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Risk of Unintentional Opioid-involved Overdose Death Among Decedents of Industries with a High Risk of Non-fatal Work-related Injury, Georgia, 2014

Emily Hosterman

ABSTRACT

RISK OF UNINTENTIONAL OPIOID-INVOLVED OVERDOSE DEATH AMONG DECEDENTS OF INDUSTRIES WITH A HIGH RISK OF NON-FATAL WORK-RELATED INJURY, GEORGIA, 2014

BY

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INTRODUCTION: The opioid epidemic continues to be a major public health issue across the United States. From 2010 – 2018 the rate of opioid overdose death in the state of Georgia increased more than 70%. Until 2013 prescription opioids were the driving force of this increase, although in recent years illicit opioids such as heroin and fentanyl have been rapidly increasing. The literature has demonstrated nationally that certain occupations that have an increased risk of injury also have a higher risk of opioid-involved death. Occupational data for the state of Georgia has never been analyzed for a potential relationship with opioid-involved death but could be a valuable resource for identifying populations at an increased risk of opioid-involved death and informing public health action and intervention.

AIM: To determine the risk of opioid-involved overdose death compared to other causes of death for residents of the state of Georgia who died in 2014 and previously worked in industries with a high risk of non-fatal work-related injury.

METHODS: Death certificate data for 2014 was obtained from the Office of Vital Records at the Georgia Department of Public Health and SAS Enterprise Guide 7.1 was used to clean, manage, and analyze the data. The dataset analyzed contained records for all residents in the state of Georgia who died during the 2014 calendar year. Opioid-involved overdose death was the dependent variable of interest. Deaths were identified using the international classification of diseases, 10th revision (ICD-10), and deaths identified as intentional (suicides and assault) were excluded due to poor data quality. The independent variable of interest was industries with a high risk of non-fatal work-related injury and were identified using the Georgia Occupational Health Surveillance Report, 2008 – 2012 (Lavender, Benson, & Bayakly, 2015). Covariates sex, age at death, marital status, and maximum education level obtained at death were coded as categorical variables and analyzed for possible confounding and effect modification of the relationship between occupational type and opioid-involved death. The independent and dependent variables of interest were coded as dichotomous variables and analyzed along with covariates using a multivariate logistic regression model.

RESULTS: Decedents previously working in industries with a high risk of non-fatal work-related injury had an increased odds of opioid-related death compared to decedents with other causes of death (OR = 1.10, 95% CI: [0.97, 1.26]) when compared to all other industries (OR = 0.91, 95% CI [0.79, 1.03]); however this association was not statistically significant. Sex, marital status at death and maximum education level obtained at death were determined to be confounders with sex acting as an effect modifier. After adjusting for these confounders, male decedents in industries with a high risk of non-fatal work-related injury were found to have a 25% increased odds of opioid-involved overdose death (OR = 1.25, 95% CI: [1.06, 1.48]) when compared to males employed in all other industries (OR = 0.8, 95% CI [0.68, 0.95]). Females

decedents from industries with a high risk of non-fatal work-related injury had decreased odds of opioid-involved overdose death (OR = 0.94, 95% CI [0.76, 1.17]) that was not statistically significant when compared to female decedents who previously worked in all other industries (OR = 1.06, 95% CI [0.85, 1.33]). Additionally, those who were married had 33% decreased odds of opioid-involved overdose death (OR = 0.67, 95% CI: [0.59, 0.77]) when compared to those who were not married, and those with a high school diploma had 24% greater odds (OR = 1.24, 95% CI: [1.06, 1.46]) of opioid-involved death compared to those with a college degree.

DISCUSSION: The results of this study support previous research that demonstrated males have a higher odds of opioid-involved overdose death compared to females and that persons in industries with a high-risk of non-fatal work-related injury have increased odds of opioid-involved overdose death compared to all industries. This indicates a likely relationship between occupational injury and opioid-involved overdose death and that prevention efforts may be made more efficient by targeting persons employed in specific industries or occupations. More research should also be done to better understand the role of sex in this relationship to determine why males appear to have higher odds of opioid-involved overdose death compared to females. A more thorough understanding of the role occupation plays in the opioid epidemic could also be valuable for improving public health interventions to more efficiently combat the opioid epidemic in Georgia and the United States.

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APPROVAL PAGE

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Author's Statement Page

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CHAPTER 1 – INTRODUCTION

1.1 Background

Full-time employed Americans spend, on average, 8.5 hours per weekday at work, adding up to about a quarter of their time every week (charts related to the latest "American Time Use Survey" news, n.d.). Some industries, such as many involving excessive manual labor, have a significantly higher risk of non-fatal work-related injury often resulting in a need for pain management (Lavender, Benson, Bayakly, 2015).) With opioids remaining one of the most effective tools for managing pain, they are often utilized to treat and manage pain resulting from workplace injuries and hazards (Kowalski-Mcgraw, Green-Mckenzie, Pandalai, & Schulte, 2017). Previous research has found a relationship between work-related injury and opioid overdose death with 57% of decedents of opioid-related overdose deaths having had at least one work-related injury (Cheng, Sauer, Porucznick, & Hegmann, 2013). While Georgia is not considered one of the states hardest hit by the opioid epidemic, from 2010 to 2018 the number of deaths resulting from opioid overdose in Georgia increased by 70% and until 2013 this increase was driven largely by the use and misuse of prescription opioids (“Opioid Overdose Surveillance Preliminary Report Georgia, 2018”, 2019). Previous research analyzing U.S. national data from 21 states has shown some occupational groups have significantly higher proportional mortality ratios for opioid overdose deaths (Morano, Steege, & Luckhaupt, 2018). Research analyzing data at the state level in other states (e.g., Massachusetts) has also found associations between occupational groups and opioid overdose death, indicating that work place environment, job duties, and the resulting risk of non-fatal work-related injury are likely contributing factors for the risk of opioid-involved overdose death (Hawkins, Roelof, Laing, & Davis, 2019).

1.2 Research Question and Aims

The opioid epidemic has been a well-documented public health problem in the United States for the past decade. However, occupational and industry data for the state of Georgia has never been analyzed for possible associations with opioid-involved overdose death and could provide critical insight into identifying high-risk populations for opioid overdose. A better understanding of the relationship between opioid-involved overdose death and industry can help us better understand the opioid epidemic and determine how and where to allocate prevention, intervention and treatment resources to those most at risk, as well as provide insight into how to improve prescribing practices and education and ultimately decrease the number of Georgians suffering opioid abuse disorder and overdose death. This study analyzed death certificate data from Georgia Vital Records at the Georgia Department of Public Health to assess the relationship between opioid-involved overdose death and industries with a high risk of non-fatal work-related injury.

CHAPTER 2 – REVIEW OF THE LITERATURE

2.1 Trends in Opioid Overdose Death

Over the past two decades the United States has seen a sharp increase in opioid-involved overdose deaths with national rates nearly tripling from 1999-2014Overdose deaths involving an opioid have been defined using the *International Classification of Disease, Tenth Revision* (ICD-10) codes pulled from death certificates and include subcategories natural/semi-synthetic opioids, methadone, heroin, and synthetic opioids other than methadone such as fentanyl (Rudd, Seth, David, & Scholl, 2016). The increasing national trend of drug overdose deaths has continued in recent years and in 2017 alone 47,600 drug overdose deaths involved an opioid, making up nearly 67.8% of all US drug overdose deaths and overdose deaths involving prescription opioids were five times higher in 2017 compared to 1999 (Overview of the Drug

Overdose Epidemic: Behind the Numbers, 2018). In 2015, opioid-involved overdose death rates increased in 30 states, including Georgia, and the District of Columbia and drug overdoses accounted for 52,404 of all deaths in the US with 63.1% involving an opioid (Rudd, Seth, David, & Scholl, 2016).

While the northeast region of the US has been reported as having the highest burden of opioid-involved overdose death in the US, the south and specifically the state of Georgia has seen sharp increases as well over the past decade with a 70% increase in the total number of opioid-involved overdose deaths from 2010-2018. The use and abuse of prescription opioids such as Oxycodone and Hydrocodone were reportedly the main driving force behind this sharp increase from 2010-2017. However, starting in 2013 illicit opioids such as heroin and fentanyl have been increasingly more of a driving force behind the increase through 2017 ("Opioid Overdose Surveillance Preliminary Report Georgia, 2018", 2019). There has been some improvement in the overall number of drug overdose deaths in Georgia with all drug overdose death categories decreasing from 2017-2018, except for heroin. When analyzed on a quarterly basis and stratified by sex, opioid-involved death rates for females trended down all quarters of 2018 except quarter 3, and the rates for males trended down quarter 1 through quarter 3 before increasing in quarter 4. However, even with this recent decrease it is too early to determine if this trend will continue and indicates a meaningful improvement in the opioid epidemic in Georgia, and the burden of opioid-involved overdose death is still considerable. In 2018 alone, opioid-involved overdose deaths accounted for 5014 emergency department (ED) visits, 2345 hospitalizations, and 873 deaths ("Opioid Overdose Surveillance Preliminary Report Georgia, 2018", 2019).

As previously stated, the largest increases in opioid-involved overdose death were concentrated in the northeast region of the US with a 107.4% increase from 2014 - 2015, however the Midwest also saw a sharp increase of 95%, while the rates in the south increased 55.6% (Rudd, Seth, David, & Scholl, 2016). While the demographics of the opioid epidemic in the US and Georgia are similar, there have been a few differences. Nationally the largest increases, when adjusted for number and age, from 2014-2015 were among White non-Hispanic and Black non-Hispanic males ages 25-44 (Rudd, Seth, David, & Scholl, 2016). However, in Georgia Whites have been reported as being 3.5 times more likely to die of an opioid-involved overdose death, 2.5 times more likely to visit the ED for any opioid-involved overdose, and 4.8 times more likely to visit and ED for a heroin overdose than Blacks. Additionally, for Georgia, persons aged 25-34 were most likely to die and visit the ED due to an overdose involving Heroin or Fentanyl, although those aged 45 and over were more frequently hospitalized because of an opioid-involved overdose death. In the US and Georgia males are at a greater risk compared to females and are 1.9 times more likely to die from any opioid-involved overdose and 3.1 times more likely to die from a heroin-involved overdose ("Opioid Overdose Surveillance Preliminary Report Georgia, 2018", 2019). In addition to this, the highest number of heroin and opioid-involved overdose deaths, ED visits, and hospitalizations occurred mostly among residents of urban areas, but there have been high rates of opioid-involved overdose ED visits in both rural and urban areas, particularly in the north, south central, and southeast regions of the state ("Opioid Overdose Surveillance Preliminary Report Georgia, 2018", 2019).

2.2 Prescription Opioids and Opioid-Involved Death

Opioids have been the most effective tool available to physicians to treat pain and particularly chronic pain, and opioid prescriptions have been dramatically increasing since the

late 1990s, followed closely by the steep rise in opioid overdose deaths (Garg, Fulton-Kehoe, & Franklin, 2017). In 2011 oxycodone was the most common drug among drug overdose deaths that mentioned just one specific drug and while both heroin and fentanyl outpaced prescription opioids from 2012 – 2016, the number of deaths per 100,000 involving oxycodone or hydrocodone has held steady (Hedegaard, Bastian, & Trinidad, 2018). Among patients receiving treatment for non-cancer pain, the rate of annual overdose was 256 per 100,000 person years among persons who recently had received medically prescribed opioids, which was substantially higher than the 36 per 100,000 person years for those who had not recently received an opioid prescription. A clear dose response relationship has also been established, with the risk of overdose increasing with an increasing opioid dosage level. Patients who were receiving an opioid dose of 100 mg of morphine or more per day had an overdose rate of 1,791 per 100,000 person years which was over 9 times higher than those receiving <20mg per day (Dunn, Saunders, Rutter,…Von Korff, 2010). These findings were consistent among Medicaid patients in Washington which displayed a clear dose-response relationship with a significantly increased risk of fatal overdose at doses greater than or equal to 90 mg/day and treatments with both long-acting and short-acting Schedule II opioids having the greatest risk compared with non-Schedule II medications only (Garg, Fulton-Kehoe, & Franklin, 2010).

2.3 Work-Related Injury and Opioids

Existing literature has established a relationship between receiving an opioid prescription and an increased risk of overdose death, and opioids are frequently prescribed to treat work-related injuries (Morano, Steege, & Luckhaupt, 2018). This is not very surprising considering work environment and factors such as a history of heavy manual labor or repetitive use of the hand are risk factors for osteoarthritis, and both sitting (OR = 2.8) and frequently raising arms

(OR = 3.1) are associated with greater work disability as a result of injury and chronic pain (Kowalski-Mcgraw, green-McKenzie, Pandelai, Schulte, 2017). These factors combined with musculoskeletal conditions have been shown to impact opioid use. In addition to opioid use as a result of work-related injury, consumption of analgesics has been found to be associated with work atmospheres perceived as "bad" (12.6%) compared with those perceived as "good" (3.7%) and risk factors related to a person's job such as low job satisfaction have also been associated with increased usage of drugs (42.9% vs. 3.3%)(Kowalski-Mcgraw, green-McKenzie, Pandelai, Schulte, 2017). Some research has found persons of a low socio-economic status have an increased likelihood of filing an occupational injury claim and prescription drug use, indicating a possible relationship between work environment and risk of opioid use disorder, a known risk factor for opioid-involved death (Kowalski-Mcgraw, green-McKenzie, Pandelai, Schulte, 2017). In a comparison of opioid-related deaths by work-related injury in the state of Utah where 66% of 385 deaths due to drug poisoning involved an opioid and 87% of these were from non-illicit drugs, 57% of decedents had at least one prior work-related injury. Other demographic factors that increased risk of opioid-involved death and have been supported by prior research were an existing psychiatric disorder, current or prior substance abuse problems, poor education, lack of religious support and an unmarried status (Cheng, Sauer, Porucznick, & Hegmann, 2013)

As mentioned previously in this paper, in a national study utilizing data from 21 states including the state of Georgia, proportional mortality ratios (PMRs) of opioid-involved death compared to deaths from other causes were found to vary across 26 occupational groups. Six occupational groups were found to have PMRs significantly above 1.00 when compared to all other occupations, they were construction (PMR = 1.25), extraction (PMR = 1.16), food preparation and service (PMR = 1.11), health care practitioners and technical (PMR = 1.16),

health care support (PMR = 1.18), and personal care and service (PMR = 1.10) (Morano, Steege, & Luckhaupt, 2018). Massachusetts has been documented as having the highest burden of opioid overdose death and the demographics of the opioid epidemic are similar to Georgia with White Non-Hispanic males aged 25-34 representing the greatest risk. Results similar to the national study were found for the state of Massachusetts with construction; agriculture, forestry, fishing, and hunting; transportation and warehousing; administrative support and waste management services; accommodation and food services; and other services except public administration having opioid-related overdose death rates significantly higher than the rate for workers in all other industries. Additionally, opioid-related overdose rates were significantly higher among workers employed in occupations known to be physically demanding and with a high rate of work-related injuries and illnesses (Hawkins, Roelof, Laing, & Davis, 2019). 78,200 non-fatal workplace injuries and illnesses (incidence rate = 2.6 cases/100,000 persons) were reported in Georgia during 2017 alone, with the highest incidence rates among many of the same industries found to be at an increased risk of opioid-involved overdose death in the existing literature ("Employer-Reported Workplace Injuries and Illnesses in Georgia – 2017", 2019). This indicates that these industries are likely at an increased risk of opioid-involved overdose death and should be analyzed to explore this relationship further for a more comprehensive understanding of the landscape of the opioid epidemic in Georgia and could be invaluable for informing public health action and intervention.

CHAPTER 3 – METHODS AND PROCEDURES

3.1 Georgia Vital Records Death Certificate Data

2014 death certificate data analyzed in this study were supplied by the office of Vital Records at the Georgia Department of Public Health. The mission of the office of Vital Records

is “to provide records and data concerning vital events to Georgians and other stakeholders” (“About Vital Records”, n.d.). Vital events are defined as death, birth, fetal deaths, induced termination of pregnancy, marriage and divorce certificates and reports. The scope and authority of the office of Vital Records is specified under Georgia Code Chapter 31-10, and the Georgia Department of Public Health Regulation 511-1-3 (“About Vital Records”, n.d.).

3.2 Sample Population

The 2014 death certificate data set was comprised of a total of 77,836 decedents. Decedents were excluded for analysis if they had a value of “-1”, representing “unknown” or missing for any of the following: opioid-involved overdose death, decedent’s primary industry, and possible covariates of education, age, race/ethnicity, sex, or marital status. Additionally, since one of the primary variables of interest was a decedent’s industry, all decedents under the legal working age of 16 at death were excluded. All decedents with an industry listed as “unemployed” were excluded as they were not in the work force, and those with an industry code listed as “retired” were also excluded due to being unable to determine in which industry the decedent had been primarily employed. A total of n = 19,690 decedents were excluded, leaving a total of n = 58,146 decedents included in the analysis of this study. Characteristics of decedents excluded can be found in Table 4.1.

When race proportions in the sample populations was compared with the overall population demographics of Georgia available for 2018, the proportions for those considered Hispanic were inconsistent and as a result race/ethnicity was excluded as a potential covariate due to unreliable data quality for this category (U.S. Census Bureau QuickFacts: Georgia, 2018).

3.3 Dependent Variable

The dependent or outcome variable of interest in this study is those who died due to opioid-involved drug poisoning. There were three variables in the original data for cause of death that were used to identify those who died of an opioid-involved death. These variables are "Cause_of_death_B", "Cause_of_death_C" and "Cause_Underlying". These variables were re-coded into a single dependent variable "Opioid_Death" with a possible value of "1" indicating an opioid-involved death and "0" indicating all other causes of death.

ICD-10 is used to indicate a cause of death for each decedent. Cause of death is determined by a state certified coroner or medical examiner and the presence of opioids is determined by toxicological screenings of samples collected from the decedent at the time of death. Decedents classified as having died due to an opioid-involved death were identified by any cause of death text field that contains the word "toxic" and at least one of the following: heroin, fentanyl (and fentanyl analogs), methadone, buprenorphine, butalbital, codeine, eddp, hydrocodone, hydromorphone, levorphanol, meperidine, norbuprenorphine, oxycodone, oxymorphone, tapentadol, tramadol. The presence of these drugs is indicated by ICD-10 codes T40.1, T40.2, T40.3, and T40.4 indicating prescription and/or illicit opioids as a contributing cause of death. ICD-10 codes X40, X41, X42, X43, X44, Y10, Y11, Y12, Y13, Y14 which indicate prescription and/or illicit opioids as an underlying cause of death. Codes X60, X61, X62, X63, X64 indicate suicidal ideation and were excluded, X85 indicating assault was also excluded ("Prescription Drug Overdose Data & Statistics Guide to ICD-9-CM and ICD-10 Codes Related to Poisoning and Pain", 2013). Deaths suspected of being of an intentional nature in the state of Georgia typically do not have autopsies conducted and have poor data quality and reporting and were considered too unreliable to be included in this study. ICD-10 codes

indicating all other underlying and contributing causes of death were coded as non-opioid-involved death.

3.4 Independent Variable of Interest

The independent variable of interest or exposure variable for this study is the decedent's industry listed on their death certificate and was coded using the National Institute of Occupational Safety and Health Industry and Occupational Computerized Coding System (NIOCCS) definitions and was listed under the variable "fnal_ind_code" in the original data set. The decedent's primary industry is determined by a state certified coroner or medical examiner through interviews of friends and family and is defined as the industry the decedent was employed in the longest. This variable was recoded as industries with a high risk of non-fatal work-related injury with possible values of "1" indicating an Industry with a high risk and "0" indicating all other Industries (NIOSH Industry and Occupation Computerized Coding System (NIOCCS), n.d.).

Industries with a high risk of non-fatal work-related injury were identified using the most current Georgia Occupational Health Surveillance Report, 2008-2012. The industries identified as carrying the highest incidence of non-fatal work-related injury were agriculture, forestry, fishing, and hunting; education and health services; leisure and hospitality; manufacturing; construction; trade, transportation, and utilities (Lavender, Benson, & Bayakly, 2015).

3.5 Covariates

The possible covariates, or additional decedent characteristics that could influence the outcome of this study, that were considered in this study were age at death, sex, marital status at death, and maximum education level obtained at death. These were all recoded into categorical variables. Age was coded into 3 categories to create more even groupings of decedents aged 16 –

44 coded as "1", those aged 45 – 74 coded as "2", and decedents aged 75 and older coded as "3". Sex was coded as "1" indicating male, or "0" indicating female. Marital status was coded as "1" indicating married, or "0" indicating not married which included all decedents who were never married or had previously been married but were now divorced, separated, or widowed. Maximum education level obtained at death was coded as "1" indicating less than a high school diploma or General Education Diploma (GED), "2" indicating the decedent had graduated high school or received a GED, or "3" indicating the decedent had been awarded a college degree. Those categorized as having received a college degree included all those who had been awarded an associate degree, a bachelor's degree, or a post-graduate or advanced degree.

3.6 Confounding and Effect Modification

After the possible covariates were identified each was assessed for a potential association with both the dependent and independent variable of interest that could cause a spurious association. Each covariate was also assessed for being a possible effect modifier or a variable that could change the magnitude of effect of the independent variable on the dependent variable. Separate 2x2 tables were created to assess for association between each possible covariate and opioid-involved death and, separately, industries with a high risk of non-fatal work-related injury. SAS Enterprise Guide version 7.1 was used along with Microsoft excel for all subsequent analyses. A chi square test of significance was used to determine if there were significant associations between each covariate and opioid-involved overdose death and separately industries with a high risk of non-fatal work-related injury. These associations which can be seen displayed in Table 4.2. Associations were detected between all possible covariates (sex, age, marital status, and education level) and opioid-involved overdose death and industries with a high risk of non-fatal work-related injury. Next, each covariate was assessed for potential

confounding and effect modification by creating 2x2 tables of industries with a high risk of non-fatal work-related injury stratified by each level of each covariate. Stratified odds ratios and 95% confidence intervals were calculated and compared to the crude odds ratio of opioid-involved overdose death among industries with a high risk of non-fatal work-related injury. These results can be found in Table 4.3.

3.7 Multivariate Analysis

After assessing for confounding and effect modification, age was excluded and covariates sex, marital status and education level were identified as confounders with sex as an effect modifier. A multivariate logistic regression model was constructed including these variables.

CHAPTER 4 – RESULTS

Demographic characteristics of the study sample are illustrated in Table 4.2 and, overall, the largest proportion of decedents were those aged 75 and older (47.8%), were not married (58.5%), and with a high school diploma (52.87%). Of all decedents from 2014, 1.6% died an opioid-involved death (n = 946). Of these, 43.23% were aged 45-74 years at death, 67.5% were not married, and 59.7% had a high school diploma as the highest level of education obtained at death. Out of all the decedents in this study, 59.2% (n = 34,434) were employed in industries with a high risk of non-fatal work-related injury. Of these 58.2% were male, 47.3% were aged 45 – 74 years, 46.8% were aged 75+ years, and 49.9% had a high school diploma as the highest level of education obtained at death.

Initially, a crude odds ratio of 1.10 [95% CI: 0.967 – 1.259] was calculated for opioid-involved overdose death among decedents with a primary industry with a high risk of non-fatal work-related injury. After running the multivariate logistic regression model with sex as an effect modifier, odds ratios of opioid-involved overdose death among female decedents of industries

with a high risk of non-fatal work-related adjusted for marital status and education level was found to be 0.95 [95% CI: 0.755, 1.1.73] and was not statistically significant when compared with females in all other industries. Conversely, male decedents employed in industries with a high risk of non-fatal work-related injury when adjusting for marital status and education level were found to be at 25% greater odds of opioid-involved overdose death [OR = 1.25; 95% CI: 1.057, 1.477] when compared to men employed in industries without a high risk of non-fatal work-related injury and this was statistically significant. Additionally, those with a high school diploma had an increased odds of opioid-involved death [OR = 1.16; 95% CI: 0.985, 1.367] compared to those with a college degree, and those who were married at death had a decreased risk of opioid-involved death [OR = 0.6; 95%CI: 0.518, 0.688] compared with those who not married. Crude and adjusted odds ratios with associated 95% confidence intervals for risk of opioid-involved overdose death for industries with a high risk of non-fatal work-related injury with and without sex as an effect modifier, as well as for covariates included in the final model can be found in table 4.4.

CHAPTER 5 – DISCUSSION AND CONCLUSIONS

5.1 Discussion

The opioid epidemic continues to be a major public health concern across the United States and Georgia, and several risk factors for opioid-involved overdose death have been identified including a prior prescription for opioid analgesics (Dunn, Saunders, Rutter,…Von Korff, 2010). Some high-risk groups for opioid-involved overdose death have been identified in Georgia such as males aged 25-34, however this is still a very large group and more information is needed to more accurately identify high risk populations within this group to more effectively target public health interventions (“Opioid Overdose Surveillance Preliminary Report Georgia,

2018", 2019). There have been several occupations identified as having an increased risk of work-related injury nationally including construction, extraction, food preparation and service, health care practitioners and technical, healthcare support, and personal care and service (Morano, Steege, & Luckhaupt, 2018). These results have been supported by a study analyzing data from Massachusetts, which found increased risk of opioid-involved overdose death for those employed in construction, agriculture, forestry, fishing, and hunting; transportation and warehousing; administrative support and waste management services; accommodation and food services; and other services except public administration. This study also established an association between occupations with a higher risk of work-related injury and opioid-involved overdose death (Hawkins, Roelofs, & Davis, 2019).

In this analysis of the risk of opioid-involved overdose death among industries with a high risk of non-fatal work-related injury as defined by the Georgia Occupational Health Surveillance Report, 2008 – 2012 there is an increased risk of opioid-involved overdose death for male decedents in industries with a high risk of non-fatal work-related injury, but no association was found for female decedents in this industry. This further supports data that there is an increased risk for males with a greater risk of work-related injury. Although it has been established that males in general are at an increased risk of opioid-involved overdose death, there is no clear explanation for this discrepancy among the sexes. One possible hypothesis that could explain this difference in risk levels between the sexes despite both being employed in industries with a high risk of non-fatal work-related injury is differing positions being held by the sexes or differing job duties. It may be that males are more likely to hold positions with a higher risk of work-related injury that results in receiving an opioid prescription. This is a hypothesis that should be explored further in future research to better understand the relationship with

occupational health and opioid-involved death and why males are at an increased risk compared to females.

5.2 Strengths and Limitations

There were several strengths and limitations to this study. One strength is that since the determination of opioid-involved death is based on toxicological testing, it is very reliable and thus there is a low likelihood of a "false positive" for the dependent variable of interest. However, all decedents with missing cause of death codes were excluded and it is likely that some of these could have been due to opioid-involved overdose death that were not identified which likely muted the effect of industries with a high risk of non-fatal work-related injury on opioid-involved overdose death. One major limitation of this study is that all participants were deceased and so this study only measured the odds of opioid-involved overdose death among those who have already died and not the true odds of opioid-involved overdose death for persons employed in industries with a high risk of non-fatal work-related injury. Another limitation is the determination of a decedent's primary industry is based off of interviews of family and friends of the decedent and many individuals hold many different jobs over their lifetime making the independent variable of interest fairly unreliable and it's possible this contributed to the weak crude association between opioid-involved overdose death and industries with a high risk of non-fatal work-related injury. Additionally, there was no information on income or socio-economic status available in this dataset which previous literature has found to be a confounding variable. Additional data quality issues arose from the large discrepancy previously noted between the proportion of decedents identified as Hispanic in this dataset and the proportion referenced in the Georgia census data. Race/ethnicity is a common covariate and one that has been identified as another possible confounder in previous literature. Many of the limitations of this study could be

summarized as data quality issues related to how death certificate data is recorded in the state of Georgia. Replicating this study in other states with possibly better data quality could be informative.

5.3 Implications of Findings

While the association found in this study is not clear as there was only a relationship found for male decedents in industries with a high risk of non-fatal work-related injury and not for females, these findings do support the existing literature indicating a relationship between occupational related injury and opioid-involved death and that males are at greater risk compared to females. This information could be used to better inform prescribing practices particularly for patients receiving treatment for work-related injury. Although there are many situations where an opioid analgesic is the best choice for the patient, improving patient education for those receiving an opioid prescription could also help mitigate the risk of opioid-involved overdose death.

Another potential application for these findings would be to develop more effective public health interventions to prevent occupation-related injury thus possibly decreasing the number of patients that require an opioid prescription. Encouraging employers to educate their staff on injury prevention could be very valuable. Existing literature has found that many injuries resulting from one's occupation are from repetitive motion and sitting for pro-longed periods of time (Kowalski-Mcgraw, green-McKenzie, Pandelai, Schulte, 2017). Therefore, encouraging the use of standing desks, and encouraging movement and the use of preventative physical therapy could be effective for preventing or mitigating work-related injury and decreasing the need for opioid prescriptions.

5.4 Conclusion

This study further supports existing literature that occupations with a higher incidence of non-fatal work-related injury are at an increased risk of opioid-involved overdose death. This relationship appears to differ for males compared with females and factors such as gender roles within these industries and analyzing the relationship between opioid-involved overdose death and more specific occupations and positions could reveal more about the specific occupational risk factors for opioid-involved overdose death. Additionally, more research needs to be done to identify other possible confounding factors such as race/ethnicity, socio-economic status and income level which could help identify those most at risk. This study along with the existing research does indicate a significant relationship between risk of work-related injury and opioid-involved overdose death and particularly for males, thus a better understanding of this relationship could prove effective for combating the opioid epidemic not only in Georgia, but throughout the United States.

TABLES

Table 4.1 Decedent characteristics of all persons excluded from this study due to missing or unknown data values.

Decedent Characteristic[A]	Opioid-involved Overdose Death n	All Other Causes of Death n	Total n
Sex			
Unknown	0	0	0
Age Groups			
< 16	3	1396	1,399
Unknown	0	0	0
Marital Status			
Unknown	14	452	466
Education Level			
Unknown	20	949	969
Primary Industry			
Retired	2	282	284
Unemployed	286	13,892	14,178
Unknown	79	3,983	4,062
Cause of Death			
Unknown	-	-	372

Source: Author's calculations using 2014 death certificate data from the Office of Vital Records, Georgia Department of Public Health

Notes

[A] Each characteristic is not mutually exclusive, and decedents may be listed in more than one category.

Table 4.2 Associations between decedent characteristics, opioid-involved overdose death and previously working in an industry with a high risk of non-fatal work-related injury for Georgia decedents in 2014.

Characteristic	Opioid-involved Overdose Death n (%)	Chi Square (p-value)	Industries with a High Risk of Non-fatal Work-related Injury n (%)	Chi Square (p-value)	Total n (%)
Sex		15.05 (.0001)		10.05 (.0015)	
Male	614 (64.90)	-	20,044 (58.21%)	-	34,159 (58.75%)
Female	332 (35.10)	-	14,390 (41.79%)	-	23,987 (41.25%)
Age Groups		2359.05 (<.0001)		34.78 (<.0001)	
16-44	397 (41.97)	-	2,038 (5.92%)	-	3,409 (5.86%)
45-74	409 (43.23)	-	16,284 (47.29%)	-	26,945 (46.34%)
75+	140 (30.23)	-	16,112 (46.79%)	-	27,792 (47.80%)
Marital Status		32.41 (<.0001)		74.56 (<.0001)	
Not Married[B]	639 (67.5)	-	20,649 (59.97%)	-	34,017 (58.50%)
Married	307 (32.45)	-	13,785 (40.03%)	-	24,129 (41.50%)
Education Level		19.62 (<.0001)		856.40 (<.0001)	
< High School Diploma	180 (19.03)	-	9,686 (28.13%)	-	13,861 (23.84%)
High school diploma	565 (59.73)	-	17,194 (49.93%)	-	30,740 (52.87%)
College Degree[A]	201 (21.25)	-	7,554 (21.94%)	-	13,545 (23.29%)
Total	946 (100)	-	34,434 (100%)	-	58,146 (100%)

Source: Author's calculations using 2014 death certificate data from the Office of Vital Records, Georgia Department of Public Health

Notes

[A] Includes all decedents with an associate's, bachelor's, master's and doctoral degrees.

[B] Includes all decedents categorized as never married, divorced, separated, and widowed.

Table 4.3 Crude odds ratios of opioid-involved overdose death for decedents previously employed in industries with a high risk of non-fatal work-related injury stratified by categories of decedent characteristics, Georgia, 2014.

Covariates	Crude Stratified OR[C]	95% CI
Sex		
Male	1.23	[1.0426, 1.4524]
Female	0.91	[0.7335, 1.1376]
Age Groups		
16-44	1.14	[0.9157, 1.4099]
45-74	1.07	[0.8782, 1.3135]
75+	0.97	[0.6909, 1.3518]
Marital Status		
Not Married[B]	1.01	[1.0094, 1.6084]
Married	1.27	[0.8582, 1.1827]
Education Level		
< High School Diploma	0.98	[0.7117, 1.3477]
High school diploma	1.26	[1.0614, 1.4940]
College Degree[A]	0.96	[0.7242, 1.2674]

Source: Author's calculations using 2014 death certificate data from the Office of Vital Records, Georgia Department of Public Health

Notes

[A] Includes all decedents with an associate's, bachelor's, master's and doctoral degrees.

[B] Includes all decedents categorized as never married, divorced, separated, and widowed.

[C] Based on unweighted and unadjusted sample population.

Table 4.4 Table 4.4 Crude and adjusted odds ratios and 95% confidence intervals of opioid-involved overdose death for decedents previously employed in industries with a high risk of non-fatal work-related injury compared to all other industries.

	Crude OR[B]	95% CI	Adjusted OR[C]	95% CI
Industries with a high risk of non-fatal work-related injury	1.10	[0.97, 1.26]	-	-
Males in industries with a high risk of non-fatal work-related injury[A]	-	-	1.25	[1.06, 1.48]
Females in industries with a high risk of non-fatal work-related injury[A]	-	-	0.94	[0.76, 1.17]

Source: Author's calculations using 2014 death certificate data from the Office of Vital Records, Georgia Department of Public Health

Notes

[A] Sex was determined to be an effect modifier and entered into final model as an interaction term.

[B] Based on unweighted and unadjusted sample population.

[C] Adjusted for marital status at death and maximum education level obtained at death.

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