measure of association used. In this study, I was calculating an odds ratio where others studies were calculating risks and rates.

Due to the increase in access to healthcare and prescription drugs seen in white, middle class individuals, we see a larger percentage of opioid addiction and fatal overdoses in this population. Because these people are more likely to be prescribed opioids as a white, middle class male, this population has also seen a great impact from the opioid epidemic. Other demographic groups have been hit heavily by this epidemic, but unlike with other illicit drugs, the discriminatory practices in healthcare have given greater access to opioid pain killers to white males.

With the increase of opioid-related deaths in the United States and especially in Georgia, it is important to understand the demographics represented in these deaths. Drug addiction has been historically linked individuals with lower socio-economic status and racial minority groups. The opioid crisis has shown that drug addiction can affect people from all backgrounds and has had a greater impact in people with higher socioeconomic status.

One of the limitations of this study is that it uses data obtained from death certificates. When reporting education attainment on death certificates, it is often up to the next of kin to provide this information. This type of reporting can result in inaccurate data. In future studies, it would be beneficial if one could match death certificates with data from educational institutions to get the most accurate record of this variable.

Another limitation is that some cases of opioid-related deaths were lost in the matching analysis. Since the frequency of deaths due opioid-related causes is similar to that of motor vehicle accidents, there were some cases that could not be matched to controls. This loss of cases could have led to results that did not represent the entire scope of the data. To improve on this, the study might include other leading causes of death to act as controls for the analysis.

Due to the inconsistency in reporting for death certificates, there were many potential confounders such as geographical location that were not included in this analysis. To expand this study, I would include all potential confounders to ensure more accurate analysis of the association between educational attainment and fatality due to opioids.

An additional limitation of this study is the control group used in the analysis. Fatal motor vehicular accidents have been found to be associated with lower socioeconomic status.

Opioid-related deaths have also been associated with socioeconomic status such that lower socioeconomic status is linked with greater risk of fatal opioid overdose. This association with lower socioeconomic status may be why there is little difference in the odds of death resulting from opioid-related causes and the controls of motor vehicle deaths among the different levels of educational attainment. Ideally, future studies would use a control group that is not associated with the exposure in the same manner that the cases are.

Conclusion and Recommendations

The overall goal of the study is to observe the association between opioid-related deaths and demographic indicators as well as educational attainment. This study supported my hypothesis that higher frequencies of opioid-related deaths would be found in middle-aged, non-Hispanic white males. This study did not support my original hypothesis that lower educational attainment would be associated with more opioid-related deaths.

It is important to understand the demographic data associated with opioid-related fatalities in order to properly create interventions targeted to the proper populations. Lawmakers must understand the population at the greatest risk of opioid abuse to create policies and programs that will reach the largest number of people impacted by this epidemic. Because opioids are an exceptionally addictive drug, those who are prescribed these opioid pain killers have high chances of becoming addicted and later using other illicit drugs. As a result of the efforts being made to decrease the number of opioid prescriptions given to patients and the surveillance of how often these prescriptions are filled, there has been a slight decrease in access to the drugs. With these restrictive measures in place, users are forced to seek out other drugs to maintain their addiction. The price of these pharmaceuticals has also forced users to seek out other illicit drugs to feed their addiction. It is important that we implement the most effective interventions before the misuse of prescription opioids leads to increased use of other illicit drugs.

Future studies would ideally use a more accurate way of obtaining information about educational attainment, if possible. I would also include other potential confounders and effect measure modifiers in this analysis. This would give a better understanding of all the variables that can potentially affect the outcome of opioid-related death. A control group that is not associated with the exposure in the same manner as the cases would result in a more accurate analysis.

Overall, although my main hypothesis was not supported by the analysis, the results from this study are important in that they show the opioid epidemic is not exclusive to individuals with low socioeconomic status. It shows that discriminatory prescription methods should be revised to prevent the large flow of prescription opioids to certain populations.

Tables & Figures

Table 1. Characteristics of matched[a] cases of death due to opioid-related causes in Georgia between 2011 and 2016[b]

	No.	%
Gender		
Female	1,069	33.36
Male	2,135	66.64
Age		
<15	21	0.66
15-24	398	12.42
25-34	855	26.69
35-44	675	21.07
45-54	664	20.72
55-64	472	14.73
65-74	98	3.06
75+	21	0.66
Race/Ethnicity		
White	2,773	86.55
African American	403	12.58
Asian	23	0.72
Multi-racial	5	0.16

[a]Matched on age category, gender, and race

[b]Cases include unintentional and intentional deaths where opioids were listed as the underlying, secondary, or contributing cause

This table illustrates the demographic distribution among matched cases of fatal opioid overdoses in Georgia between 2011 and 2016. These are matched cases so these are the same distributions found in motor vehicle accidents used in the analysis. 3,892 controls were not matched to cases and therefore excluded from this analysis.

Table 2. Overall distribution of drug types among opioid related deaths in Georgia between 2011 and 2016[a*]

		Cause B		Cause C		Contributing Condition A		Contributing Condition B		Total	
Name	**ICD-10 Code**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Opioid	F11	396	22.16	95	5.37	7	0.81	0	0.00	498	10.42
Opium	T40.0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Heroin	T40.1	141	7.89	326	18.44	117	13.57	44	12.09	628	13.14
Opioid Pain Reliever	T40.2-T40.4	1210	67.71	1264	71.49	675	78.31	285	78.30	3434	71.83
Unspecified Narcotics	T40.6	40	2.24	83	4.69	63	7.31	35	9.62	221	4.62

[a]Percentages represent the percentage of all causes listed in each type of secondary cause of death

* This table shows the frequencies and percentages of the subsets of opioids among all opioid-related deaths. The underlying cause of death for each opioid-related death is listed as either drug poisonings, unintentional death, suicide, homicide, and undetermined cause (mental and behavioral disorders due to psychoactive substance use (F11.0-F16.9, F-18.0-F19.9), accidental poisoning (X40-X44), intentional self-harm (suicide) via poisoning (X60-X64), assault via poisoning (homicide) (X85) and a poisoning event of undetermined intent(Y10-Y14).
Causes B and C represent the contributing causes of death (excluding the immediate cause of death, which is Cause A), here the specific drug overdose resulting from the underlying cause of death. Contributing conditions (other significant conditions) A and B describe conditions that contributed to death but not resulting in the underlying cause of death.

Table 3. Distribution of cases and controls among levels of educational attainment*

Education Level	**Cases**		**Controls**	
	No.	%	No.	%
No High School Diploma or GED	660	10.30	741	11.56
High school diploma or GED	1442	22.50	1,404	21.91
Some college or more	1,102	17.20	1,059	16.53

* This table describes the frequencies and percentages of cases and controls at each level of educational attainment.

Table 4. Odds ratios comparing levels of educational attainment (two separate models)*

	Odds Ratio	**95% Confidence Interval**	**P-value**
Some college or more vs. No high school diploma or GED	1.171	(1.022, 1.343)	0.0234
High school diploma or GED vs. No high school diploma or GED	1.15	(1.013, 1.013)	0.0303

*4: This table shows the odds ratios of death due to opioid related causes compared to death due to fatal motor vehicle accident among the different levels of educational attainment. The lowest level of education attainment, no high school diploma or GED, was used as the reference groups for both calculations.

References

1. Edmunds, M. W. (2016). Dealing With Opioid Overdose. *The Journal for Nurse Practitioners, 12*(5). doi:10.1016/j.nurpra.2016.04.001

2. Unick, G. J., & Ciccarone, D. (2017). US regional and demographic differences in prescription opioid and heroin-related overdose hospitalizations. *International Journal of Drug Policy, 46*, 112-119. doi:10.1016/j.drugpo.2017.06.003

3. Herzig SJ, Rothberg MB, Cheung M, Ngo LH, Marcantonio ER. 2014. Opioid utilization and opioid-related adverse events in nonsurgical patients in US hospitals. J. Hosp. Med. 9:73–81

4. Johnson, A. M. (2000). Opiates. *Clinical Pediatric Emergency Medicine,1*(5), 328-333. doi:10.1016/s1522-8401(00)90006-5

5. Stein, C. (2016). Opioid Receptors. *Annual Review of Medicine, 67*, 433-451. doi:doi:10.1146/annurev-med-062613-093100

6. Wide-ranging online data for epidemiologic research (WONDER). Atlanta, GA: CDC, National Center for Health Statistics; 2017. Available at http://wonder.cdc.gov.

7. Rudd RA, Seth P, David F, Scholl L. Increases in Drug and Opioid-Involved Overdose Deaths — United States, 2010–2015. MMWR Morb Mortal Wkly Rep. ePub: 16 December 2016. DOI: http://dx.doi.org/10.15585/mmwr.mm655051e1.

8. Kolodny et al. 2015. The prescription opioid and heroin crisis: A public health approach to an epidemic of addiction. Annual Review of Public Health, 36, 559-74

9. INCB (Int. Narc. Control Board). 2007. The Report of the International Narcotics Control Board for 2007. Vienna: INCB

10. Vasilenko, S. A., Evans-Polce, R. J., & Lanza, S. T. (2017). Age trends in rates of substance use disorders across ages 18–90: Differences by gender and race/ethnicity. Drug and Alcohol Dependence, 180, 260-264. doi:10.1016/j.drugalcdep.2017.08.027

11. Hedegaard H, Warner M, Miniño AM. Drug overdose deaths in the United States, 1999–2015. NCHS data brief, no 273. Hyattsville, MD: National Center for Health Statistics. 2017.

12. Prescription Opioid Overdose Data. (2017, August 01). Retrieved April 02, 2018, from https://www.cdc.gov/drugoverdose/data/overdose.html

13. Hall, A. J. (2008). Patterns of Abuse Among Unintentional Pharmaceutical Overdose Fatalities. Jama, 300(22), 2613. doi:10.1001/jama.2008.802

14. Zhou, C., Yu, N. N., & Losby, J. L. (2018). The Association Between Local Economic Conditions and Opioid Prescriptions Among Disabled Medicare Beneficiaries. Medical Care, 56(1), 62-68. doi:10.1097/mlr.0000000000000841

15. Substance Abuse Research Alliance (2016) Prescription Opioids and Heroin Epidemic in Georgia

16. National Institute on Drug Abuse. (2018, February 28). Georgia Opioid Summary. Available at https://www.drugabuse.gov/drugs-abuse/opioids/opioid-summaries-by-state/georgia-opioid-summary

17. Ko, J. Y., Patrick, S. W., Tong, V. T., Patel, R., Lind, J. N., & Barfield, W. D. (2017, August 17). Morbidity and Mortality Weekly Report (MMWR). Retrieved January 10, 2018, from https://www.cdc.gov/mmwr/volumes/65/wr/mm6531a2.htm

18. Gaither, J. R., Leventhal, J. M., Ryan, S. A., & Camenga, D. R. (2016). National Trends in Hospitalizations for Opioid Poisonings Among Children and Adolescents, 1997 to 2012. *JAMA Pediatrics, 170*(12), 1195. doi:10.1001/jamapediatrics.2016.2154

19. Mazer-Amirshahi, M., Mullins, P. M., Rasooly, I. R., Anker, J. V., & Pines, J. M. (2014). Trends in Prescription Opioid Use in Pediatric Emergency Department Patients. *Pediatric Emergency Care, 30*(4), 230-235. doi:10.1097/pec.0000000000000102

20. McPhillips, HA, Stille, CJ, Smith, D. Potential medication dosing errors in outpatient pediatrics. J Pediatr. 2005;147:761-767

21. National Center for Health Statistics. (2017, March 17). Retrieved from https://www.cdc.gov/nchs/fastats/leading-causes-of-death.htm

22. National Highway Safety Administration (2017) *2016 Fatal Motor Vehicle Crashes: Overview* [Fact Sheet]. Retrieved from https://crashstats.nhtsa.dot.gov/Api/Public/Publication/812456

23. General statistics. Retrieved from http://www.iihs.org/iihs/topics/t/general-statistics/fatalityfacts/state-by-state-overview

24. Wilson FA, Stimpson JP, Pagán JA. Fatal crashes from drivers testing positive for drugs in the U.S., 1993-2010. *Public Health Rep Wash DC 1974.* 2014;129(4):342-350.

25. National Institute on Drug Abuse. Drugged Driving. Retrieved from https://www.drugabuse.gov/publications/drugfacts/drugged-driving#references

26. Harper, S., Charters, T. J., & Strumpf, E. C. (2015). Trends in Socioeconomic Inequalities in Motor Vehicle Accident Deaths in the United States, 1995–2010. American Journal of Epidemiology, 182(7), 606-614. doi:10.1093/aje/kwv099

27. Green, J. (2017). Epidemiology of Opioid Abuse and Addiction. *Journal of Emergency Nursing, 43*(2), 106-113. doi:10.1016/j.jen.2016.09.004

28. Braver ER . Race, Hispanic origin, and socioeconomic status in relation to motor vehicle occupant death rates and risk factors among adults. Accid Anal Prev . 2003;353:295–309.

29. Cubbin C , LeClere FB, Smith GS. Socioeconomic status and injury mortality: individual and neighbourhood determinants. J Epidemiol Community Health . 2000;547:517–524.

30. Singh GK , Siahpush M. All-cause and cause-specific mortality of immigrants and native born in the United States. Am J Public Health . 2001;913:392–399.

31. Singhal, A., Tien, Y., & Hsia, R. Y. (2016). Racial-Ethnic Disparities in Opioid Prescriptions at Emergency Department Visits for Conditions Commonly Associated with Prescription Drug Abuse. *Plos One, 11*(8). doi:10.1371/journal.pone.0159224