Postmortem Toxicologic Findings: The Presence of Alcohol and Psychoactive Drugs in Those Who Died by Suicide

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Approval Page

Abstract

Background: Substance use and abuse is strongly associated with higher rates of suicidal ideation, attempts, and ultimately suicide completion. The study objective was to examine the presence of alcohol and psychoactive drugs in the blood of individuals who died by suicide. Research aims were (1) explore the prevalence of alcohol and toxicological drugs in individuals who died by suicide by various demographic characteristics, (2) explore the prevalence of alcohol and specific toxicological drugs by methods of suicide, and (3) determine whether pharmaceutical and illicit drugs were associated with the method of suicide (specifically violent-non-drug-related means vs. drug-related means).

Methods: Data was extracted from the Medicolegal Death Investigation log database, retrieved from 2017-2020 within the metro-Atlanta region. Descriptive analyses and regression analyses were conducted.

Results: The presence of alcohol and psychoactive drugs in the blood of individuals who died by suicide had the highest percentages among the age group 25-44, White males that resided in middle-income areas. There were notable differences between detected drugs and methods of suicide. The top five identified drugs were Amphetamines (N=83), Cocaine (N=32), Anti-Depressants (N=27), Opioids (N=24), and Benzodiazepines (N=20). These identified drugs were more common in decedents who used firearms, hanging/ asphyxia, and poisoning/ drug overdose. Individuals who tested positive for pharmaceutical drugs had lower odds of violent-non-drug-related death compared to drug-related death (OR=0.006; 95% CI=0.001-0.027, $p<0.001$) whereas individuals who tested positive for illicit drugs had higher odds of violent-non-drug-related death compared to drug-related death (OR=3.005, 95% CI=1.165-7.755, $p=0.023$), even after controlling for relevant confounders.

Conclusion: Results of this study were consistent with previous research on the prevalence of alcohol among individuals who died by suicide across various demographic characteristics, however, the prevalence of drugs contradicted findings from other studies. Findings that individuals who tested positive for illicit drugs had higher odds of violent-non-drug-related death compared to drug-related death means support the importance of reducing access to lethal means of self-harm (particularly firearms) for a person at risk of suicide is an important part of a comprehensive approach to suicide prevention.

Authors Statement

This thesis project is dedicated to my family, friends, and committee members. First, I would like to thank my faculty chairperson, Dr. Owen-Smith for your continued guidance throughout this entire journey. Second, I would like to thank my other committee member, Dr. Geller for your support and availability to provide great feedback when I was in moments of stress. Third, I would like to thank Dr. Gowitt, Chief Medical Examiner at Dekalb County Medical Examiner's Office for your understanding and flexibility while I completed my thesis project. Finally, thank God for my family and friends who kept me lifted up in prayer and encouraged me to keep pushing on toward my goal.

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Chapter 1 INTRODUCTION

Suicide prevention is a major public health concern as suicide continues to plague the United States. Nationwide, suicide remains the tenth leading cause of death and has taken the lives of over 48,000 individuals in 2019 (National Institute of Mental Health, 2020). According to the Centers for Disease Control and Prevention (CDC), the proportion of suicide has increased from 10.5 per 100,000 in 1999 to 14.2 per 100,000 in 2018. Despite attention from public health officials, challenges still remain when identifying predisposing risk factors to suicide. Suicide risk arises from a complex array of factors that are varied but depend on an individuals' social and demographic characteristics, psychiatric disorders, and, of interest in this study, substance use and abuse. Substance abuse has been shown to be strongly associated with higher rates of suicidal ideation, attempts, and ultimately suicide completion (Sheehan, Rogers, & Boardman, 2015). In fact, the risk of suicidal behaviors is 6.2 times higher when associated with alcohol and drug abuse (Ruiz & Stockburger, 2017). Therefore, understanding the relationship between alcohol and drug use and suicide will potentially lead to preventative measures and interventions aimed at suicide prevention.

The use of postmortem toxicological analysis has been used to identify the prevalence of alcohol and psychoactive substances in the blood of individuals who died by suicide. Researchers such as Holmgren et al. (2010), Jones et al. (2013), and Choi et al (2018) utilized toxicological analysis to measure the association between blood alcohol concentrations (BAC) and other drugs in relation to the suicide method. These studies reported similar findings of alcohol being the most prominent drug type identified in cases where substances were detected in the blood of individuals who died by suicide. This is concerning, as alcohol is classified as a depressant that can have an adverse effect on the frontal cortex of the brain. The frontal cortex is

a component of the central nervous system (CNS) that controls cognitive and emotional functions such as behavioral spontaneity, response inhibition, movement, and social interaction (Kolb, 1984). The effects of alcohol may alter these functionalities by interacting with brain receptors in the CNS that interfere with the responsibilities of gamma-aminobutyric acid (GABA) neurotransmitters. GABA neurotransmitters functions are to communicate between nerve cells and suppress excitatory nerve pathway activity (Mukherjee, 2013). This impaired neuronal signaling may cause an individual to behave inappropriately, inducing behaviors such as dysphoria, deprived judgment, aggression, impulsive behavior, high-risk taking, and loss of inhibition. Such cognitive effects have been closely linked to an increased risk in suicidal behavior, which in turn can predispose vulnerable individuals to act on suicidal ideations (Choi et al., 2018).

Along with alcohol, medications – including both pharmaceutical and illicit drugs – are highly prevalent in postmortem blood samples from individuals who died by suicide. Pharmaceutical drugs fall into two categories: over-the-counter drugs (which can be purchased without a prescription) and prescribed medications. Over the counter drugs are nonprescribed medications that are used to treat minor illnesses and their symptoms such as coughs, colds, and headaches. Prescribed psychotropic medications are generally administered to treat physical and psychiatric ailments, which may include clinical depression, anxiety disorder, bipolar disorder, schizophrenia or post-traumatic stress disorder (PTSD). Despite the pharmacological effects of prescription drugs, they can lead to abuse when self-administered beyond therapeutic restrictions. Prescription drug abuse has been defined as “any intentional use of a medication with intoxicating properties outside of a physician’s prescription for a bona fide medical condition, excluding accidental misuse” (Compton & Volkow, 2006). This includes use of

medications prescribed for another user or abuse of medications that fit into the same drug class as illicit drugs. The most commonly abused prescription drugs fall into three classes: (1) opioids, which are primarily prescribed for pain relief (e.g., hydrocodone, oxycodone, and morphine), (2) CNS depressants, which are primarily prescribed for anxiety or common sleep disorders [e.g., sedatives (including barbiturates and non-benzodiazepines sedatives hypnotics), tranquilizers (including benzodiazepines), and hypnotics], and (3) stimulants which are primarily prescribed for attention-deficit hyperactivity disorder (ADHD), and narcolepsy (e.g., . amphetamines, methamphetamines, methylphenidates, and cannabinoids). Cannabinoids have a chemical structure of both cannabidiol (CBD) and tetrahydrocannabinol (THC), which are two natural compounds derived from a Cannabis sativa plant. While the THC compound is notorious for the high sensation or psychoactive effects, CBD is more well known for its medical benefits. Therefore, CBD may be present in prescription medications for the treatment of various conditions yet are commonly abused when bounded with THC in the form of marijuana.

Prescribed psychotropic medications are abused when reinforced by methods other than orally administered or the dose intake is larger than therapeutic levels. According to Compton & Volkow, prescription medications ingested through injection, smoking, snorting or inhalation tends to heighten the dosages, leading to the tolerance and dependence on the intoxicating effects of a prescribed agent. While such medications are intended to reduce an array of medical conditions, they may also play a role in inducing withdrawal symptoms like depression, suicidal ideation, and death (Schub & Karakashian, 2018). Indeed, a large number of studies have examined the adverse effects of prescription medications on suicide. However, limitations exist when trying to infer causation between medications and the heterogeneous measurement of suicidal behavior (Benson et al., 2018). To address such shortcomings, researchers have turned

to medical records and the analysis of toxicological findings of those who died by suicide. Therefore, the use of toxicological analysis needs to be investigated further to identify patterns of prescription drug abuse among individuals at risk of suicide.

Illicit drugs, by contrast, are any illegal substances that are used for recreational purposes. Classification of illicit drugs are as followed: (1) CNS depressants which include heroin, (2) stimulants which include cocaine, and (3) hallucinogens which consist of LSD, ketamine, and methylenedioxymethamphetamine (MDMA, e.g., ecstasy). Such substances are highly addictive and can pose as a serious threat, especially when simultaneously combined with other psychoactive substances. For example, individuals may concurrently use multiple pharmacological agents to counter side effects resulting from other agents with opposite reactions (e.g., the use of sedatives to overcome effects from stimulants) or to decrease undesirable drug effects (e.g., the use of cocaine to reduce alcohol-induced sedation) (Compton & Volkow, 2006). Although common trends have been identified, the relationship between illicit drug use and suicide is complex and has not been well developed in current research. What is known about both – pharmaceutical and illicit drugs is that such substances have a synergistic effect on suicidal behaviors, not entirely due to the effects of the comorbidity of psychiatric disorders. However, considerable studies have stated that drug abuse that co-occurs with alcohol and psychiatric disorders is strongly implicated in suicidal behavior, increasing the role in impulsivity and aggressive behavior (Vijayakumar et al, 2011). Therefore, the prevalence and severity of drug use warrant further research to examine the causal relationship between substance abuse and suicide.

Purpose of Study

Despite the known suicide risk of substance use and abuse among those who have died by suicide, relatively few studies have examined the role of alcohol and psychoactive drugs interfaced with race and ethnicity. Researchers such as Choi et al (2018) and Sheehan et al (2015) examined whether rates of suicide differed by race/ ethnicity yet had a predominately non-Hispanic White sample population. Even fewer studies have examined the prevalence of substance use among individuals who died by suicide in relation to socioeconomic status (SES). Karriker-Jaffe (2013) differentiated substance use outcomes among affluent and disadvantaged neighborhoods compared to middle-class neighborhoods. The methodology used in this study was from a nationally representative database from the 2000 and 2005 National Alcohol Surveys (NAS), that retrieved data through telephone interviews and face-to-face surveys of U.S adults. Survey data was subsequentially matched with indicators of neighborhood SES from the 2000 U.S. Decennial Census, at which respondents were measured across three dimensions of SES. The three dimensions are as followed: (1) income, (2) educational capital, and (3) employment opportunities. The results of this study did not have a significant association between neighborhood disadvantage on alcohol-related outcomes. However, respondents that resided in disadvantaged neighborhoods (compared to middle-class and affluent) had significantly higher odds of daily tobacco use, and monthly marijuana use for men, in addition to, even greater odds of tobacco use and monthly illicit drug use for women.

Similar to this research, Karriker-Jaffe (2011) conducted a systematic review that summarized the effects of area-level SES on substance use outcomes. Specifically, this study examined an area-level disadvantage hypothesis among three theoretical questions: (1) Are residents in a given area similar in their substance use outcomes, (2) Are study characteristics

contributable to the effects of area-level SES on substance use outcomes, and (3) Are substance use outcomes exacerbated based on area-level disadvantage. The results of this study suggest that there is a strong correlation between geographic area and substance use outcomes, however, there were inconsistent findings that supported the hypothesis that area-level disadvantage was associated with increased substance use. Specifically, results stated that alcohol and drug use outcomes were significantly higher among disadvantaged neighborhoods. Whereas the combination of alcohol and drug use outcomes were more prominent among affluent neighborhoods compared to area-level disadvantage.

While several studies have examined the causal relationship between neighborhood SES and substance use outcomes, these findings were not specifically examined among suicides. As such, racial and ethnic minorities along with social determinants of health among suicides have not been properly represented in existing research. Therefore, the current study draws its sample from one of the largest, most diverse cities in the state of Georgia – the Metro Atlanta region. As of 2019, the Metro-Atlanta region holds a race origin of: 40% White, ~ 51% Black or African American, ~ 0.3% American Indian and Alaska Native, and 4.4% Asian. The ethnicity origin in the Metro Atlanta region comprises of: 4.3 % Hispanic, and 38 % Non-Hispanic. This thesis will specifically examine the prevalence of substance use and abuse in individuals who died by suicide by the method of suicide, overall and by demographic characteristics such as age, gender, race/ ethnicity, and SES.

Research Aims

I. Explore the prevalence of alcohol and toxicological drugs among individuals who died by suicide by various demographic characteristics and SES.
II. Explore the prevalence of alcohol and specific toxicological drugs by the method of suicide.

III. Determine whether pharmaceutical and illicit drugs are associated with the method of suicide (and specifically violent-non-drug-related vs. drug-related methods).

Chapter 2 LITERATURE REVIEW

An extensive body of research has shown that alcohol use and abuse are associated with suicidal ideation, suicide attempts, and completed suicide. Researchers such as Ruiz & Stockburger (2017), Gossop (2005), & Sher (2006), suggest that the relationship between alcohol and suicidal behavior may be explained in the following ways:

> (1) alcohol abuse may affect suicidal ideation and attempts (2) suicidal ideation and attempts may affect the urge to abuse alcohol (3) alcohol abuse and suicidal phenomena have a cyclical relationship, at which they may affect each other (4) alcohol abuse may not affect suicide, but it may be synergistic with other risk factors that affect suicide, or (5) alcohol abuse and suicidal ideation and attempts may each be affected by some third variable with themselves being directly related.

A common variable that may increase the risk for both alcohol abuse and suicide ideation and attempts is the influence of impulsivity. Impulsivity is a complex construct that has been a strong predictor of suicidal behavior while at the same time is exacerbated by the use of alcohol. When the relationship between impulsivity and suicidal behaviors has been measured, a positive correlation was established when researchers explored the frequency of suicide attempts and ideations among individuals not currently experiencing suicidal behaviors.

For example, Dougherty et al. (2004) performed various rapid-decision behavioral measurements among community-recruited groups to explore the frequency of suicide attempts and impulsivity. The recruited groups were categorized into three samples: (1) adults with no suicide attempts, (2) adults with one suicide attempt, and (3) adults with multiple suicide attempts. Impulsivity was assessed using two criterion measures, the Barratt Impulsiveness Scale

(BIS) self-reports and the Immediate and Delayed Memory Tasks laboratory behavioral measure. The BIS consists of 30 dichotomous items designed to investigate patterns of impulsive behaviors that have been widely used to make a comparison between suicidal and non-suicidal groups. The Immediate Memory Tasks (IMT) and the Delayed Memory Tasks (DMT) are stemmed from two subcategories: (1) continuous performance test (CPT) and the go/no-go task. Theoretically, both tasks require participants to rapidly respond to target stimuli that were proposed to measure impulsive behavior. Impulsive responses were tracked by commission errors which are responses to incorrect stimuli, and omission errors, which are nonresponses to correct stimuli. According to Dougherty et al. both types of errors are result from anticipatory, or incomplete processing of the stimulus, which leads to a quick nonreflective decision. Therefore, the results of this study suggested that impulsivity had no distinction among participants with different histories of suicide attempts. However, impulsive behaviors during the IMT and DMT measurements were significantly higher among participants with a history of a single attempt or multiple attempts to suicide compared to participants with no suicide attempt. This outcome shows that the multi-model assessment provides divergent evidence for the varied aspects of impulsivity and suicidal behaviors.

In the same study, Dougherty et al. examined the relationship between suicidal ideation and impulsivity using the IMT and DMT laboratory behavioral measures and the reward-directed task. The reward-directed task is the preference to choose a smaller-sooner reward versus a larger-later reward among a greater number of choices. Impulsivity was demonstrated when participants preferred the smaller-sooner reward over the larger-later reward, exhibiting an intolerance for delayed reinforcement. The performances of such behavioral measures were classified into three samples: (1) individuals without current or past suicidal ideation, (2)

psychiatric inpatients with no current thought of suicide, and (3) psychiatric inpatients with current suicidal ideation. Those in the suicide ideation group experienced higher levels of impulsivity during the IMT and DMT rapid-decision measures, which indicated more uninhibited responses. Similarly, individuals with a history of suicide ideation had significantly higher proportions of impulsivity in the reward-directed responses compared to individuals with no past of suicidality.

Klonsky & May (2010) evaluated if traits of impulsivity prospectively predicted whether suicide attempts would increase among a sample of those who have considered suicide but never attempted. This study used a multidimensional model to measure impulsivity referred to by the acronym UPPS. The UPPS dimensions include (1) urgency, which assesses an individuals' tendency to give in to strong impulses when experiencing depressed emotions, (2) perseverance, which analyzes if an individual is persistent in completing a task or obligation, (3) premeditation, which assesses an individual's action or planning of something without thinking through potential consequences, and (4) sensation, which measures an individual's preference for excitement or stimulation. When applying these four facets to the results of this study, it was stated that urgency, (lack of) perseverance & sensation did not differ among participants with histories of suicide attempts and ideation. However, low premeditation was more likely among participants with suicidal behavior compared to participants who had never been suicidal. While these findings have theoretical implications on the relation between impulsivity and suicidal behavior, low premeditation has been strongly predicted among alcohol abusers (Klonsky and May, 2010). As such, the nature between alcohol abuse and related constructs of impulsive behaviors needs to be furthered clarified in this study.

To explore the relationship between alcohol and impulsive-aggressive behavior, researchers have found a positive casual correlation when analyzed in an experimental study design. Bushman's (1997) narrative review highlighted the utilization of a balanced placebo design to explore alcohol-related aggression among humans. The balanced placebo design is when half of the participants are told that they will receive alcohol and the other half are told they will not receive alcohol. Within each of the groups, half of the participants will receive alcohol (antiplacebo) and the other half will receive a placebo. In addition to this comparison, a group of participants was added as a control group, in which participants are told they were not receiving alcohol nor were they given alcohol. To enhance the credibility of the antiplacebo drink, experimenters poured all beverages from "legitimate" bottles, diluted the alcohol, used false Breathalyzer readings, and had participants complete tasks that would distract them from the interoceptive signs of intoxication (Bushman, 1997). These necessary steps ensured that the psychological (e.g., expectancy) and pharmacological effects of alcohol can be tested in the study. In turn, the utilization of a balanced placebo design will have the ability to test the validity of three explanations of alcohol-related aggression.

Bushman explained the effects of alcohol on human aggression by classifying the associations as physiological disinhibition, alcohol-related expectancies, and indirect cause. The physiological disinhibition explanation is when alcohol directly increases aggression by reducing the effects of the brain that is responsible for inhibiting aggressive responding. The most sufficient test to examine this explanation was the antiplacebo versus the control group comparison to provide the pure pharmacological effects of alcohol on aggression. Alcohol-related expectancy explanation is when participants expect the consumption of alcohol to cause aggression or participants use the consumption of alcohol as an excuse to lack accountability for

their actions. The best comparison for this explanation was the placebo versus control group in attempt to identify the effects of alcohol-related expectancies on aggression. Finally, the indirect cause explanation posits that alcohol increases aggression by causing cognitive, emotional, or physiological changes that result in inaccurate risk assessment and reduced self-awareness. Since alcohol indirectly increases aggression, experimental manipulations of aggression such as provocations, frustrations, and aggressive cues were tested among intoxication versus non-intoxicated participants.

Such proposed explanations of alcohol-related aggression were analyzed by the use of meta-analytic procedures, at which, integrated findings were retained from previous meta-analytic reviews and presented as a standardized mean difference. The results of this review did not support the hypothesis that the psychological and pharmacological effects of alcohol on aggression can be determined, in part because there are a range of other independent variables that tend to share similar influences on aggression as alcohol. These variables may include a history of physical violence, neglect, or social (e.g., risk-taking) and nonsocial (e.g., psychological arousal) behaviors. Another possibility may be related to the concept of deception. In an experimental study, participants may become suspicious of the content of the beverages when they realize other facets of the experiment such as taste, smell, and the psychological effects of alcohol are not consistent across comparison groups. In contrary to these results, Bushman stated that participants that are intoxicated are, on average, more aggressive than non-intoxicated participants. Even so, the idea that alcohol indirectly increases the cause of aggression was confirmed by the experimental manipulations that facilitate aggression. In this, provocations, frustrations, and aggressive cues were shown to be more elevated on intoxicated participants than non-intoxicated participants (Bushman, 1997).

Chachamovich et al. (2012) differentiated levels of impulsivity and aggression among alcohol-related compared to non-alcohol related suicides. To measure this association, a psychological autopsy approach was used in efforts to investigate behavioral dimensions for suicidal behavior. This technique involves identifying a close relative or friend best acquainted with the decedent to act as an informant. To support the reliability of this method, two informants were used to complete comprehensive interviews. The content of such interviews was derived from two behavioral measures, which included the Brown-Goodwin History of Aggression (BGHA) and BIS test. The BGHA is a 12-item questionnaire that assesses the lifetime history of aggressive behaviors across childhood, adolescence, and adulthood. Different from Dougherty et al., study, the BIS was used to validate a proxy-based assessment of the decedent by the selected informants. However, higher scores of both behavioral measurements indicated levels of impulsive-aggressive behaviors among individuals who have died by suicide. According to the BGHA scores, higher traits of both impulsivity and aggressiveness were demonstrated among suicides that meet the criteria for alcohol abuse than non-alcohol related suicides. Additionally, higher levels of aggressiveness were present since childhood compared to adolescence and adulthood suicides. Chachamovich et al. suggest that these findings may represent a late outcome of suicide phenomena that initiated at the early stages of life. In all, alcohol abuse constitutes as a risk factor to suicide behaviors, however, this study's findings show that alcohol-related suicides have a higher level of impulsivity and aggressiveness than non-alcohol related suicides.

Alcohol in combination with other psychoactive drugs has been shown to increase one's risk for suicide. According to Vijayakumar et al. (2011) the relationship between cannabis uses and suicide is stronger for alcohol abusers than non-alcohol users. Similar findings were

identified in Chachamovich's et al., where personality disorders were identified using the psychological autopsy methodology. Findings reported that alcohol-related suicides in contrast to non-alcohol-related were more likely to be associated with both cocaine and cannabis abuse or dependence. Abuse of pharmaceutical drugs has also been proven to increase the risk for suicide completion when in combination with alcohol (Schub & Karakashian, 2018).

Another relevant factor that contributes to suicide risk is the co-occurrence of substance abuse and psychiatric disorders. In a study that explored the relationship between bipolar disorder and substance abuse, stated that individuals treated with bipolar disorder have an increased risk of suicidal behavior when in combination with alcohol (Dougherty et al., 2004). Chachamovich's et al. reported Antisocial Personality Disorder was significantly higher among alcohol-related suicides compared to non-alcoholics with respect to schizophrenia, depressive, bipolar, and panic disorder. In general, the association between substance abuse and suicide is complex and often influenced by the presence of confounding factors such as alcohol and other psychiatric disorders.

An underlying mechanism that is common in substance abuse and psychiatric disorders is the role in aggressiveness and impulsivity. Referring back to Dougherty's et al study, impulsivity was assessed across phases of Bipolar Disorders and the comorbidity of substance abuse. Phases of Bipolar Disorders were grouped into two categories: (1) Bipolar patients who are not currently experiencing manic or depressive episodes, and (2) bipolar patients that either have a history or no history of substance abuse. Impulsivity was measured using both the self-report questionnaires and the IMT and DMT behavioral assessment. The findings from the self-reports showed a positive correlation between trait impulsivity and Bipolar Disorders, independent of substance abuse. While the IMT and DMT behavioral results suggested that trait impulsivity had

a greater significance among inpatients during a Bipolar episode with comorbid substance abuse than inpatients without substance abuse. A supported study that solely examined the magnitude of substance use and human aggression had consistent findings of Dougherty's et al study. Bushman conducted a literature search of studies that measured human aggression among subjects using the balanced placebo design. In this study, aggression was defined as, "any form of behavior directed toward the goal of harming or injuring another living being who is motivated to avoid such treatment" (Bushman, 1997). The administration of drugs used in experimental studies typically falls into four categories: (1) CNS depressants, for the purpose of this section, ethyl alcohol, (2) CNS Stimulants, (3) Opiates, and (4) Hallucinogens. The results of this analysis state that the psychological and pharmacological effects of CNS depressants cannot independently be a determinant, however, together, they cause aggression. Likewise, subjects that were given CNS depressants were significantly more aggressive compared to subjects given the placebo. Among drugs other than CNS depressants, CNS stimulants and subjects who self-medicated with codeine and marijuana cigarettes inhibited increased levels of aggression compared to subjects who were given a placebo. As such, it has been established that the comorbidity of substance abuse and psychiatric disorders are a predictor to suicide, yet suicidal behavior is more common when traits of impulsivity and aggression are detected.

Chapter 3 METHODOLOGY

Case Identification

The type of deaths reported to the DeKalb County Medical Examiner's Office fall under the jurisdiction of the Georgia Death Investigation Act, O.C.G.A. 45-16-24. This includes those deaths involving violence, accidents, suicide, sudden or suspicious circumstances, children under the age of 7, executions, inmates, hospital admittance within 24 hours where the patient never gained consciousness, or when a physician is unable to sign a death certificate. Death cases are reported to a Medical Examiner's Office by coroners, deputy coroners, and law enforcement. The Medical Examiner's Office determines if an examination will be performed. In their examination of the deceased, forensic pathologists aim to determine the cause and manner of death.

Data Collection

This is a cross-sectional retrospective study that was conducted by the examination of secondary information extracted from the Medicolegal Death Investigation (MDI) log database. MDI compiles data from death certificates, coroners, and Medical Examiner's reports that are based on the death scene, ongoing investigations, and crime lab toxicology reports. Reviewed data will consist of de-identified information of suicide decedents such as age, gender, race, residential zip code, method of suicide, and blood specimen samples. The inclusion criteria were suicide deaths. The exclusion criteria were all homicide victims and accidental deaths.

Incident year

This data was retrieved from the years 2017-2020 within the Metro-Atlanta region of the state of Georgia. Specifically, DeKalb County and outer counties that include Hall County, Henry County, Rockdale County, Richmond County, White County, and Jefferson County.

Toxicological Analysis

Postmortem toxicological analysis was analyzed through accredited testing laboratories, the National Medical Services (NMS), and the Georgia Bureau of Investigation (GBI) Division of Forensic Sciences (DOFS). Through the analysis of postmortem specimens, NMS and GBI toxicologists can establish whether traces of alcohol, drugs, or poisons are present, and if so, the quantity. Toxicologists from the NMS and GBI laboratory receive labeled and sealed packages of forensically secured blood, urine, and other biological specimen samples from the DeKalb County Medical Examiner's Office. The decision to send postmortem specimens to either NMS or GBI is determined by the forensic pathologist's contingent on the nature of the case.

Analysis of Blood-Alcohol Content

BAC measures the amount of ethanol (Ethyl Alcohol) in the blood. Determinations of ethanol are performed by headspace gas chromatography (GC). This was expressed as a whole number with the units of mg/dL or as a decimal number with units of g/100 mL which is equivalent to % w/v.

Analysis of Other Toxicology Drugs

To determine the prevalence of drugs other than ethanol, postmortem toxicology from GBI DOFS was performed via the use of gas chromatography/mass spectrometry (GC/MS), liquid chromatography/mass spectrometry/mass spectrometry (LC/MS/MS), and liquid chromatography – high resolution mass spectrometry/mass spectrometry (LC-HRMS/MS to identify the presence of amphetamines, cocaine, and cocaine metabolites. Estimations of measurement uncertainty for all toxicology quantitation's are reported at a coverage probability of 95.45%.

Postmortem toxicology from NMS utilized high performance liquid chromatography with tandem mass spectrometry (LC-MS/MS), colorimetry, enzyme immunoassay (EIA), enzyme-linked immunosorbent assay (ELISA), and gas chromatography (GC). Detected drugs will include but are not limited to: Detected drugs will include but are not limited to: Amphetamines, Anticonvulsants, Antidepressants, Antihistamines, Antipsychotic Agents, Benzodiazepines, CNS Stimulants, Cocaine and Metabolites, Hallucinogens, Hypnosedatives, Hypoglycemics, Muscle Relaxants, NonSteroidal Anti-Inflammatory Agents, Opiates and Opioids.

Measures

1. Suicide Method

In the MDI log database, suicide methods were coded based on the circumstances of death. The identified methods include the following: firearm, hanging/ asphyxia (included suffocation) poisoning/ drug overdose, jump/ fall from height, contact with moving objects (train/ other vehicle), stab/ cuts (sharp instrument, blunt force), and other (carbon monoxide gas, fire, and undetermined causes). While all suicides are conventionally considered violent deaths in forensic pathology literature because they result from intentional and voluntary harm inflicted against oneself, for the purposes of this study, methods of suicide were divided into violent-non-drug-related and drug-related methods of death. Violent-non-drug-related deaths were coded as firearm, hanging/ asphyxia, jump/ fall, motor vehicle collisions, and stab/cuts. Drug-related deaths were coded with poisoning/ drug overdose.

2. Toxicology

The dichotomous measure of BAC was based on whether alcohol was detected (0 = no, 1 = yes). Toxicological categories were identified as: Amphetamines, Anticonvulsants, Antidepressants, Antipsychotic Agents, Barbiturates, Benzodiazepines, Cocaine, Marijuana,

Heroin, Opioids, and other drugs, which include Antihistamines, other CNS Stimulants, Hallucinogens, Hypnosedatives, Hypoglycemics, Muscle Relaxants, NonSteroidal Anti-Inflammatory Agents, and Opiates. These categories were furthered conceptualized into two categories: (1) pharmaceutical and (2) illicit drugs. Pharmaceutical drugs included Amphetamines, Anti-Consultants, Anti-Depressants, Anti-Psychotics, Barbiturates, Benzodiazepines, Opioids, and other (coded dichotomously as 0 = no, 1 = yes). Illicit drugs included Cocaine, Marijuana, and Heroin (coded dichotomously as 0 = no, 1 = yes).

3. Socioeconomic Status

Neighborhood SES was based on the median household income. The determination of median household income was defined using U.S. Census data on the average household income in Georgia, which is a collection of zip code, area code, city and state demographic profiles in the United States. The census data was used as a benchmark to calibrate the first and third quartile of median household income for my sample population. The 25^{th} percentile was designated as lower income, the 50^{th} percentile was the median, and the 75^{th} percentile was designated as higher income. Median household income averaged $31,560 in the sample's lower income tracts and $72,413 in the higher income tracts, both of which were significantly different than the median income in the middle-income tract ($49,199). The national median income was $58,700. Census tracts of geographical areas other than Georgia, composed at least 1.2% of the tract data. Therefore, given the small number of non-Georgian zip codes, these were classified as other in this analysis.

Statistical Analysis

The results of this study were analyzed using SPSS. First, a frequency analysis was conducted to examine demographic variables, alcohol, toxicology drugs, and suicide methods of

all decedents. Second, two binary logistic regression models examined the odds of (1) pharmaceutical drugs and deaths by violent non-drug-related (vs. drug-related) and (2) illicit drugs and deaths by violent-non-drug-related (vs. drug-related) suicide methods as the dependent variable, with demographic characteristics as covariates. The regression model results were reported as adjusted OR with 95% CI and p-value.

Chapter 4 RESULTS

First, descriptive statistics were conducted to examine the prevalence of alcohol and toxicological drugs among individuals who died by suicide by various demographic characteristics, overall and by alcohol and drug category (see Table 1). The results of positive cases for each toxicological analysis had the highest percentages across similar demographic characteristics and SES. It was found that the prevalence of alcohol positive cases was most commonly identified (N = 102), predominately among the age group 25-44. The percentage of positive alcohol cases also had a greater prevalence in White males, compared to women. Moreover, the prevalence of alcohol positive cases varied among median household income tracts. The statistics illustrated that alcohol was more common in middle-income tracts compared to the lower and higher income tracts. The presence of drugs other than alcohol had consistent findings as those that tested positive for alcohol only. Similar results were shown for decedents that tested positive for alcohol and drugs combined (see Table 1).

Second, descriptive statistics were conducted to examine the prevalence of alcohol and specific toxicological drugs by methods of suicide (see Table 2). There were notable differences between detected drugs and the method of suicide. While there was prevalence across all methods, the presence of substances distributed across firearm, hanging/ asphyxia, and poisoning/ drugs. In terms of classification of drugs, the top five identified drugs were

Amphetamines (N= 83) subsequent to Cocaine (N =32), Anti-Depressants (N = 27), Opioids (N = 24) and, Benzodiazepines (N = 20). Among those that tested positive for Amphetamines, the preferred method was either firearm, hanging/ asphyxia, or poisoning/ drugs. It was also found that Cocaine had higher levels of positive tests among those who used firearms (59.4%). The presence of alcohol in combination with toxicological drugs had a higher likelihood of being prevalent in Amphetamines, Cocaine, Anti-Depressants, and Opioids by the top three identified suicide methods (see Table 2).

Finally, two regression analyses were conducted to examine whether pharmaceutical and illicit drugs were associated with the method of suicide (and specifically death by violent-non-drug-related vs. drug-related means). The regression model also controlled for age, gender, race, and income tracts. Results indicate that those who tested positive for pharmaceutical drugs had lower odds of death by violent-non-drug-related compared to drug-related means (OR=0.006; 95% CI=0.001-0.027, $p<0.001$, see Table 3) whereas individuals who tested positive for illicit drugs had higher odds of death by violent-non-drug-related compared to drug-related means (OR=3.005, 95% CI=1.165-7.755, $p=0.023$, see Table 4). While there is no statistical significance among race, age, and income tracts, there was an association between gender and the method of suicide. Specifically, females were significantly less likely to use violent-non-drug-related means compared to drug-related means of suicide, whereas men were more likely to use violent-non-drug-related means compared to drug-related means. Overall, the presence of both - pharmaceutical and illicit substances in the blood of individuals that died by suicide had an association with the method of suicide, even after controlling for demographic and SES confounders.

Chapter 5 DISCUSSION, RECOMMENDATION, CONCLUSION

Discussion

The current study provides the most detailed examination of three research aims that explored the prevalence of alcohol and toxicological drugs in individuals who died by suicide. As expected, alcohol was the most commonly detected substance, second to amphetamines among substance positive cases. Individuals that tested positive for alcohol and drugs other than alcohol were equally present in demographic characteristics, SES, and the three leading methods of suicide (firearms, hanging/ asphyxia, and poisoning/ drug overdose). Consistent with these findings, the co-occurrence of alcohol and drugs was most prevalent among pharmaceuticals compared to illicit drugs. Specifically, cases positive for pharmaceutical drugs had higher proportions in hanging/ asphyxia, and poisoning/ drug overdose, whereas illicit positive cases were commonly detected among individuals with the preferred method of firearm. This study also finds significant differences in the association between specific drugs and death by violent-non-drug-related compared to drug-related suicide means. For those that tested positive for illicit drugs, were 3.1 times more likely to be associated with violent-non-drug-related means compared to drug-related suicide means. In contrast, positive cases for pharmaceutical drugs were significantly associated with drug-related compared to violent-non-drug-related suicidal means. These results were consistent when controlling for gender, age, race, and SES income tracts.

Previous literature has shown that the prevalence of substance use has varied by demographic characteristics. The results in this study are somewhat contrary to previous literature in age which has shown that late-middle aged decedents had a higher prevalence of positive alcohol cases among the age group 50-64, compared to four later age groups 65 and older [6]. However,

the results of this study are consistent with previous research that examined the presence of alcohol and toxicological drugs among similar age group demographics [32,15,14]. The results are also supported with race and gender findings, where White males had higher proportions of positive alcohol and drug cases compared to females. In the current research, the primary study that contrasted with this study's findings had a greater prevalence of alcohol cases among Hispanics in comparison to Non-Hispanic Blacks, Asians, and American Indian/ Alaska Natives [6]. Also in contrast with this study were the findings of substance positive cases among neighborhood SES. Among studies that examined the relationship between SES and substance use outcomes, had findings that substance use patterns are strongly associated with disadvantaged or affluent neighborhoods. However, results are consistent with Karriker-Jaffee's observations [16], which found that younger men who reside in middle-class neighborhoods had higher odds of daily tobacco use compared to lower-and-higher income neighborhoods.

Consistent with previous research, the drugs most commonly combined with alcohol were Anti-Depressants, Cocaine, and Amphetamines [6]. Bradvik et al also stated that Benzodiazepines and alcohol were commonly identified among suicide decedents that tested positive for substances. The findings of previous research also have divergent results from this study when the prevalence of drugs was identified by the method of suicide. Contradictory studies suggest that Anti-Depressants, Cocaine, Marijuana, and Opioids had a higher prevalence among hangings when compared to firearms deaths [32]. Darke et al findings suggest that pharmaceuticals (Anti-Depressants, Anti-Psychotics, and Benzodiazepines) detected higher percentages among drowning cases [10]. In similarity to this study, psychostimulants (methamphetamine, benzoylecgonine, and MDMA) were most prevalent in gunshot cases [10].

Jones et al detected the overall prevalence of pharmaceutical drugs was higher in drug overdoses compared to hangings [14].

Many researchers have identified the prevalence of alcohol and other drugs among individuals that died by suicide, however, a small number of studies examined the relationship between specific drugs and the method of suicide. This study offers evidence that illicit drugs were strongly associated with violent-non-drug-related compared to drug-related suicidal means whereas an inverse association was identified among pharmaceutical drug cases. In contrast with this study, those that tested positive for opioids were significantly less likely to hang themselves than shoot themselves. In the same study, those that tested positive for Anti-Depressants were significantly more likely to hang themselves than shoot themselves [32]. Darke et al also presented findings that suggest pharmaceutical licit drugs had greater odds of being associated with violent-non-drug-related means compared to drug-related suicide means. When stratified by demographic variables, results were consistent for females that tested positive for drugs was associated with drug-related (Poisoning/ Drugs) compared to violent-non-drug-related suicide means [25,15].

Strengths

There were three major strengths to this study. The first strength was the measurement of toxicological drugs within a diverse population. Although Whites had a higher likelihood to test positive for alcohol and psychoactive drugs, this study had a sample population that adequately represented racial and ethnic groups. The second strength was the examination of substance use outcomes by neighborhood SES. The bulk of research that differentiated the prevalence of substance use and abuse by neighborhood SES, did not examine this relationship among individuals that died by suicide. Third, this study conducted a regression model to examine the association between toxicological drugs and the method of suicide. In turn, this study was able to

determine whether pharmaceutical and illicit drugs were associated with the method of suicide. These findings were also controlled for relevant confounders, increasing the significance of the study's findings.

Limitations

There were a few limitations of this study that warrant mention. The first limitation of this study is the proportion of cases where no blood samples were submitted for toxicologic testing. These include deaths that occurred after prolonged hospitalization, days or weeks after the fatal injury occurred, and deaths in which the body was found in a state of advanced decomposition. The second limitation is that a large number of cases had blood samples sent to the state crime lab (GBI) rather than a private reference laboratory for toxicologic analysis. When a cause of death is apparent at the time of autopsy, the standard operating procedure of the office is to send samples to GBI for a limited toxicologic panel to screen for the presence of amphetamines, cocaine, and cocaine metabolites at no charge to the office. If amphetamines, cocaine, or cocaine metabolites are present, further screening for and quantitation of other drugs will be performed. When no anatomic cause of death is apparent, such as in the case of acute drug toxicity or decedents with no underlying natural disease, blood samples are typically submitted to a private reference laboratory (NMS Labs) for a full toxicologic work-up for a fee passed onto the taxpayer. Further discretion is left to the physician who performs the autopsy; blood samples may be submitted to NMS Labs when a history of drug use is known, or psychoactive drugs were found on the scene. Due to these cost-saving, standard operating procedures, this study was unable to present an accurate representation of toxicological findings from all suicide deaths that were reported to the Medical Examiner's Office. Another limitation is the proportion of outer county cases released to the funeral home without an examination or post-mortem toxicology testing. Sometimes, an apparent suicide is investigated by a coroner's

office that is assigned a case number, discussed with a medical examiner, and the body is released from the scene. Typically, a suicide letter is found at the scene and there is no evidence of foul play. In these cases, the coroner will sign the death certificate without requesting an autopsy. The final limitation is unavailable census tract data for the measurement of neighborhood SES. Therefore, 9.7% of Georgian zip codes are not accounted for in this study due to missing data.

Study Implications/ Knowledge Gaps

As indicated in this study, the prevalence of alcohol and drugs are similar across all demographic groups. However, this study had inconsistent findings with previous research on the prevalence of substance use among different SES income tracts. Literature suggests that the association between SES and substance use outcomes varied, though minimal research has been done among those who died by suicide. In this study, those who died by suicide with either drugs, alcohol, or both were most commonly in the middle-income group. It is noted that the study's median income in the middle-income tract is lower than the national median income. It is likely that this study's middle-income tract would be classified as a lower income tract in other studies. Although speculative, when considering the middle-income tract to be lower income my findings are compatible with those of other studies that describe that residents of disadvantaged neighborhoods may be associated with increased substance use as a coping mechanism in response to stressors of neighborhood challenges [11, 16, 17]. Therefore, additional recommendations for research include an examination of SES by median income, in similarity to the national median income, to provide more comprehensive evidence on the relationship between SES and substance use outcomes.

The findings of this study contradicted previous literature regarding the prevalence of toxicological drugs by the method of suicide. As identified in this study, those that tested positive for Amphetamines, Cocaine, Anti-Depressants, Opioids, and Benzodiazepines commonly used the preferred methods of firearms, hanging/ asphyxia, and poisoning/ drug overdose. The findings from this study also have implications for the association between specific drugs and death by violent-non-drug-related means compared to drug-related suicidal means. This study revealed that illicit drug positive cases were significantly more likely to be associated with violent (particularly firearms) compared to drug-related suicide means. This information may be taken as more lethal means of self-harm are associated with increased cogitations and diminished impulse control among those who are experiencing suicidal behaviors [32]. Overall, there is a dearth of conclusive literature describing the prevalence and association between drugs and the method of suicide. Therefore, additional research is warranted to examine the etiology of specific drugs and the lethality of suicide means to implement policies aimed at suicide prevention.

Conclusion

In summary, this study examined the prevalence of alcohol and psychoactive drugs among individuals that died by suicide. The study's findings confirm previous research on the prevalence of each toxicological analysis among demographic characteristics. One important result of this study that was not supported by previous literature was the prevalence of alcohol and toxicological drugs by neighborhood SES. Additional findings contradictory to previous literature was the association between specific drugs and death by violent-non-drug-related compared to drug-related suicide means. To address such knowledge gaps in the literature, this

study implicated that additional research should be conducted in efforts to effectively implement policies necessary in deterring suicides.

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APPENDIX A

Table 1 - Descriptive Statistics of Alcohol and Psychaoctive Drugs among Sociodemographic Characteristics

Sociodemographics	N (%)	Positive for Alcohol Only	Positive for Drugs other than Alcohol	Positive for Both Alcohol & Drugs
Age Group				
< 18	25 (4.4%)	1 (1.0%)	3 (3.8%)	0 (0.0%)
18-24	82 (14.4%)	14 (13.7%)	8 (10.1%)	4 (7.1%)
25-44	204 (35.8%)	43 (42.2%)	37 (46.8%)	32 (57.1%)
45-64	160 (28.1%)	33 (32.4%)	23 (29.1%)	17 (30.4%)
65+	95(16.7%)	9 (8.8%)	8 (10.1%)	3 (5.4%)
Not Tested/ Missing	4 (0.7%)	2 (2.0%)	0 (0%)	0 (0.0%)
Total	570 (100.0%)	102 (100.0%)	79 (100.0%)	56 (100.0%)
Gender				
Female	138 (24.2%)	22 (21.6%)	31 (39.2%)	18 (32.1%)
Male	432 (75.8%)	80 (78.4%)	48 (60.8%)	38 (67.9%)
Total	570 (100.0%)	102 (100.0%)	79 (100.0%)	56 (100.0%)
Race				
African American / Black	164 (28.8%)	21 (20.6%)	27 (34.2%)	14 (25.0%)
White	359 (63.3%)	75 (73.5%)	47 (59.5%)	39 (69.6%)
Asian	17 (3.0%)	2 (2.0%)	2 (2.5%)	1 (1.8%)
Other	30 (5.3%)	4 (3.9%)	3 (3.8%)	2 (3.6%)
Total	570 (100.0%)	102 (100.0%)	79 (100.0%)	56 (100.0%)
Ethnicity				
Hispanic	32 (5.6%)	7 (6.9%)	4 (5.1%)	3 (5.4%)
Income Tract				
Lower Income Tracts	90 (15.8%)	17 (16.7%)	11 (13.9%)	12 (21.4%)
Middle Income Tracts	347 (60.9%)	57 (55.9%)	50 (63.3%)	34 (60.7%)
Higher Income Tracts	105(18.4%)	20 (19.6%)	16 (20.3%)	9 (16.1%)
Other	7 (1.2%)	2 (2.0%)	1 (1.3%)	1 (1.8%)
Not Tested/ Missing	21 (3.7%)	6 (5.9%)	1 (1.3%)	0 (0.0%)
Total	570 (100.0%)	102 (100.0%)	79 (100.0%)	56 (100.0%)

APPENDIX B

Table 2 Descriptive Statisitcs of Alcohol and Classification of Psychoactive Drugs by Method of Suicide

	Method of Suicide							
Classification of Drugs	Firearm	Hanging/ Asphyxia	Posisoning/ Drugs	Jump/Fall	MVA	Stab/ Cuts	Other	*Total*
Amphetamines								
Percent Positive	25 (30.1%)	23 (27.7%)	27 (32.5%)	1 (1.2%)	1 (1.2%)	5 (6.0%)	1 (1.2%)	83 (100.0%)
BAC +	11 (29.7%)	11 (29.7%)	12 (32.4%)	0 (0.0%)	0 (0.0%)	2 (5.4%)	1 (2.7%)	37 (100.0%)
Anti-Convulsants								
Percent Positive	0 (0.0%)	0 (0.0%)	5 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	5 (100.0%)
BAC +	0 (0.0%)	0 (0.0%)	2 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (100.0%)
Anti-Depressants								
Percent Positive	7 (25.9%)	1 (3.7%)	18 (66.7%)	0 (0.0%)	0 (0.0%)	1 (3.7%)	0 (0.0%)	27 (100.0%)
BAC +	4 (33.3%)	0 (0.0%)	7 (58.3%)	0 (0.0%)	0 (0.0%)	1 (8.3%)	0 (0.0%)	12 (100.0%)
Anti-Psychotics								
Percent Positive	1 (25.0%)	0 (0.0%)	2 (50.0%)	0 (0.0%)	0 (0.0%)	1 (25.0%)	0 (0.0%)	4 (100.0%)
BAC +	1 (50.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (50.0%)	0 (0.0)	2 (100.0%)
Barbiturates								
Percent Positive	0 (0.0%)	0 (0.0%)	1 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (100.0%)
BAC +	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Benzodiazepines								
Percent Positive	4 (20.0%)	1 (5.0%)	15 (75.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	20 (100.0%)
BAC +	1 (16.7%)	1 (16.7%)	4 (66.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	6 (100.0%)
Cocaine								
Percent Positive	19 (59.4%)	6 (18.8%)	1 (3.1%)	0 (0.0%)	1 (3.1%)	4 (12.5%)	1 (3.1%)	32 (100.0%)
BAC +	11 (55.0%)	5 (25.0%)	1 (5.0%)	0 (0.0%)	0 (0.0%)	2 (10.0%)	1 (5.0%)	20 (100.0%)
Marijuana								
Percent Positive	2 (15.4%)	2 (15.4%)	7 (53.8%)	0 (0.0%)	0 (0.0%)	2 (15.4%)	0 (0.0%)	13 (100.0%)
BAC +	0 (0.0%)	0 (0.0%)	1 (33.3%)	0 (0.0%)	0 (0.0%)	2 (66.7%)	0 (0.0%)	3 (100.0%)
Heroin								
Percent Positive	1 (50.0%)	0 (0.0%)	1 (50.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (100.0%)
BAC +	1 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (100.0%)
Opioids								
Percent Positive	5 (20.8%)	1 (4.2%)	16 (66.7%)	0 (0.0%)	0 (0.0%)	2 (8.3%)	0 (0.0%)	24 (100.0%)
BAC +	3 (33.3%)	1 (11.1%)	5 (55.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	9 (100.0%)
Other								
Percent Positive	13 (20.6%)	3 (4.8%)	39 (61.9%)	0 (0.0%)	0 (0.0%)	6 (9.5%)	2 (3.2%)	63 (100.0%)
BAC +	7 (25.9%)	0 (0.0%)	16 (59.3%)	0 (0.0%)	0 (0.0%)	3 (11.1%)	1 (3.7%)	27 (100.0%)
Total	337 (59.1%)	150 (26.3%)	44 (7.7%)	9 (1.6%)	3 (0.5%)	21 (3.7%)	1 (1.1%)	570 (100.0%)

APPENDIX C

Table 3 Odds of death by violent means		
Variable	Adjusted OR (CI)	P-Vlaue
Gender (female)	0.200 (0.085, 0.475)	p < 0.001
Age Group		
< 18	*ref*	p = 1.000
18-24	0.615 (0.037, 10.172)	p = 0.734
25-44	0.450 (0.034, 5.973)	p = 0.545
45-64	0.281 (0.021, 3.846)	p = 0.342
65+	0.091 (0.006, 1.481)	p = 0.092
Race		
White	*ref*	p = 0.269
African American/ Black	0.412 (0.150, 1.136)	p = 0.087
Asian	0.272 (0.026, 2.811)	p = 0.274
Other	1.598 (0.140, 18.202)	p = 0.706
Income Tract		
Lower Income Tracts	1.193 (0.418, 3.403)	p = 0.741
Middle Income Tracts	1.112 (0.327, 3.781)	p = 0.865
Higher Income Tracts	*ref*	p = 0.941
Drug Presence		
Licit	0.006 (0.001-0.027)	p < 0.001

APPENDIX D

Table 4 Odds of death by violent means		
Variable	Adjusted OR (CI)	P-Vlaue
Gender (female)	0.188 (0.098, 0.361)	p < 0.001
Age Group		
< 18	*ref*	p = 0.820
18-24	0.439 (0.046, 4.229	p = 0.476
25-44	0.415 (0.049, 3.496)	p = 0.419
45-64	0.289 (0.034, 2.452)	p = 0.255
65+	0.271 (0.030, 2.467)	p = 0.246
Race		
White	*ref*	
African American/ Black	1.066 (0.485, 2.344)	p = 0.873
Asian	0.815 (0.145, 4.570)	p = 0.816
Other	1.916 (0.229, 16.040)	p = 0.549
Income Tract		
Lower Income Tracts	*ref*	
Middle Income Tracts	0.907 (0.604, 1.361)	p = 0.637
Higher Income Tracts	*ref*	
Drug Presence		
Illicit	3.005 (1.165, 7.755)	p = 0.023