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Childhood Blood Lead Levels and Adolescent Crime Rates in the United States

Jude Juiye Soweh
Walden University

Walden University

College of Health Sciences

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Jude Buba Juiye Soweh

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Review Committee
Dr. Chinaro Kennedy, Committee Chairperson, Public Health Faculty
Dr. Xianbin Li, Committee Member, Public Health Faculty
Dr. Jagdish Khubchandani, University Reviewer, Public Health Faculty

Chief Academic Officer and Provost
Sue Subocz, Ph.D.

Walden University
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Abstract

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Jude Buba Juiye Soweh

MA, University of Maryland Baltimore County, 2011

MBBS, Nnamdi Azikewe University, Nigeria, 1998

BS, Yaounde University, Cameroon, 1989

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

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Abstract

Juvenile violent crime rates in the United States have been on a continuous decline since 1996. Despite this decrease, youth violence as well as racial differences in crime rates continues to be a public health issue in the United States. Researchers have linked externalization behavior in children to factors including genetics, parental upbringing, abuse, school environment, and media exposure but have not fully considered the relationship between early childhood lead contamination and youth violence. This was an ecologic study of the relationship between early childhood blood lead levels (BLLs; ≥ 10μg/dL before 2012 or ≥ 5μg/dL after 2012) and crime arrest rates in United States. A secondary data analysis was conducted of existing data on youth violence and BLL obtained from the Office of Juvenile Justice and Delinquency Prevention and Center for Disease Control and Prevention respectively. Results of linear multiple regression analysis showed a significant positive correlation between the percentage of confirmed childhood BLL ≥ 10μg/dL in states from 1999 to 2001 and robbery, weapon, and drug abuse arrest rates in 2016. Further analysis indicated that the total crime rate per 100,000 population in states was significantly correlated with the 2012-2016 mean percentage of confirmed childhood BLL ≥ 5μg/dL in states (B = 35.17, $p = 0.03$). Results may help public health professionals, medical care providers, and policy makers to make informed decisions and better target interventions to further alleviate the effects of childhood lead poisoning at home and abroad. Improvements in children's health may benefit individuals, families, organizations, and society through the promotion of public health and the reduction of adverse impacts associated with lead contamination in childhood.

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Dedication

I am dedicating this dissertation to my wonderful parents, Pa Umaru Soweh (of late) and Ma Salamatu Soweh. Although without any formal education themselves, my parents were very instrumental in my early years of education and sacrificed tremendously for me to reach this level.

Furthermore, I dedicate this work to my lovely and talented wife, Lylian Soweh, who stood by me to ensure the accomplishment of this project. Great appreciation also goes to our three amazing children, Loyce, Micah, and Jason, for their understanding and encouragement toward the work on this project.

Finally, I entrusted this dissertation in the hand of the Almighty God, the Omnipotent, who directed this job at all levels and speared my life for its realization.

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Chapter 1: Introduction to the Study

Introduction

Youth violence continues to be a significant issue in the United States despite government efforts that led to a decreasing trend between 1991 and 2015 (Keyes et al., 2017). The Juvenile Justice Institute (2014) identified that approximately 93,000 youths are held yearly in juvenile justice facilities across the United States. The government spends over $7,146,521each day to support these facilities, constituting between 8 to 21 billion dollars annually (Juvenile Justice Institute, 2014). Youth antisocial behavior contributes to the increasing high school drop-out rate all over the country. Research on antisocial problems in children implicates genetics, parental upbringing, abuse, school environment, and the media, among others, but there is insufficient data to clarify the leading cause (Taylor et al., 2016). I conducted an ecologic study to identify the relationship between childhood blood lead levels (BLLs) and adolescent violence in the various states. With knowledge of whether childhood BLL and youth violence are correlated, public health officials may be better able to develop targeted interventions to alleviate lead contamination in childhood. Study findings may also help officials to develop practical measures for addressing higher BLL in children less than six years old.

Chapter 1 starts with a background section in which I discuss recent literature on antisocial behavior and BLL as a possible contributing factor. I also clarify the gap in the literature that was the basis of the present study. Next is the problem statement, purpose of the study, and research questions and hypotheses. I then provide overviews of the study's theoretical framework and nature. These sections are followed by definitions of

key terms used in the study and discussion of the assumptions, scope and delimitations, limitations, and significance of the study along with social change implications. The chapter ends with a summary and a transition to Chapter 2.

Background of the Study

The background review of adolescent violence focuses on the existing factors and causes of antisocial behavior in children in contemporary societies. It touches on the various scientific efforts aimed at identifying and solving adolescent violence to better the world in which individuals live. It starts with adolescent violence as a societal issue and implicates genetic, media, school environment, violence, depression, and lead as an environmental agent to antisocial behavior. The examination of these problems is through the lens of Ecosocial theory, which posits that the health of a population is the product of the interaction of human society with the broader environment (McMichael, as cited in Krieger, 2011).

Adolescent Violence as a Societal Issue

Adolescent violence is a nation-wide issue as more than 1,154,093 juveniles are arrested annually in the United States (Federal Bureau of Investigation [FBI], 2010). According to the Office of Juvenile Justice and Delinquency Prevention (OJJDP; 2017) the arrest rate for juveniles has decreased, from 6,493.6 per 100,000 persons ages 10-17 in 2000 to 2551.7 per 100,000 persons ages 10-17 in 2016. However, adolescent violence remains a public health problem in the nation. Johnston, O'Malley, Bachman, and Schulenderg (2011) noted that among 12th graders all over the United States, 50% use illegal drugs, 19% are smokers, and over 70% drink alcohol illegally. The risk factors of

adolescent violence are similar in different nations and include mental health concerns, educational failure, low religiosity, harsh physical punishment, abuse, parental mental health issue, single parents, and low socioeconomic status (Murray, Anselmi, Gallo, Fleitlich-Bilyk, & Bordin, 2013). Yet, the expression of adolescent violence differs in different nations.

Adolescent violence as defined by the OJJDP in 2017 includes aggravated assault, larceny-theft, drug abuse, and weapons crimes. High adolescent violence is a robust predictor of a range of costly public-health issues (Foster & Jones, 2005). Foster and Jones (2005) also noted that adolescent violence may result in deaths, nonfatal injuries, depression, and financial loses. In 2014, more than 4,300 persons 10 to 24 years of age were victims of homicide, 86% of which involved a firearm (CDC, 2018). The National Juvenile and Justice Department (2016) noted that about 850,500 youths were registered as have externalization behavior in 2016. This high number constitutes a huge financial burden for communities. In 2015, the rate for nonfatal injuries among persons aged 10–24 years was 753.2 per 100,000 persons, and this was the lowest for the 15-year period of 2001 to 2015 (David-Ferdon et al., 2018). David-Ferdon et al. (2018) also noted that 485,610 young persons were treated in emergency departments for assault-related injuries, which together with homicide-related expenses, posed a financial burden of over 18.2 billion dollars. In addition, Poirier et al. (2016) observed that children who exhibit antisocial behavior often experience depressive symptoms, more common in girls than boys.

Furthermore, the high rate of adolescent violence in a community increases the high school dropout rate (Healthy North Texas, 2015). Furthermore, McCarty et al. (2013) pointed out that high adolescent violence in a community is a predictor of other behavioral problems at adult age. As these findings indicate, adolescent violence is a pressing issue for individuals and society, more broadly.

Genetics and Violence

Genetics play a role in the development of conduct problems, some of which result in adolescent violence. At early childhood, some traits are common identifiers of later conduct problems in children. For example, Longman, Hawes, and Kohlhoff (2016) found a significant positive relationship between callous-unemotional traits and conduct problem severity in childhood and adolescence with a large effect size ($r = .39$, $p < .001$). The association is consistent across sex and sample size (Longman et al., 2016). Callous-unemotional traits are characterized by the phenotype component of psychopathy, which includes lack of guilt, lack of empathy, and manipulative use of others (Frick, Ray, Thorton, & Kahn, 2014). Persons with this trait often show signs of antisocial behavior.

Furthermore, genetically driven sensation seeking is most predictive of increased conduct problems in adolescence (Harden, Quinn & Tucher-Drob, 2012). Meanwhile, Girard, Pingault, Doyle, Falissard, and Tremblay (2016) established that poor language development is a predictor of conduct problems in childhood. Most conduct problems in childhood do persist to adolescence. However, genetics only contributes 40% to 60% of externalization disorders in children (Hicks, Foster, Lacono, & McGue, 2013). Nonetheless, Krieger (2011) emphasized that the presence or absence of specific factors

in the environment shapes the expression of the genetic constitution during development, which eventually affects children's behavior.

Gender and Violence

There exist some differences in antisocial behavior in male and females. Bogart et al. (2013) identified that male adolescents have a more significant tendency towards antisocial personality, sexual abuse, as well as alcohol and drug use. Meanwhile, the female teenagers have an increased tendency towards emotional violence, but there is no link of gender difference to family dynamics and delinquent behaviors (Wong et al., 2013). Community risk level seems to have a linear relationship with boys and a quadratic relationship with girls supporting the differences in gender and antisocial behavior (Wong et al., 2013). Ethnicity also has a part to play in antisocial behavior in children. Bogart et al. (2013) pinpointed that the prevalence of antisocial behavior in female blacks is more than in whites.

Family Cohesiveness and Violence

According to Lambie, Ioane, Randell, and Seymour (2013), living with both parents during an intervention on an adolescent with conduct problem decreases the probability of that individual's further engagement in future offending behavior. Such implicate the family status, intact versus non-intact family in the development of adolescent's conduct problem.

Media as Causal Factor to Violence

Media, including television, video games, and the film industry may promote violent behavior in children (Plante and Craig, 2015). In fact, Plante and Craig shared

that media is no longer a necessary nor sufficient cause but a causal factor like other causal factors in the development of antisocial behavior in children. The degree of childhood violence is a prediction of adult criminality (Bogart et al., 2013). Excessive exposure to media violence promotes aggressive behavior in delinquent youth in the process of modeling violence. Continuous reinforcement by seeing antisocial behavior encourages bold action in young people in a disinhibiting process (Plante, and Craig, 2015). The media can be applied positively to reduce antisocial behavior by promoting social skill training, self-control, and modeling of appropriate behavior in movies (Synder, 1995). Film makers need to value societal values in their productions.

Education and Violent Behavior

Schools sometimes promote violent behavior in children due to inadequate and unimaginative preparation by teachers (Bao, Li, Zhang, Wang, 2015). An increase in the level of environmental frustration leads to low safe esteem, a propagator of antisocial behavior (Bao et al., 2015). The use of openness to legitimate opportunities reduces the need or desire to participate in illicit activities (Edwards, 1996). Thus, aggression in school children may be regarded as a coping response. DePedro et al. (2016) noted that adult support in schools lowers the level of physical and nonphysical violence through peer victimization reduction, which in turn reduces violence in schools. The caring relationship is associated with high level of pro-social behavior which eventually leads to decrease violence (DePedro et al., 2016). Teachers need to be conscious of equality in the execution of their school duties.

Abuse and Adolescent Violence

Voith, Topitzers, and Reynolds (2016) identified that in 2010, child protective service reported 695 children who experienced maltreatment (CDC, 2014). Up to 10 to 13% of children endure verified abuse and neglect yearly (CDC, 2014). Direct exposure to intra-family violence coupled with child abuse (verbal, emotional, and physical conflict on a child) and neglect can violate a child's sense of safety and eventually contribute to antisocial behavior (Voith et al., 2016). Parents and caregiver need to handle children carefully to avoid abusing them or letting them witness violence at home. Greater child victimization and exposure to violence leads to poorer child outcome (Ratner, et al. 2006).

Environmental Lead and Adolescent Violence

The association between environmental lead exposure and violent behavior relate back to 1943 when Byers and Lord identified that 19 out of 20 children they had treated for lead poisoning later in life developed aggressive behavioral issues (Byers and Lord as cited by Marcus et al., 2010). Since then, researchers have continued to look for the links between toxic chemical and mental health. The results of a landmark study conducted by Marcus, Fulton, and Clarke (2010) identified heterogeneity in the association between lead exposure and antisocial behavior. However, after analysis, they summarized the estimate of the connection between lead exposure and conduct problems to be near causal. Cossío-Torres, Calderón, Tellez-Rojo, and Díaz-Barriga, (2013) identified the presence of health risk behavior in adolescent who had continuous exposure high lead levels until adolescent.

Lead toxicity is said to be one of the human-induced rapid environmental changes which can cause neurodevelopmental disorders (Cai & Calisi, 2016). One of the latest researches by Li et al., (2016) found evidence that early childhood lead exposure results in sex-dependent and gene-specific DNA methylation differences in the peripheral blood of adult victims. Thus, postulating that the decrease in brain volume in the lead exposed children as revealed by Marcus et al. (2010) may be due to the gene methylation process.

Rosmer (2014) noted that about half a million children in the United States between the ages of one to five have BLL above 5 µg/dL of blood. This value is the current CDC reference level at which public health intervention is a necessity (CDC, 2012). However, even lower non-toxic levels of lead have been found to cause behavioral problems in children (Huang et al., 2016, and CDC 2012). A recent study in Canada by Taylor, Forbes, Opeskin, Parr, & Lanphear, (2016) identified a significant positive relationship between childhood lead exposure and subsequent rates of aggressive behavior. There is a paucity of research examining the association between lead exposure and violent behavior in children (Mielke & Zahran, 2012), despite the some evidence of a connection between lead exposure and socio-behavioral issues that are precursors to criminal behavior (Taylor et al., 2016). Rauh and Margolis (2016) also ascertained the necessity of incorporating dimensional approaches including longitudinal studies on neurotoxic exposures for a better outcome assessment to aid the reduction of the burden of mental health disorders. In this vein, the present research is an ecologic cross sectional study to examine whether exposure to lead, defined as having had a BLL≥5µg/dL in

childhood at state level, is associated aggregate prevalence of violence in the various states in the United State.

The findings from this study may have both national and international implications (Mielke & Zahran, 2012). Results will help public health practitioners make informed decisions on how to help youths identified with violence problems. Such information will lead to changes on the handling lead toxicity gearing towards a reduction in public health burden from the disease such as long-term illnesses, social problems, and possibly deaths.

Problem Statement

Adolescent violence is a nation-wide issue in the United States. During the period 2001 to 2010, more than 1,154,093 juveniles were arrested annually (FBI, 2010). According to the Office of Juvenile Justice and Delinquency Prevention (OJJDP), (2016), more than 1,071 arrests, on average, occurred per 100,000 juveniles nationally in 2016. Although there has been a drop in the arrest rate in the country, violence continues to result in mortality and increase in financial expenditures (OJJDP, 2016). Another issue is ethnic disparity in adolescent violence. For example, among youth 10-24 years, the homicide rate was at 48.2 per 100,000 for non-Hispanic African Americans, 9.6 per 100,000 for Hispanics and 2.6 per 100,000 for non-Hispanic Whites in 2016 .(OJJDP, 2016). However, this distribution is not proportional to the population.

The high disproportionality in these numbers indicates perceived discrimination against particular racial groups that could lead to a behavioral problem in youth (Gogart et al., 2013). Even though childhood and adolescence are marked by increased behavioral

problems (Monahan et al., 2014), further understanding of this issue may help public health officials and policy makers find lasting solutions. Adolescent violence is a robust predictor of costly public health problems and might often leads to behavioral issues in adulthood (McCarty et al., 2013). Studies on antisocial behaviors implicate genetics (Longman et al., 2016), media (Plante & Craig, 2015), school environment (Bao et al., 2015), child abuse (Voith et al., 2016), and gender difference (Wong et al., 2016) as risk factors. Furthermore, low income (D'Onofrio et al., 2017) and lack of family connectedness (Foster et al., 2017), as well as acculturation stress (Hurwich-Reiss et al., 2016), may be risk factors for violence. Several research studies have implicated environmental exposure to lead as a risk factor for antisocial behavior and suggested the need for diverse approaches to elucidate this fact (Mielke et al., 2012; Rauh et al., 2016; Reyes, 2015; Taylor et al., 2016). Building on this foundation, the present study was an ecological study aimed at finding out whether high environmental lead exposure (≥ 5µg/dL) in childhood may contribute to the prevalence of adolescent violence in U.S. states.

Purpose of the Study

The purpose of this ecologic, cross-sectional study was to examine the relationship between surveillance BLL below 6 years of age and the prevalence of adolescent violence in various states in the United States. The ecosocial theory is useful in this project to examine whether environmental exposure to lead as depicted by the BLL in childhood influences the prevalence of adolescent violence in the various states in the country. The independent variable was the routine BLL at childhood, which was

defined as high when ≥ 5µg/dL and normal when < 5µg/dL following CDC (2012) guidelines. The dependent variable was the prevalence of adolescent violence for each state in the country. For the independent variable, I used data from the CDC on the average BLL between 1999 and 2005. Data on adolescent violence came from the FBI through the OJJDP. In addition, I examined how state income level can model the relationship between childhood BLL and adolescent violence in the various states.

Research Questions and Hypotheses

Research Question 1: Is there an association between having BLL ≥ 5µg/dL below 6 years of age and subsequent adolescent violence in the various states of the United States?

$H_0$1: There is no association between BLL ≥ 5µg/dL in children below 6 years of age and subsequent adolescent violence in the various states of the United States.

H_A1: There is an association between BLL ≥ 5µg/dL in children below 6 years and subsequent adolescent violence in the various states of the United States.

Research Question 2: Is the association between BLL ≥ 5µg/dL below 6 years of age and adolescent violence at 10 through 18 years of age modifiable by state income levels?

$H_0$2: There is no modification of the association between BLL ≥ 5µg/dL below 6 years of age and adolescent violence at 10 through 18 years of age by state income levels.

H_A2: The is a modification of the association between BLL ≥ 5µg/dL below six years of age and adolescent violence at 10 through 18 years of age by state income levels.

Theoretical Foundation

This ecologic study examines the relationship between having BLL ≥ 5µg/dL below six years of age and subsequent high prevalence of adolescent violence in the various states in the United States of America. It is a quantitative study that will apply the Ecosocial theory to influence the data collection, analysis, and interpretation of the research findings (Krieger 2011). The Ecosocial theory will provide the concise hypothesis and the working model to think through this research process (Alderson, 1998). The Ecosocial theory embraces the biomedical theory, which is the main theory useful in the diagnosis and treatment of diseases.

Foundations of Ecosocial Theory

The Ecosocial theory was first proposed by Krieger in 1994 and was used to explain how racial inequality implicates health inequality (Krieger, 1994). The theory posits that the health of a population is the product of the interaction of human society with the broader environment, including the ecosystem and other life-support processes (McMichael, as cited in Krieger, 2011). It is a multilevel theory that seeks to explain the distribution of diseases in a population and social inequality in health by integrating social and biological reasoning with the dynamics of historical and ecological perspectives (Krieger, 2012).

Constructs of Ecosocial Theory

Krieger (2011) identified three constructs within this theory. The first construct illustrates the link between political ecology, political economy, ecosystems, spatiotemporal scales, and social levels. The second construct criticizes the framing of

determinants as proximal and distal. The third construct proposes an alternative explanation to guide hypothesis generation, study design, and data interpretation. Based on the social epidemiological sciences, the Ecosocial Theory uses the interdisciplinary approach to conceptualize the occurrence of a particular phenomenon (Krieger, 2011). Even though genetics plays a part in behavior, societal forces shape the pattern of the distribution of behavior in the population (Pickett & Wilkinson, 2010).

Ecosocial Theory and Biomedical Model

The Ecosocial Theory tries to bring together objective and subjective knowledge to guide public health practice in the search for human emancipation (Krieger, 2012). It embraces the biomedical model which posits that all illnesses, symptoms and signs of a disease are due to the pathological lesion that disrupts the functioning of the body systems (Wade, 2004). The interaction between the body systems and the injury causes the patient to perceive and experience symptoms peculiar to the particular lesion. Child lead poisoning is the ecological agent that gets to the body through environmental lead exposure.

Societal Realities and Ecosocial Theory

The Ecosocial theory, unlike most research methods, considers life realities of discrimination issues at individual and structural level in determining health inequality in society (Krieger, 2012). The model views the health of a population as an interaction of many factors from the community and the environment, which are different in different localities. Krieger, (2012) argue in preference of levels, pathways, and power as the social determinant of health rather than the proximal and distal causation of health

problems. Krieger (2017) demonstrated that life, health, and death of humans are similar to other organisms and as such depend simultaneously on their biological system and society. The development and expression of our social being can only be through living and engaging in our constituted society and ecosystem in real time (Krieger, 2017). For example, Gaber and Wright (2016) used the Ecosocial theory to identify that there is a relationship between the role of the segregated built environment and the structural vulnerability concerning police violence.

Ecosocial Theory and the Social Ecology Model

Krieger's Ecosocial theory embraces Bronfenbrenner's social, ecological model as identified by Krieger (2011). According to the Social Ecology model, the determinant of the health of a population depends on the interaction at the various sublevels which include individual level, microsystem, mesosystem, exosystem, and macrosystem. That guides the postulation that the environmental lead exposure differences will, in the long run, modify children's behavior accordingly. As children grow and develop, they acquire patterns of behavior in the immediate environment nested in the various systems (Bronfenbrenner and Stephen as cited by Krieger 2011). These systems interact with one another and together with the genetic constitution of an individual model behavior in children.

Research Variables and Ecosocial Theory

In this study, the etiological agent acting as the independent variable is lead contamination depicted in the collected routine blood lead levels. The interaction of the lead in the body system together with the effects of the environment may model the

development of adolescent violence, the dependent variable at later age. The interaction of genetics, societal factors, and environment will play a role in the differential exposure of children to the pathological agent, lead. The interaction of the genetic factors and social factor with the environment may subsequently lead to the differences in the prevalence adolescent violence in the various states in the United States of America.

Nature of the Study

I conducted this ecologic study to determine whether there is an association between early childhood BLL ≥ 5µg/dL and subsequent development of a high prevalence of adolescent violence in the various states in the United States of America. It takes the form of a quantitative cross-sectional design, which will make use of pre-existing data for both the independent variable, childhood BLL and the dependent variables, states adolescent violence.

Description of the Variables

The independent variable is the aggregate average of childhood BLL for each state and the dependent variable is the prevalence of violence for the various states. The childhood blood lead levels are routine BLL of children obtained at the ages below six year for surveillance purposes. According to the Center for Disease Control and Prevention (2012), BLL ≥ 5µg/dL requires public health action. The study will consider BLL ≥ 5µg/dL as high and BLL < 5µg/dL will be normal in the evaluation. For years before 2012 when this standard was adjusted to BLL ≥ 10µg/dL The information was retrieved from the existing childhood BLL surveillance database at the Center for Diseases Control and Prevention.

The dependent variable in this study is the prevalence of adolescent violence in the various states in the country. This information is established by the Federal Bureau of Investigation and was obtained from the database of the Office of Juvenile Justice and Delinquency Prevention Program (OJJDP). The violence rate for each state was realized by summarizing the various crime arrest rates for that state. The crime arrest rates under consideration are arrests rates from aggravated assaults, Rubbery, Larceny-theft, drug abuse, and weapons. The summary arrest rates were then analyzed using linear regression. The covariate in this study was the state income level obtained from the Census Bureau database.

Rationale for Selecting the Design

The study is an ecologic cross-sectional study that which examined pre-existing data to describe the existing relationship if any between childhood BLL and subsequent violence at state level in the United States of America (U.S.). According to Frankfort-Nachmias, Nachmias, & DeWaard (2015), a cross-sectional design is useful in studying family variable and antisocial behavior in children. This study is a descriptive study where the risk factors and the outcome will be measured simultaneously (Department of Health, 2011). The study will look at exposures, outcome, and covariates related to violence at state level. The exposure here is lead contamination at childhood estimated in terms of childhood BLL. The outcome variable is the prevalence of adolescent violence rate in each state in the U. S. The state income level was useful as a covariate in this study. The income level of the state was based on the standard levels set by the Census Bureau. Data analytical techniques can enable the transformation of result from a cross-

sectional study to simulate results from a posttest-only experimental group design (Frankfort-Nachmias et al., 2015). Also, it allowed for a single short collection of data which makes it relatively quick and easy to perform (Department of Health, 2011). There is a time constraint attached to a dissertation process making this design very convenient. The study is a descriptive analytical study, which is very much possible with a cross-sectional study (Frankfort-Nachmias et al., 2015). However, only logical or theoretical inferences are obtainable using this cross-sectional design because the cause and effect cannot be directly under control (Franckfort-Nachmias et al. (2015). As such, it will be difficult to determine with certainty that exposure to lead resulted to the violence or that other intervening variables played a part. The best design to determine whether lead poisoning at childhood will cause adolescent violence is an experimental design or a cohort study. But, experimental conditions allow for the manipulation of the independent variables in a controlled fashion which is not feasible in real life situations in children because of ethical issues.

Definitions

Independent variable: For this study, is the surveillance BLL at childhood calculated as an average for each state over the stipulated period, 1999 to 2005. The BLLs are quantitative levels of lead in blood using capillary or venous blood analyzed by a certified laboratory as part of the Clinical Laboratory Improvement Amendment or by approved portable devices (CDC, 2016). The standard reference value of 5µg/dL used to identify children with elevated BLL is at the 97.5th percentile of the National Health and Nutrition Survey's (NHANES) levels for blood lead distribution in children (CDC,

2016). I examined whether the state percentage of confirmed childhood BLL was greater than normal for the considered years.

Dependent variable: For this study, the prevalence of violence for each state using juvenile arrest rates for the various juvenile crimes committed in the state. I obtained this information from the OJJDP. Crime rates included aggravated assault, robbery, drug abuse, larceny-theft, and weapons as measured by the FBI. A summary of crime rates for each state was provided per 100,000 persons aged 10-17 years. Adolescents' commission of crimes in their homes, schools, or in social situations impairs their family, academic, or social functioning, researchers have found (OJJDP, 2018).

Crime rate: The rate at which various crimes are committed in a community. In this study, I used violent crime rates as provided by OJJDP per 100,000 persons aged 10-17 years.

Ecosocial theory: A theory that posits that even though biological characteristic do matter, the determinants of certain disease conditions are multifaceted and also depend on the social and ecologic environment (Krieger, 2011). The theory answers the question of who and what drives the current and changing patterns of inequality in health.

Exosystem: The third level of the ecological system where an individual may not be an active participant in the decision-making process but is affected by decisions (Coreil, 2010). For example, decision-making in a company may result in a father of a child losing a job, which may affect the child's development.

Macrosystem: The fourth ecological system comprising the cultural environment in which people live as well as the economy, cultural values, and political systems

(Coreil, 2010). Coreil also indicated that the influence of the macrosystem on a person's development can either be positive or negative.

Mesosystem: The second level of the ecological system consisting of the interactions between a person's microsystems (e.g., the interaction between members of a family or between peers (Coreil 2010)

Microsystem: The first and the most influential of Bronfenbrenner's ecological systems; it is closest to and has direct contact with a person (Bronfenbrenner 1979). Examples of the microsystem include family, peers, and caregivers.

Social ecological model: A model that posits that the societal and ecological influence on health and the model relationship is affected by social systems: microsystem, mesosystem, exosystem, and macrosystem (Bronfenbrenner 1979).

Assumptions

One assumption is that all states participated in the lead surveillance program recommended by the CDC back in 1995 (CDC, 2018). This recommendation followed the Lead control Act of 1988 passed by Congress recommending the screening of infants and children for elevated BLL (Congress 1987-88). The law also recommended the elimination of lead contamination through drinking water, the treatment of lead poisoning and education of the public on lead poison.

A second assumption is that all states followed the rules of the uniform reporting system for the childhood BLL laid down by the Center for Disease Control and Prevention in 1995. By this rule all children from one year to six years are to be screened and treated for elevated blood lead level.

The next assumption is that all states followed the uniform reporting system for crimes committed in their states to the Federal Bureau of Investigation. It is only when rules in dictating and reporting crime are strictly followed that data collected can make sense and when analyzed will produce result that will have practical application.

Another assumption is that the Census Bureau data collection process followed the rules strictly for the data used in the generation of state income level. The state income level data will be useful as a moderating factor to the relationship between state childhood average blood lead leave and prevalence of adolescent violence.

Scope and Delimitations

The study was an ecological, cross-sectional study to determine whether childhood BLL have a relationship with the prevalence of violence in the various states of the country. The choice of the dependent factor, violence is because I see a lot of antisocial behavior in children at the alternative education center where I work. I have a keen interest in the perpetuating factor of the high rate of antisocial behavior in the adolescents in a community. While reading the literature on the possible causes of antisocial behavior in children, I found a gap in the literature linking antisocial behavior to lead poisoning. Understanding that surveillance of BLL exist for the student all over the country, I decided to search for a possible link between children's BLL at ages one to five and subsequent prevalence of violence in the various states of the country. I did not choose an experimental method, which should have been the best to elucidate the cause and effect because of ethical issues.

I conduction the study under the guidelines of the Ecosocial theory, one of the most recent theories proposed by Krieger in 1994. It explains how the interactions between ecological systems perpetuate and model the inequality in the distribution of a particular disease among population groups (Krieger 2012). Given that there is racial disproportionality in the arrest rate in the United State (Office of Juvenile Justice and Delinquency program, 2016); it will best explain how inequality in environmental lead exposure at childhood could cumulate to antisocial behavior later on in life.

In this study student 10 to 17 years are target population in country. The target year for violence is 2016. It implies that the sample size will consist of children born in the United States from 1999 to 2006. However, only state averages of the sample will be useful in the study. The result of the study may be internally valid for all states that participated in the study but not generalizable to other countries.

Limitations

The study is designed to use existing data from three distinct federal departments. The summary data for the surveillance the BLL for children born from 1999 to 2006 will come from the Center for Disease Control and Prevention. Meanwhile the data for the arrest rates will come from the database of the Federal Bureau of Investigation. The Census Bureau on the other hand provided data for income level for the various states in the country. The scope of this study was limited to the available data from these institutions, and the validity of the results depends on efficient and legitimate modalities of the data collection techniques. Since the government is directly involved in the

collection and summarization of the data in all three databases, I believe that their data collection methods are acceptable and valid for this project.

The project will include all 50 states in the Unites States of American and data collection for BLL will span children born from 1999 to 2006. This large sample size will confer internal validity to the studied population and other similar populations. However, it may not command generalizability to other populations. Not all children in all state may have given blood for surveillance lead level and not all states may follow the protocol of monitoring children BLL.

Missing data may be a problem when using existing data. Too many cases with missing data introduce skewness to the data and analysis using multiple regressions as it is the analytical tool in this study may not be possible. Deleting cases with missing data reduce sample size and the statistical power (Ellis, 2015). Data analysis with more than 5% missing data may not be valid for the said population (Morrow 2016). The multiple imputation methods in the Statistical Package of the Social Sciences program will be a useful method of dealing with the missing data.

Ethical guidelines are of scientific validity, respect for participants, and respect to the vulnerable population (Bernabe et al., 2016). All data in this project did not contain identifiable information and therefore consent acquisition is not a limitation.

Significance of the Study

This research was carried out under the guidance of the Ecosocial theory. The theory posits that the society consists of interwoven ecological systems whose interaction with one another to bring about the inequality in the health of the particular population

(Krieger, 2017). There is inequality in the proportion of juvenile cases handled in Juvenile Courts in 2016 as follows; 44% white non-Hispanics, 36% non-Hispanic Black and 18% Hispanics (OJJDP, 2016). The Ecosocial theory was the best theory in explaining the inequality in the distribution of antisocial behavior in this community. That is because it searches through the various ecological systems to identify the determinants of the violence problems in the country. This is in line with the fact that the first step in problem solving is the proper identification of the correct issues underlying the problem. I discussed the significance of this study under three headings: theoretical significance, practical importance, and social change relevance.

Significance to Theory

The theoretical basis of this study is not different from other research projects that contribute to the knowledge base in the field. The study relies on the Ecosocial theory to identify the relationship if it exists between routine BLL and the prevalence of violence in the various states. In detecting whether or not a relationship exists, I will at least contribute in building up knowledge in the field of epidemiology. Given that the study pinpoints an existing connection, it will spark more research toward confirming the findings and or identifying possible solutions to adequately deal with the problem.

Most development in our society today is built on a foundation of research knowledge. Every piece of research knowledge is essential because it can lead to further research that may eventually produce the result that will be of practical importance to improve the world around us. The result of this project may not be generalizable but will contribute to the knowledge-based regarding lead poisoning during childhood and

antisocial behavior development at the high school age. This study will, hopefully, stimulate more research in the field to confirm or dispute findings. It may also support the Ecosocial theory that the presence or absence of specific factors in the environment shapes the expression of the genetic constitution during development, eventually affecting children's behavior (Krieger, 2011). Findings from a proper design research can never be minimized but will contribute significantly to the knowledge-base in the field.

Significance to Practice

The practical application of this study depends on the results. If the research shows no significant relationship between BLL and the prevalence of violence, probably it will yield no practical application. However, if there is a substantial relationship between BLL and conduct problem in the community it might generate some meaningful applications. With a positive relationship, the practical importance is that it will inform clinician and public and mental health workers to think of lead poisoning as a possible cause of a behavioral problem during an assessment. Also, the demonstration of an association between BLL ≥5µg/dl and violence will tilt the minds of researchers towards targeted interventions for the prevention of environmental lead contamination. Other responses will be aiming at the development of faster means of testing and treatment of children with a high BLL at childhood. Such will reduce the development of the untoward behavioral problems in the community. Internalization problems such as depression can lead to violence, and depression is a robust risk factor for drug use in teens (Khoddam, Jackson, and Leventhal, 2016). On the other hand, Poirier et al. (2016) identified that youth with antisocial behavior experiences depressive symptoms, which

are more common in girls than boys. Therefore, when clinicians and public health workers are assessing depression, they should think of violence as a possible factor and at the same time suspect lead contamination because all of these factors are intertwined. The hope is that this research will produce statistically meaningful results that will have practical importance in real life.

Significance to Social Change

Evidence-based decision making comes from sound research, which are a potent means of bringing about social change in the community today. One of the contributions of this study is to direct efforts toward the implementation of social change in the community aiming at ameliorating violence behavior through the country. The sound conclusions derived from the study will owe distribution to the decision makers, Court system, police, and parents or guardians to effect social change in the community. In this way, efforts stemming from this research may eventually lead to the design and establishment of quality programs and therapies that will provide families and youth the insight to action for the realization of a change in behavior (Dallas Juvenile Department, 2016). Such will go a long way to reduce the financial burden and the many public health problems that result from violent behavior such as high arrest rate, and increase high school dropout rates. The cumulative result will decrease adolescent death from depression resulting from conduct problem (Poirier et al., 2016), decrease complications and a decline in the societal financial burden. All of these contribute to a positive social change in the community**.**

Summary and Transition

The chapter started with an introduction indicating how violence is a wide nationwide problem with a significant public health burden. The background of the study follows closely identifying the prominent research studies in the field and the knowledge gap that propagated the need for this research study. The problem statement elaborates on the persistent of antisocial behavior in the country over the years. It was followed closely by the purpose of the study, the research questions, and the hypothesis.

The chapter points out the Ecosocial theory proposed by Krieger in 1979 as the foundational guidance to the study. The theory has four constructs and embraces the biomedical model, and the Social Ecology Model. The Ecosocial model posits that the health of a population is an interaction between many factors in the community and its ecological environment which is different in different localities. The nature of the study describes the various variable involved in the research and rationale for selecting the ecological cross-sectional design for the study.

The chapter ends up with the assumptions, delimitations, limitation and the significance. It elaborates the importance of the study in three parts; theoretical, practical, and social change significance. All of which are geared towards improvement to effect a positive social change in the community.

The next chapter is the literature review, which will dive into a detail explanation the search strategies, theoretical foundation, and an exhaustive review of the literature on lead poisoning and the prevalence of violence in the various states.

Chapter 2: Literature Review

Introduction

In the United States, juvenile violence continues to be a nation-wide issue as shown by the yearly arrest rate of over 1,154,093 youth between 2001 and 2010 (FBI, 2010). In 2017, more than 809,770 juveniles were arrested for crimes committed (OJJDP, 2018). Although there has been a decrease in the juvenile arrest rate, juvenile violence continues to be a public health problem in the United States. In addition, there is ethnic disproportionality in the distribution of adolescence violence. For example, in 2015 there were 48,043 (152 per 100,000) juvenile incarcerations in U.S. juvenile detention facilities (OJJDP, 2017). The rate distribution among the various ethnic groups shows 433 per 100,000 for non-Hispanic African American, 142 per 100,000 for Hispanic White, and 86 per 100,000 non-Hispanic White juveniles (OJJDP, 2017). An uneven distribution of juvenile incarceration may propagate violence because the section of the community with more detention my feel that there is some sort of discrimination against them.

Conduct problems are a robust predictor of costly public health issues and can lead to behavioral dilemmas at adulthood (McCarty et al., 2013). Risk factors for antisocial behavior include genetics (Longman et al., 2016), media exposure (Plante &Craig, 2015), school environment (Bao et al., 2015), child abuse (Voith et al., 2016), and gender differences (Wong et al., 2016). Several recent research studies have implicated environmental lead exposure in childhood as a risk factor for juvenile violence (Mielke et al., 2012; Rauh et al., 2016; Taylor et al., 2016), suggesting the need for further research. Thus, the purpose of this study was to investigate the relationship

between BLL > 5µg/dL at childhood and violence at ages 10 through 18. The findings from this study may expand the current knowledge on environmental lead exposure and violence. Public health officials may subsequently apply study findings in the detection and prevention of lead poisoning in young children.

In this chapter, I review the current literature to provide a multifaceted background on the theoretical, historical, and empirical aspects of violence and its possible link to lead contamination in childhood. The review will start with the literature search strategies followed by a discussion of the theoretical framework I used for the study. In the subsequent literature review section, I offer an empirical examination of the variables under study. The chapter ends with a summary of the main research findings in the literature and a transition to Chapter 3.

Literature Search Strategy

I concentrated my literature search on Walden University database resources, Google Scholar, conferences, and seminars. For each of the databases, I started with a broader search without any limitation to gain a grasp of similar research studies and related topics. Then, I restricted the search to full-text and peer-reviewed journal articles published from 2013 through 2019, to identify current literature. Also, I searched through the reference list of critical articles to select references deemed necessary for further review. I verified the peer-reviewed status of all journals that provided materials for the analysis using Google Scholar and Ulrich's Periodical Directory. Furthermore, I searched the Walden library for current dissertations with similar variables to those in my study.

In my data searches, I used several search terms either alone or in combination with *and* as a Boolean operator. I have organized the terms into 14 categories as follows:

- juvenile violence (*antisocial behavior*, *crime*, *conduct problems*, *problem behavior*, and *juvenile delinquency*);
- lead poisoning (*childhood lead level*, *lead poisoning in children*, *surveillance lead level*, and *lead exposure in children*);
- theories (Eco social *theory*, *social ecology theory*, and *biomedical theory*);
- family (*intact family*, *family coercion*, *family bonding*, and *family attachment*);
- peers (*peer influence*, *delinquent peers*, and *peer pressure*);
- heredity (*genetics*, *genetic traits*, and *familiar characters*);
- policies (*lead policies*, *childhood lead policy*, and *Texas lead surveillance policy*);
- education (*school climate*, *acculturation*, and *individualized curriculum*);
- ethnicity (*nationality*, *national*, *tribes*, and *racial groups*);
- gender (*sex difference* and *gender difference*);
- descriptive (*adolescent*, *childhood*, and *adulthood*);
- youth development (*adolescent development* and *child development*);
- culture (*cultural conflict* and *cultural orientation*);
- research participant (*barriers to recruitment in research* and *barriers to research participants*); and

- crime (*crime rate in the United States*, *juvenile crime rate*, and *violent crimes*).

Among the search terms, *violence* and *childhood BLL*, used either alone or with *and* as a Boolean operator, provided most of the articles for the literature review. For example, juvenile violence as a search term alone in the Midline database brought up 8,432 articles. With further limitation to full-text and peer-reviewed journal articles published from 2013 through 2019, 2,251 articles remained. Further linkage of the search terms *conducts problems and lead levels* yielded 36 articles, of which I deemed 12 necessary for the review.

Theoretical Foundation

This study was an ecologic, cross-sectional study that was undertaken to trace the relationship between adolescent violence in the United States and the surveillance BLL at childhood. I used ecosocial theory (Krieger, 2011) to guide the data collection, analysis, and interpretation of the research findings. According to Alderson (1998), ecosocial theory offers a concise working model for quantitative studies.

Origin of the Ecosocial Theory

The ecosocial theory stems from the *web of causation model* designed by MacMahon, Pugh, and Ipsen in 1960 to explain the complex interrelationship between multiple specific risk factors for diseases (Krieger, 1994). MacMahon et al. (1960) noticed that many chronic diseases were appearing and could not be explained by the single agent causal scientific theory called biomedical theory. They then used the web of causation model to illustrate the multifactorial origin of chronic diseases and the means

of tackling such complex issues in the public health arena (MacMahon et al., 1960). This illustration was first published in their book called *Epidemiologic Methods* in 1960 (Krieger, 1994). The most important feature of the web model was that it implicated the diverse aspects of the agent, host, and the environment in the multifactorial etiology of the disease (Krieger 1994). In their book, MacMahon et al. urged epidemiologists to use the web of causation model to identify points of breakage of the web that can be useful in the prevention of the disease. The web of causation was designed under the framework of the biomedical model and by itself was not a framework to be exploited by the scientist (Krieger 1994). Thus, it has not been in use to explain the etiology and distribution of disease in the community.

The biomedical model assumes that the human body should be studied in the rule of science with the abandonment of the body's personal, historical, sociocultural, political, and biographical contexts, as factors (Gordon as cited by Kirkengen et al., (2016). It emphasizes the use of laboratory activities and technology useful in translating health research. It embraces the philosophical and methodological stance of reductionism which holds that the explanation of a phenomenon is best by analyzing the properties of its part (Krieger, 2011). Krieger (1994) took the web model idea in view of developing a modern science theory called the Ecosocial Theory. Among other critical scientists who buy this idea is Kirkengen et al. (2016), who advocated for an advanced science theory that can be useful in the diagnosis and management of our modern diseases with multifactorial origin. Krieger (1994) improved on the web model to build a theory that genuinely integrates biology, social, and ecological understanding of the health, disease,

and wellbeing. The Ecosocial theory embraces the biology of the biomedical model but rejects its assumptions as stipulated in the above paragraph (Krieger, 2011).

Major Propositions of the Ecosocial Theory

Krieger 2011 identified six core propositions of the Ecosocial theory as follows

1. People constitute part of a system, biologically, in their life experiences, in societal and ecologic context thereby creating population pattern of health and disease. The distribution of a particular disease in the community is never even but disproportionate according to the means.
2. The epidemiologic profile of any society is modifiable by their current and changing struggle for power, property, and the production and reproduction of social and biological life. Such changes involve people, other living things, and the biophysical world around them.
3. The determinants of current and changing patterns of disease distribution including health inequity are exogenous to the body and manifest by interactions at different sublevels. This proposition embraces Social Ecologic Model developed by Bronfenbrenner in 1980. According to the Social Ecologic Model, the determinants of the health of a population depend on the interaction at the five nested hierarchical levels that interacts with one another. The sub levels include individual, interpersonal, community, organizational, and policy/enabling environment (Krieger, 2011). The Ecosocial theory, unlike most research methods, considers life realities of discrimination at individual and

structural level issues in determining health inequality in society (Krieger, 2012).

4. Societies exhibit social division by property and power, and those with more power are fewer having greater resources. Meanwhile, those, with less power have fewer resources and carry the most significant burden of diseases. Krieger (2017) demonstrated that life, health, and death of human are similar to other organisms in their struggles and as such depend simultaneously on their biological system and society.
5. The explanation of disease distribution in the community cannot only be by the disease mechanism because disease mechanism does not account for rates and pattern of change in complexity, over time and place (Krieger, 2011). For example, Gaber and Wright (2016) used the Ecosocial theory to identify that there is a relationship between the role of the segregated built environment and the structural vulnerability concerning police violence.
6. The practice of reflective epidemiology in the broader context of methodological approaches can explain the population patterns of health, disease, and well-being. History is critical because we live our history and we can make health inequality in our population to be history (Krieger, 2015). By reflecting on the pass, we can build a better future. The graduation change of infectious diseases to chronic diseases in the world

portrays the vivid interactions occurring between people society and the ecosystem.

Assumptions for the Application of the Ecosocial Theory

Krieger (1994) identified the following assumption in her original article for the application of the Ecosocial theory:

- The Ecosocial theory uses the terms natural and social environment instead of exogenous environment;
- The theory embraces history instead hiding it from view;
- It is open to the biological, social, and ecological points of views;
- It encourages epidemiologist to think outside of the box when they encounter a striking pattern during a data collection process;
- It rejects the use of special population in favor of marginalized population;
- It talks about social classes instead of persons;
- Social conditions are conceptually and categorically distinct from natural conditions;
- The Ecosocial framework has the potential of raising new conceptual and methodological questions about shaping the human health (Krieger, 1994).

Literature on the Application of Ecosocial Theory

Krieger (2015) pointed out in a commencement address at the University Of California Berkeley School Of Public Health that our goal in public health is to build “a

just and sustainable world in which we and every being on this planet may truly thrive." And that to pursue this course we need an absolute understanding of the following:

"Public health is for public good and is not a commodity; the strategy of the "commons" is baseless; Good science is not enough, but bad science is harmful; Good evidence however vital is not enough to change the world (Krieger, 2015)". Thus for the clarity of causal inference and actions to promote health equity, population sciences need to broaden knowledge on whom and what makes population and means (Krieger, 2012). The Ecosocial theory can be at the basis of the explanation of the causal mechanisms between the prevalence of juvenile violence and BLL

Krieger (2017) used the attributable risk factors of the population to explain how the Ecosocial theory can best elucidate the multifactorial causation in a population. For a disease that has many risk factors, the population attributable fraction (PAF) for each of the risk factors is given by the equation (PAF) = Pd (RR-1)/RR.
Where Pd = population of cases attributable to the risk factor, RR adjusted relative risk). If all the PAF are summed up for all possible risk factors, the result must be above 100% (Krieger 2017). But the Ecosocial Theory, putting in context the biological, social, and ecological factors in play may provide a suitable explanation rather than the mathematical approach that is baseless.

Krieger (2014) using the Ecosocial theory demonstrated that there is robust and consistent evidence linking discrimination and health outcome distribution in a population. Discrimination does not only causes harm, but by definition it is wrong to "unjustly deny people fair treatment, abrogating human rights, and constrain possibilities

for living dignified and expressible lives (Krieger, 2014). Krieger (2013) noted that the fact that estrogen receptor sensitive breast cancers are treatable using anti-estrogen drugs implicates the eradication of breast cancer in some patients and not in others. Thus societal, life course, pathology, and evolution play a part in existence or non-existence of breast cancer in a female or a particular population (Krieger 2013). While some diseases like breast cancer are treatable in particular population some other breast cancers are not in other population.

Suicide is a serious public concern in the U.S. and is second to motor vehicle accident in causing death (CDC, 2016). The reduction of access to lethal means has the potential of drastically reducing the burden. However, there are few restrictions on firearm despite empirical evidence that fire arm is the most common means for suicide. Death from suicide entails an interaction of bodily function resulting to the intention of once life. But the availability of firearm to terminate life is control by societal forces. Lewiecki, & Miller, 2013) noted that the introduction of a waiting period and permit requirements that restrict access to handguns should be a top priority for reducing deaths from impulsive suicide in the United States . However, this endeavor does not receive the appropriate attention due to societal forces.

Reasons for Selecting the Ecosocial Theory for this Dissertation

The dependent variable in this dissertation is adolescent violence, with a disproportionate distribution among the various racial groups in the population. In 2016, the arrest rate among the various racial group include 5,142.5 per 100,000 for non-Hispanic African Americans, 3,783.7 per 100,000 for Hispanic white, and 1,980.9 for

non-Hispanic Whites. Juvenile violence has a multifactorial origin including genetic (Longman, Hawes, & Kohlhoff, 2016); gender (Bogart et al., 2013); media (Plante and Craig, 2015); and School environment (Bao, Li, Zhang, Wang, 2015). Child abuse can also lead to conduct problems (Voith et al., 2016). The identification and treatment of a disease with a multifactorial origin and an unequal distribution in the population groups needs a modern theory like the Ecosocial theory to elucidate its multifaceted aspects (Krieger, 1994; Krieger, 2017; Kirkengen et al., 2016). Also, the independent variable is blood lead levels in children which might be different in the population groups depending on the varied exposure sources in different environments of which social factors play a part. Children might be exposed to lead because they live in houses built before 1978 (CDC, 2014); drink lead-contaminated water (Kennedy, 2014), and because of occupational exposure in pregnant women (La-Llave-León et al., 2016). Children may be living in lead dust environment or merely living in an urban area with high lead levels in the air (Carrel et al., 2017). Thus, lead exposure in children has a multifaceted origin and has an unequal distribution among population groups. Studies on disease conditions caused by multiple factors need a modern theory to guide and direct the process. Furthermore, Philips as cited by Philips et al. (2013) noted that the Ecosocial theory values the perspectives of all stakeholders in the community. Thus, the Ecosocial theory is the right model to be useful in this project.

Literature Review

The literature review in this dissertation will be centered around the recent development on the factors contributing to valence in our society, as the dependent

variable and BLL as the independent variable. This background review embraces the existence factors and causes of antisocial behavior in children in our societies today. It touches on the various scientific efforts in ameliorating childhood conduct problem to better the world in which we live. Violence in a society has a multifaceted origin and in the analysis of the literature, I considered the following factors; adjustment disorder, genetics, peer influence, educational environment, media, family environment, race, acculturation, and environmental lead as depicted in the blood lead levels.

Juvenile Violence

One of the most significant mental health problems in our society today is adolescent violence. As children grow and develop they acquire patterns of behaviors from their immediate environment such as family, neighbors, and the society at large (Philips et al. 2013). According to the ecosocial theory, the acquisition of these patterns of behaviors is on the basis of the interaction of the genes with the physical and the sociocultural environment. The World Health Organization defined violence as “the intentional use of physical force or power, threatened or actual, against oneself, another person, or against a group or community, that either results in or has a high likelihood of resulting in injury, death, psychological harm, mal-development, or deprivation (WHO, 2019)" . On the basis of this definition violence is characterized as self-perpetrated as is the case with suicide and self-abuse, interpersonal violence where violence is between individuals, or collective violence perpetrated by an entire group of individuals. Violence on the other hand can be offline or online. Online violence is harassment through the internet without any physical contact and Offline violence may or may not involve

physical contact (Ojanen, 2014). Adolescent violence stems from conduct problems in children. The American Psychological Association (1994) defined conduct problems as antisocial behaviors that are characteristics of conduct disorder and oppositional defiant disorders. The American Psychological Association (2013) characterized conduct disorders by a persistent and repetitive pattern of antisocial and rule-breaking behavior classified into four groups. These groups are; (a) aggression to people and animals, (b) destruction of property, (c) deceitfulness or theft and (d) severe violations of rules (American Psychiatric Association, 2013). Meanwhile, Opposition defiant disorders refer to a recurrent pattern of negative, hostile, and rebellious behavior with social or educational impairment (American Psychological Association 1994). Most recently Poirier et al. (2016) saw the need of classifying adolescent violent behavior on the basis of assessment by multiple informants. Using teachers and parent assessment, Poirier et al. (2016) identified three subtypes of conduct problems: those noted by both teachers and parents as severe, those recognized only by teachers, and those identified by both teachers and parents as moderate. Even though this classification is simple, much still need to be done to standardize such a classification system. Although the risk factors of conduct problems are multifaceted, Murray et al. (2013) noted that these elements are similar in the different nations. The risk factors of violent behavior include mental health concerns, educational failure, low religiosity, harsh physical punishment, abuse, parental mental health issue, single parents, and low socioeconomic status (Murray et al., 2013). The mentioned factors and others like genetics, racial behavioral differences,

acculturation, and the media will have a detailed analysis under their various headings below. I will start this section by considering violence behavior as a societal issue.

Violence as a societal issue. The prevalence of youth violence has been decreasing since 2011 from a prevalence of 8.2% to 4% in 2017(Youth Risk Behavior Surveillance System [YRBSS], 2018). However, youth violence is still challenging problem in our nation. There are approximately 70 million youths in the United States making up about 25% of the population (Census Bureau, 2015). Among this number about 1.5 million adolescents of age 18 years and below are under detention yearly because of antisocial activity (Ramirez, 2008). Also, 600,000 minors cycle through the juvenile court system with about 700.000 belonging to gangs (Ramirez, 2008). In 2017 over 809,700 juvenile arrests occurred constituting an arrest rate of 773.2 per 100,000 persons aged 10-17 (OJJDP 2018). These values demonstrate that there is a high rate of violence in our society. Youth delinquency has been a growing nation-wide problem warranting the creation of the American Bar Association Commission on Youth at Risk to take care of the problem (Center for Disease Control and Prevention, 2013). The delinquency rate is seen in the high violence rate in the society today. The National Violence death system reported 41,000 dead from suicide and 19,000 deaths from homicides in 2013 (CDC, 2013). A reduction in the violence rate among children in our society may eventually curtail such high incidents of unexpected deaths and the expenditure on the detained youths. Non-fatal injuries also lead financial loses. For example, in 2015, 684,610 juveniles sustained assaults related injuries that cost the government approximately $3.4 billion for medical expenses and lost productivity

(David-Ferdon et al., 2018). This accounted for up to 32% of the 1.5 million people treated for assault related injuries for that year. Also it is estimated that each day the government spends over $7,146,521 constituting between 8 to 21 billion dollars annually (Juvenile Justice Institute, 2014).

Juvenile violence has a multifaceted origin and the following section discuss the details of certain factors implicating juvenile violence in the society. Among this factors are genetics, school environment, family environment, peer pressure,

Genetics. At early childhood, some traits are common identifiers of later conduct problem or violence in children. For example, Longman, Hawes, and Kohlhoff, (2016) identified a significant positive relationship between Callous-unemotional traits and conduct problem severity in childhood and adolescent with a large effect size ($r = .39$, $p < .001$). The relationship is consistent across gender and sample size (Longman et al., 2016). Callous-unemotional traits are characterized by the phenotype component of psychopathy which includes a lack of remorse, a lack of empathy, manipulative use of others, and deceitfulness (Frick, Ray, Thorton & Kahn, 2014). Klingzell, et al. (2016) added that children with Callous Unemotional trait are associated with increase fearlessness and psychopathic characters. Children with fearlessness and psychopathy are therefore subject to early intervention. However, there is still need for researcher to develop effective interventional programs for children identified with callous unemotional traits. Furthermore, Girard, Pingault, Doyle, Falissard, and Tremblay (2016) conducted a large cohort study in the United Kingdom, examining 18,553 children bone between 2000 and 2003 and noted that poor language development at the age of three has

an association with conduct problem development at the age of five and vice versa. However, this study did not go beyond five years old, and there is no clarity on whether conduct problems actually reaches the adolescent age. There is no precision on whether language problem in childhood is a predictor of violence in adolescents. This knowledge will however help practitioners to watch children who have problem with language development to guide against violence development at a later age. Thus, indicating the need for program development that will be effective in preventing violence in children who have problem with language acquisition at three years of age.

Many genes have been said to interact with environment to produce externalization disorders in children. Weeland, Overbeek, de Castro, and Matthys (2015) piloted a systematic review on the gene-environment interaction and externalization behavior and found 31 studies consistently supporting the polymorphism of the Monamine oxidase (MAOA) gene as a contributing factor in externalization behavior. The gene is located on the X chromosome and has a low activity variant and a high activity variant. The gene codes for the MAOA enzyme responsible for the deamination of dietary amine. The high-activity variant allele speeds up the degradation of dopamine and serotonin in the brain. Eme as cited by Weeland et al. (2015) noted that the fast degradation of dopamine result in decrease motivation and decrease control, while fast degradation of serotonin result to a decrease in memory, learning, and mood. The decrease in both dopamine and serotonin result in impulsivity, antisocial behavior, and alcoholism (Eme as cited by Weeland, et al., 2015). Meanwhile, the low variant is not implicated in the development of externalization behavior. Weeland et al. (2015)

identified the following polymorphic gene as having inconsistency in determining externalization behavior in children: dopamine receptors D4 (DRD4) and D2 (DRD2); the dopamine transporter 1 (DAT1); the catechol-O-methyltransferase (COMT)); and the 5- serotonin transporter linked polymorphic region (5- HTTLPR).

School environment. An excellent school climate is essential in preventing violence in school. Schools also act as a point for the generation of delinquent behavior in children due to inadequate and unimaginative preparation by teachers (Bao, Li, Zhang, Wang, 2015). An increase in the level of environmental frustration leads to low self-esteem contributing to the generation of antisocial behavior (Bao et al., 2015). The use of openness to legitimate opportunities reduces the need or desire to participate in illicit activities (Edwards, 1996).With this approach; it is possible to see aggression as a maladaptive coping response. DePedro et al. (2016) noted that adult support in schools lowers the level of physical and nonphysical violence through peer victimization reduction, which in turn reduces violence in schools. The caring relationship is associated with high level of pro-social behavior which eventually leads to decrease violence (DePedro et al., 2016). Teacher education programs need to ensure a focus on the impact of an excellent teacher-student relationship in reducing violence in school children (Runion, 2014). However, Erdelja et al. (2013) did not find any correlation between conduct problems and poor school achievement. Meanwhile, Hale et al. (2014) examined three longitudinal studies linked to multiple health problems generated by school environment among which were risk behavior, obesity, mental health, and victimization. Hale et al. (2014) identified that risk behavior is the highest health outcome implicating

antisocial practice in schools. Thus, suggesting that the school environment is the best place to institute corrective programs to fight antisocial behavior in children.

On the other hand, Powers, Bierman, and Coffman (2016) identified that restrictive education placement in secondary school is associated with the development of CP and high school non-completion. Thus, there is need to design studies to find better alternatives for restrictive educational placement in schools.

Family environment. Family environment has a potential of either increasing or reducing violence in children. The following subheading substantiates the impact of single parents, intact family, and abuse in the generation of conduct problems in children.

Intact versus non-intact family. Erdelja et al. 2013) working on conduct problems in incarcerated children, demonstrated that there is a link between having parents who do not live together and higher exposure to violence and poorer-self-concept. The higher exposure to violence and poor self-esteem eventually lead to the development of antisocial behavior in children (Erdelja et al., 2013). Nonetheless, parental monitoring whether in an intact or non-intact family is a good predictor of good behavior in children (Lopez-Tamayo, et al. 2016). The absence of close monitoring in children is a predictor of antisocial behavior in children. Henneberger, Tolan, Hipwell, and Keenan, (2014) suggested that Inductive parenting, whether intact or non-intact, exerts a small but potentially important effect on peer influence and may be one way of preventing the instrumental criminality believed to be transmitted through the peer influence process.

Single parents and violence. Violence in children may have an association with parental upbringing and psychiatry disorders. Doria, Antoniuk, Assumpcao Junior,

Fajardo, and Ehlke (2015) found out that of 69 incarcerated children in Brazil, only 29% lived with their parents. Children with Conduct disorder, attention deficit hyperactive disorder, and substance abuse disorders have an association with conduct problem (Doria, Antoniuk, Assumpcao Junior, Fajardo, & Ehlke, 2015). Even though Doria et al. (2015) identified a link between poor education achievement and violent behavior, Erdelja et al. (2013) noted that there was no correlation between delinquency and poor educational achievement. Such a difference might have arisen from the studied population. Doria et al. (2015) studied incarcerated children most of whom had psychiatry disorders probably acting as impairment to learning. The other study dealt with incarcerated youth population in a different country with fewer psychiatry problems and all were males (Erdelja et al., 2013). It is not always the case that single parents are associated with antisocial behavior in children because the time at which a child starts having only a single parent in life also matters. Markowitz and Ryan, (2016) identified that father's departure early in life has a significant association with antisocial behavior but not depression. However, father's departure later in childhood does not correlate with behavioral problems (Markowitz & Ryan, 2016). There is a need to know when father or mother was not in the life of a child.

Derdelija, Vokal, Bolfan, Begovac, and Begovac (2013) found out that incarcerated adolescents were more likely to have parents who did not live together, and were more exposed to violence at home or in the community, and had a poorer self-image. This result confirms that the feeling of basic security at home and in the community is very important to adolescents and can prevent them from peer influence.

Abuse and conduct problem. Voith, Topitzers, and Reynolds (2016) identified that in 2010, child protective service reported 695 children who experienced maltreatment (CDC, 2014). Up to 10 to 13% of children endure verified abuse and neglect yearly (CDC, 2014). Direct exposure to intra-family violence coupled with child abuse (verbal, emotional, and physical conflict on a child) and neglect can alter a child's sense of safety and eventually contribute to antisocial behavior (Voith et al., 2016). The presence of caring adults in community positively enhance youths' attitude in the development of spirituality (James et al. 2015) which is useful in healing from traumatic injuries and substance abuse, precursors of CP(Blakey, 2016). Furthermore, Fleck man, Drury, Taylor, and Theall (2016) demonstrated that exposure to both direct and cross-contextual indirect violence has an influence on externalizing behaviors in children. Salari, Ralph & Sanders (2014) found out that reducing adolescent-parent conflict relationship was beneficial in curtailing conduct problem in children, thus, parenting programs are a promising parenting intervention for tackling adolescent externalizing problems.

Gender and adolescent violence. There exist some differences between delinquent behavior in male and females. Bogart, Loeber, Slotboom, Bijleveld, Hipwell, Stepp, Koot, (2013) identified that delinquent male adolescents have a greater tendency towards antisocial personality, sexual abuse, as well as alcohol and drug use. Meanwhile, the female teenagers that engage in delinquent behavior have a greater tendency toward depression, but there is no link of gender difference to family dynamics and delinquent behaviors (Wong et al., 2013). Community risk level seems to have a linear relationship

with boys and a quadratic relationship with girls supporting the differences in gender and antisocial behavior (Wong et al., 2013). Ethnicity also has a part to play in in children with the same gender. Bogart et al. (2013) identified that the prevalence of delinquent behavior in female blacks is more than in white. The explanation of this difference tilt towards economic disadvantages, single parent rearing, women as head of household, all of which significantly result in depression, decrease parental control and lack of supervision (Bogart et al., 2013, Edward et al. 2009).

On the other hand, Murray et al. (2013) noted that antisocial behavior in adolescents in Brazil is higher than in other countries; however, boys did not always have a higher risk of antisocial behavior than girls. Thus, there is lack of consensus that any gender is more prevalent in violence than the other. But that societal forces play a part in determining which gender is more prevalent in a specific conduct problems than the other.

Peer pressure and violence. Pyrooz, & Sweeten, (2015) estimated through self-reporting that in 2010 there were about 1,059,000 youth gang members in the United States. The gang members were disproportionately male, black, Hispanic, from single-parent households, and families living below the poverty level. These gangs are established through peer influence. Chen, Drabick, and Burgers (2015) used systematic review of existing theoretical models and evidence to find the associations between peer rejection and deviant peer affiliation with violence. Burgers (2015) identified a consistent link in the development and maintenance of violence with peer rejection and deviant peer association. Thus, a society that promotes peer rejection and deviant peer association

such as gangs is bound to have more children with antisocial behavior than one with less peer rejection and fewer children involved in gangs. Besides peer rejection and peer affiliation, peer victimization is also a cause of adolescent. Runions, (2014) noted that teacher-child conflict in kindergarten predicted subsequent increase in reactive aggression, hyperactivity, and victimization of peers. That suggests the need to emphasize the essence of teacher-student relationship in teachers' training programs. Classroom must be void of discrimination to maintain a good learning environment to avoid peer victimization.

Pyrooz, and Sweeten (2015) suggesting that peer influences and gang prevention should target children before they reach the teens instead of gang intervention or suppression strategies aimed at teens.

Race and violence. There exist racial differences in the distribution of violence behavior in society. African-American adolescents exposed to neighborhood disadvantage are at increased risk for engaging in problem (Smith et al., 2014). Rousseau, Hassan, Measham, and Lashley, (2008) identified that low collective self-esteem and high levels of perceived racism are predictors of problem behavior in immigrant population. The study supported the link between minority status and the development of behavioral problem in the youths (Rousseau et al., 2008). The Office of Juvenile Justice and Delinquency Prevention (2016) confirmed the ethnic disparity among the various ethnic groups in the country. In 2016, their data showed that the arrest rate in African Americans was 5,142.5 per 100,000, Hispanic white 3,784.7 per 100,000, and for White non-Hispanic 1,980.9 per 100,000. This arrest is disproportional to the population which

is more of White than African American and Hispanic (Census Bureau 2016). This distribution shows that either there is a bias in the arrest rate or the distribution of crime rates in the various racial groups is accurate. Whatever the case one will postulate that there are some factors in the community which can either be social, sociocultural that are responsible for the distribution of the uneven arrest rates.

Acculturation violence. Immigrant children in trying to maintain the culture of the receiving nation as well as that of their parent may encounter problems with the parents. Such problems may eventually contribute to violence among adolescent children. For example adolescents in Hispanic families trying to adapt the American cultural practices eventually compromise their family relationship which may lead to antisocial behavior (Schwartz et al., 2013). Schwartz et al. (2013) noted that adolescent immigrants who have poor family functioning and have discrepancies between adolescent and parent functioning have poor adolescent outcome. Thus, professionals across social, health, and settlement sectors must work in collaboration to address the pre and post determinants of immigrants' adolescent metal health and illness to provide timely and effective services to the youths (Guruge, & Butt, 2015). Such services might go a long way in reducing the development of violence in the society.

Mental state and violence. McCarty et al. (2013) in a prospective cohort study identified that the interaction between growth in depression and conduct problem symptoms uniquely predicts later substance use impairment problems. Thus, the clinical assessment of substance use impairment problem in children should look back at the history of their violence behavior and depression. Furthermore, persistent violent

behaviors in childhood increase the risk of alcohol use in adolescent (Heron et al., 2013). According to Heron et al. (2012), 15% of boys and girls 13 to 15 years are high-frequency drinkers, and one out of three are classified as hazardous drinkers at age 16. The patterns of growth in depression and violent behavior are likely more important than the static levels at any particular point-in-time in relation to substance use risk (McCarty et al., 2013). The assessment of risk of substance use in adolescent should look closely at their violence behavior and depression in the history of those students.

Doria et al. (2015) administered the Brazilian version of the scale of the Schedule of Affective Disorder (K-SADS-PL) to 69 incarcerated adolescent with mean age 15.5 in Brazil to find out whether there is a link with adolescent violence behavior and affective disorders. Using the L-SADS-P scale on children with violent behavior proved that there is high prevalence of affective disorders in children with conduct problems in Brazil. It might not be generalizable to the United State but there is need for research to elucidate this relationship to help in intervention on violent behavioral problems.

Illegal drug use and adolescent violence. Heron et al. (2013) identified that antisocial behavior in children is a predictor of illegal drug use. Also, an increase in antisocial behavior also contributes to an increase in substance use (Cerdá, Prins, Galea, Howe, & Pardini, 2016). The assessment of risk of substance use in adolescent should look closely at their conduct problems and depression in the history of those children. Fidalgo et al (2016) conducted a cross-sectional survey of 4,034 students from 43 schools in Brazil to determine the link between drug use and psychiatric symptomatology. The results indicated that 48.5% presented with significant symptoms, 7.9% had subclinical

symptoms and 43.6% with no symptoms (Fidalgo et al., 2016). Thus, indicating that psychopathological symptoms are associated with tobacco, alcohol, and marijuana use by 15-18-year-old children. D'Amico et al. (2016) also supported the fact that greater use of alcohol and marijuana is associated with externalization behavior and worse functioning in high school. However, there is a reciprocal relationship between societal violence and drug use but children with violent behavior appear to engage in greater and more diverse substance use (Barkley Fischer, Smallish &Fletcher, 2004). Arria, Caldeira, Vincent, Bugbee, O'Grady, (2014) noted that false identification use is associated with in frequency alcohol use disorders which has an associating with antisocial behavior. Cracking down on the use of false identification in schools can reduce the frequency of adolescent violence.

Furthermore, Salatio-Oliveria et al. (2016) analyzed data from the Pelota 1993 birth cohort study in Brazil to find the relationship between prenatal maternal smoking, catechol-O-methyltransferase (COMT) gene and conduct problem in children. The result indicated that prenatal maternal smoking was associated with high conduct problem scores in children (IRR =1.24, 95% CI: (1.14-1.34), P< .001). Thus, high maternal smoking is detrimental to fetal development with a link to conduct problem in children.

Media and adolescent violence. Media, including television, video games, and the film industry may promote delinquent behaviors in children (Plante, and Craig, 2015). In fact, Plante and Craign shared that media is no longer a necessary nor sufficient cause but a causal factor like other causal factors. The degree of childhood violence is a prediction of adult criminality (Bogart, et al., 2013). Excessive exposure to media

violence promotes aggressive behavior in delinquent youth in the process of modeling violence. Continuous reinforcement of visual delinquent behavior encourages aggressive action in young people in a disinhibiting process (Plante, and Craig, 2015). The media can be applied in a positive manner to reduce antisocial behavior. Movies can assist schools and families in educating adolescents about delinquency through the promotion of social skill training, self-control, and modeling of good behavior in their products (Synder, 1995). Though, social media is detrimental in causing violence in children, it has tremendous potential of improving research, support, education, and pediatric heart disease advocacy (Schumacher, Lee & Pasquali, 2015). It is therefore necessary that media should be used in an appropriate manner to influence positive behavior in our society.

Blood Lead Levels and Lead as an Environmental Contaminants

The association between environmental lead exposure and societal violence dates back to 1943 when Byers and Lord identified that 19 out of 20 children they had treated for lead poisoning later in life developed aggressive behavioral issues (Byers and Lord as in Marcus et al., 2010). Before then it was thought that complete recovery from lead poisoning treatment was free from further problems. Since then, researchers continued to look for the links between toxic chemical and mental health. Rauh and Margolis (2016) pointed out that such inquiries to identify relationships between poisonous metals exposures and mental health outcome is of enormous public health and societal value. Marcus, Fulton, and Clarke (2010) conducted a meta-analysis to determine the relationship between environmental lead exposures and conduct problems and found 19

articles involving 8,561 children and adolescent. The results of this landmark study identified heterogeneity in the association between lead exposure and adolescent violence. However, Marcus Fulton, and Clarke (2010) after analysis, summarized the estimate of the connection between lead exposure and antisocial behavior to be near causal. Since then scientist continued to find the relationship between environmental lead contamination and antisocial behavior.

Childhood exposure to lead remains a critical health control problem in the United States. Due to intense research on childhood lead toxicity, the threshold of lead exposure keeps on changing over the last four decades. The BLL toxicity changed from 60 to 30 micrograms per deciliter (µg/dL) in 1975, 25µg/dL in 1985, 10 µb/dL in 1991 (CDC, 2012). By 2012 the CDC identified that there was no safe blood lead level in children and the level was reduced to 5µg/dL (CDC, 2012). The goal of the U.S. Department of Health and Human Services is to reduce the blood lead level in children and eliminate the high blood lead levels in children by 2020 (Healthy People 2020, 2017). For the attainment of this goal, there is the need for research to identify further effects of low lead levels in children for direct guidance and fortification of actions.

Even though there has been a sustained reduction of lead contamination since early1970, lead poisoning remains a problem in our nation (Hwan-Cheol et al., 2015). Chronic lead toxicity causes issues with our major organ systems including the brain, heart, liver, and kidney (Hwan-Cheol et al., 2015). Low levels of lead exposure, in the long run, results to a variety of problem including carcinogenicity (Hwan-Cheol et al., 2015). But, blood lead chelation extracts removes lead from extracellular fluid and

therefore is only suitable for acute conditions. Chronic lead levels accumulate more in intracellular tissue, 33% in the liver, and more in the kidney and spleen than other organs (Hwan-Cheol et al., 2015). Shao et al. (2017) noted that over 2.5% of children below six years of age have BLL above 5µg/dL, the minimum limit set for public health action by the CDC. The Center for Disease Control and Prevention (2017) puts these numbers at half a million children.

The distribution of lead contamination is not the same in all population. Although, Carrel et al. (2017) noted that rural communities have the same high risk of having elevated BLL as the urban dwellers. Studies have identified that areas around the airport still have high lead levels because of some air vessels that are still using leaded aviation gasoline (Kessler, 2013).

In developing countries, this problem is even severe. For example, Bodeau-Livinec (2016) examined 225 mothers and 686 offspring in a rural area of Benin and found a higher BLL >50µg/dL in 44% of mother and 58% of their children.

Research on lead and its complications has intensified over the past decade. Yang and Raine, (2009) analyzed radioactive images of children with the BLL concentration as opposed to healthy children in a systematic search of the literature. Findings of this study indicated a decrease in brain volume of children with antisocial behavior compared to healthy children especially at the prefrontal cortex and anterior cingulate cortex, implicating both regions in antisocial behavior (Yang & Raine, 2009).

Furthermore, Cai and Calisi (2016) found out that the rate of elevated BLL in pigeons in Manhattan, New York correlates with higher blood lead level in children.

Such results render the possibility of circumvention of the ability of the measurement of the environmental lead toxicity in human (Cai & Calisi, 2016). That can act as a quick assessment of lead toxicity before the proper evaluation of lead toxicity and treatment in a population. Carrel et al. (2017) noted that lead surveillance in new borne could direct public health effort on specific localities where case management may have a more significant impact. In the same line, Castellanos and Fuente (2016) in a literature review of 49 articles on the effect of heavy metals and the nervous system found an association between lead and both the peripheral and auditory nervous system dysfunction. However, there is still need for studies to pinpoint how these relationships occur.

Higher blood lead levels are of a multifactorial origin. The next sections demonstrate in details how certain factors are implicated with an increase in levels of lead in blood.

Lead paint in old houses and BLL. Lead paint ingestion in children is from the normal mouthing behavior in children. Children turn to put anything they pick up into their mouth. In 1978 the Environmental Protection Agency identified that lead poisoning in children was due to lead-based paint. That was the reason for banning lead-based paint through the 1978 Lead poisoning prevention Act. The Center for Disease Control and Prevention (2017) noted that there are over four million homes in the nation with lead-based paint. Such high number of houses still having lead painting exposes children to lead contamination with an approximation of half a million children ages one to five years with elevated blood lead levels above 5μg/dL (CDC, 2017). The 5 μg/dL is the standard set by the CDC above which there is the need for public health action (CDC

2012). The high number of children with lead levels above standard implies detoxification of all of them if there is sufficient proof that high lead levels implicates violent behavior in children. Such treatment will entail a reasonable amount of resources and manpower. The manipulation of paint chips, contaminated dust, and bullet dust may be sources of contamination lead in children (Center for Disease Control and Prevention (2017) Exposure and uptake are age-dependent; toddlers and small children ingest much more dirt than older children. The enforcement of Legislation on properties increased the proportion of homes that are certifiable as nonhazardous, thereby decreasing childhood BLL (Rogers et al., 2014). However, due to non-compliance by proprietors of rental homes, such regulations are not very efficient.

The average BLL of children living in Mid-Appalachia are proportionally higher (7.75%) than the entire nation (5.79%) because of the ecological relationship with a higher number of houses built before 1950 (Wiener & Jurevic, 2016). Lead regulations are effective in controlling lead poisoning in children but need much more reinforcement for better results.

Water contamination and BLL. Water is still a source of lead contamination in children. The contamination of drinking water by lead may come from the water source itself or leakage in lead pipes from welding on water pipe junctures (Kennedy et al. 2016). Levallois et al. (2014) in Quebec, Canada, identified that despite the average relatively low concentration of lead in drinking water (3.3µg/dL), tap water continues to be the source of elevated BLL in young children. Sadler, LaChance, and Hanna-Attisha, (2017) used geocoded data collected in 2013 and 2015 to determine the relationship

between social and built environmental variable and high blood lead level in children in the Water Crisis in Flint, Michigan. Results indicated that Social and built environment correlates with the lead-in-water contamination that implicated the Flint water crises, leading to high BLL in children (Sadler et al. 2017). It implies that social and contextual factors may have caused the deteriorating neighborhoods, which still have unchanged lead water pipes causing the water problem.

Soil contamination and blood lead level. Environmental lead contaminations affect younger children than older children. Levellois et al. (1991) examined the blood lead levels of residents around a lead-reclemation pant that recover lead plates from battery without smelting. The source of the soil contamination was lead dust from the pieces of lead stored around the facility. The residents were classified based on their distances from the facility. Levallois et al. (1991) identified that young children closer to the plants have more elevated blood lead levels than the older children and adult. The results suggest that younger children are more susceptible to lead poisoning in an environment than older children. The amount of lead present in the soil of a particular area also account for seasonal variation in blood lead levels in children as depicted in Flint Michigan (Laidlaw, Filippelli, Sadler, Gonzales, Ball, & Mielke, 2016). Blood lead levels in children tend to rise in warm weather months, a phenomenon that is associated with increasing environmental exposure and increased outdoor activities in children (Kennedy et al., 2016). Thus, a necessity to monitor children activities at the playing ground to prevent or reduce their mouthing habit.

Air pollution and BLL. Lead is also identified as an air pollutant that can be inhaled to increase the BLL in children. Lead is a widespread pollutant, and has realistic link between exposure and human disease (CDC, 2017). Spatial modeling using the Geographic information system (GIS) of childhood lead poisoning and risk factors may help in surveillance of blood lead levels. GIS-integrated screening could eliminate spatial bias due to disparities in reporting. Thus, addresses are needed in the data collection of lead levels. Regions with high ambient lead levels in the United States have persistent health disparities the area. The study noted that lead additives in gasoline had more impact on childhood lead exposure than the dust from leaded paint (Akkus, & Ozdenerol, 2014). This was demonstrated in Chile where the use of leaded gasoline was dropped by 30% because of the transition to unleaded gasoline. The average blood lead levels of 422 infants dropped from 8.3µg/dL to 5.9 µg/dL in two months (Pino et al., 2004). This result confirms lead additive in gasoline is a severe cause of lead air pollution that can affect the health of children. Furthermore, the only leaded gasoline now in the United States is aviation gasoline or avgas. Researchers found out that ambient lead levels around airports is higher than the background lead level (Kessler, 2013). Suggesting the need of the elimination of aircraft leaded gasoline.

Gender/socioeconomic status and blood lead levels. Lead levels also vary with gender and socioeconomic status. Lim, Ha, Hwang, Son, and Kwon, (2015) conducted a cohort study composed of 6,094 children to find out the relationship between BLL, individuals, and their socioeconomic status. The result identified a significant high level in boys (mean = 1.73µg/dL) than girls (mean = 1.56 µg/dL). The association between

high blood lead levels in low socioeconomic children was stronger with an Odd ratio of 2.88, 95% CI than the less deprived community. The high BLL in boys than girls may also signify their high physical activity state and hand-to-mouth actions at early childhood.

Instituted programs and BLL. In 2014 the Lead Surveillance program conducted by CDC noted a prevalence of 76,680 children less than five years old with BLL 5-9μg/dL (Raymond & Brown, 2017). The result was from the 32 states that took part in the program in that year. Even though CDC confirmed 41% of the elevated values, this number is still high warranting a closer look at the effectiveness of lead prevention programs. Shao, Zhang, and Zhen, (2017) examined the impact of local lead prevention program and the lead hazard control program in reducing childhood blood lead levels. Shao et al. (2017) made use of time series analysis on the monthly time series of lead surveillance data in Syracuse, New York. The monthly averages were on a decline form 8.77μg/dL to 3.94μg/dL during the period 1992 to 2011, for children under six years old. At the national level, 2.5% of children under the age of six have BLL ≥ 5μg/dL. Segmented time series focused on the reduction in a fixed period. The part that worked for this program was the removal of lead-based paint by replacing new doors, windows, and siding in the homes (Shao et al. 2017). The impact was a reduction BLL by 50% per 10 years interval. Federal Housing Assistance Program also helps in the reduction of BLL in children. Ahrens, Haley, Rossen, Lloyd, and Aoki (2016) used the 2005 to 2012 data from the National Health and Nutrition Examination Survey to elucidate this fact. Children living in assisted housing had a significantly lower geometric mean BLL of

(1.44 µg/dL; 95% CI (1.31, 1.57) than comparable children who did not receive housing assistance (1.79 µg/dL, 95% CI (1.59, 2.01; P < .01). Federal programs are useful in detecting and reducing lead contamination in children but cannot cover all the affected children.

Food and blood lead levels. Lead contamination of our food comes from lead in tap water used in preparing food, processing, and canning of food, deposition from air and children ingestion of inanimate object contaminated with lead (Gao et al., 2017). The Center for Disease Control and Prevention (1991) noted that lead-soldered cans, improperly fired ceramic ware, leaded crystal, result in lead leaching into food. A recent study in California conducted from 2011 to 2012 to test and identify foodstuff and candies with contaminated lead, implicated 17 candies with high lead levels (Hanley et al. 2017). Even though the study found that most lead-contaminated candies came from Mexico, it is necessary to be away that food can be contaminated with lead. However, much work is needed to determine the best approaches to sample and establish the magnitude of the lead-contaminated food in the country for prevention purposes.

Lead laws and lead contamination. In the past three decades, federal and state laws have had a significant reduction in the rate of lead poisoning in children (Korfmacher & Hanley 2013). The federal Lead Poisoning Prevention Act in 1978 banned the consumer use of lead paint (CDC, 2013). This law was fortified by Residential Lead-Based Paint Hazard Reduction Act of 1992. The 1992 act with amendments in 2005 aiming at the eliminating lead-based paint hazards in all housing in the nation as rapid as possible (CDC, 2013). Despite all state and federal regulation with

the objective of eliminating lead poisoning in children, it continues to be a problem in the United States. Kennedy et al. (2014) examined the effectiveness of lead laws in various states in the country regardless of stringency in preventing primary lead exposure among young children. The result indicated that states that have lead regulations with effective reinforcement like Massachusetts and Ohio have fewer lead poisoning cases among children less than 72 months than those without lead legislations (Kennedy, Lordo, Sucosky, Boehm, and Brown, 2014). However, lead paint is not the only source of lead poisoning in children. Children can have lead contamination through the lead in plastics and paints on toys (CDC, 2013). Also, leaded gasoline causes lead air pollution (Pino et al., 2004), lead in tap water and contaminated soil (Kennedy et al. 2016). I believe that with proper reinforcement of the lead poisoning prevention laws there will be a significant reduction in childhood lead poisoning in the country.

Smoking and blood lead level. Smoking continues to be a problem of lead toxicity in our nation despite the decreasing smoking rate. Richter et al. (2013) examined the BLL of smokers and none smokers by age and residency using the national nutrition survey between 1999 and 2008. The results identified a positive trend in BLLs of youths as a result of secondhand smoke. Prenatal smoking lead to higher lead level in blood and fetal exposure to low doses of lead in utero is a risk factor to lower birth weight.

Occupational exposure and blood lead levels. Some occupations may expose workers to lead contamination which may eventually affect them or their young ones at home. Gebrie, Tessema, Ambelu, (2014) examined the relationship between the BLLs of construction workers at Jimma, Ethiopia and found out that their mean blood lead levels

were higher (40.3µg/dL) than in non-construction worker (29.8 µg/dL). Pregnant women in this particular environment are at risk of bringing forth children with developmental abnormalities due to lead poisoning since the levels are higher than standard 5µ/dL as prescribed by the CDC. Another study by Gao et al. (2017) on 2,018 preschool children in China also implicated father's occupation for lead contamination in children with an average BLL of 48.9µg/dL in these children. In the same trend, La-Llave-León et al. (2016) assessed the association between BLLs and occupational exposure in pregnant women from Durango, Mexico. The result demonstrated that pregnant women who do not wear protective equipment and have exposure to workplace or environment lead contamination have a higher propensity for lead poisoning than those who were not exposed. Lead poisoning in pregnant women has a direct link to lead poisoning to children because of in-utero exposure and via breastfeeding (Bodeau-Livinec et al., 2016). Furthermore, Newman et al., (2015) reported on a new source of take-home exposure from parents working in an electronic recycling facility (e-scrap). Thus, suggesting the need for E-scrap workers to follow the protocols of the Occupational Safety and Health Administration lead standard of 1987.

Summary and Conclusions

Adolescent violence in our society is multifaceted in origin. Kirkengen et al. (2016) and Krieger (1994-2017) identified that, although the biomedical framework has been very successful in dealing with infectious diseases, there is a need for a radical revision of the model for a better understanding and dealing with our multifactorial medical problems. The Ecosocial theory developed by Krieger in 1994 has the potential

of becoming a modern framework to handle chronic diseases because it takes into consideration the biological, ecological, and societal forces in the determination of the distribution of diseases in a community (Krieger, 2017). There are many risk factors to antisocial behavior in children including genetic, media, family environment, school environment, peer influence, race, drug use, mental status, and acculturation. The risk factors are similar in many countries implying that identified prevention programs in developed nations may also be applicable in developing countries (Murray et al., 2013).

More recently research has implicated heavy metal poisoning notably lead to be a contributing factor to adolescent violence (Mielke et al., 2012 & Taylor et al., 2016). This present study is out to determine the relationship between high BLL during childhood and the prevalence of adolescent violence in the United States. That is by the views of researchers in this field who saw the need of further studies to elucidate the link between elevated blood lead levels and conduct problems (Mielke et al., 2012; Taylor et al., 2016; and Rauh et al., 2016). That will help for further research to identify excellent pathways of dealing with the problem of lead poisoning in our community.

The next chapter will dwell on the methodological approach that will be useful in conducting this ecologic study in determining the link between BLL and the prevalence of adolescent violence in our community.

Chapter 3: Research Method

Introduction

The purpose of this ecologic, cross-sectional study was two-fold. I sought to determine whether there is a relationship between surveillance BLL at one to five years of age and subsequent adolescent violence in the various states of the United States. I also assessed whether the existing relationship, if any, was modifiable by state income levels. In this chapter, I will address the research methodology. The chapter starts with the rationale for choosing the quantitative cross-sectional design and the methodological procedures used in conducting the study. Thereafter, I will describe the population under study including sampling size, sampling procedure, and the deliberations to determine the sample size.

I used existing data and performed a secondary data analysis. Data sources included the government institutions the CDC, the OJJDP, and the U.S. Census Bureau. Thus, it will be necessary to describe the reputations of the data sources and the procedures for gaining access to the data. In the chapter, I will also provide details about the data analysis plan and discuss internal, external, and construct validity. The last sections of this chapter include more detail about the ethical procedures necessary to gain access to the existing data including agreements, institutional permissions, and other essential guidelines to protect participants' confidential information. The chapter will end with a summary of the inquiry methodology and a transition to Chapter 4, which includes the data analysis and interpretation of the results.

Research Design and Rationale

I used an ecologic study design to describe the existing relationship, if any, between surveillance BLLs below 6 years of age and the prevalence of violence in the various U.S. states. The independent variable in this study was childhood BLL; I obtained data from the lead surveillance archival data set presently stored by the CDC. The dependent variable was adolescent violence levels of each state in the country. The violence level of each state was determined as the arrest rate per 100,000 persons aged 10-17 years. The covariate in the study was the income level of the various states in the country, data for which were obtained from the U.S. Census Bureau.

I sought to answer the following research questions and hypotheses:

Hypothesis 1: There is an association between BLL ≥ 5µg/dL in children below 6 years of age and subsequent high prevalence of adolescent violence in the various states in the United States.

Hypothesis 2: The association between BLL and the violence rate may be modifiable by state income level.

RQ1: Is there an association between having BLL ≥ 5µg/dL below 6 years of age and subsequent high prevalence of adolescent violence in the various states in the United States?

$H_0$1: There is no association between BLL ≥ 5µg/dL in children below 6 years of age and subsequent high prevalence of adolescent violence in the various states in the United States.

H_A1: There is association between BLL ≥ 5µg/dL in children below 6 years of age and subsequent high prevalence of adolescent violence in the various states in the United States.

RQ2: Is the association between BLL ≥ 5µg/dL below 6 years of age and adolescent violence at later ages of 10 through 17 years modifiable by state income levels?

H_02: There is no modification of the association between BLL ≥ 5µg/dL below 6 years of age and adolescent violence at later ages of 10 through 17 years by the state income levels.

H_A2: There is a modification of the association between BLL ≥ 5µg/dL below 6 years of age and adolescent violence at later ages of 10 through 18 years by the state income levels.

As indicated by the research questions and hypotheses, the study was a descriptive cross-sectional study that was undertaken to determine the association between exposure to lead and subsequent adolescent violence in the United States. I also sought to assess whether the existing relationship between lead exposure and the prevalence of adolescent violence is modifiable by state median income. Although this was a descriptive study, it offers insight about predictors of the relationship between exposure to BLL > 5µg/dL and the prevalence of violence in the various states.

I concluded that an experimental study design was inappropriate for my investigation. The use of an experimental design to study the cause and effect relationship of certain phenomena is ethically unacceptable in research with human beings (Frankfort-

Nachmias, Nachmias, & DeWaard, 2015). Even though in 2017 there were some revisions of the Nuremberg Code by the federal government, the code still holds that there should be no direct exposure experiments on human beings (Annas, 2018). Pandis (2014) identified cross-sectional studies as a feasible alternative to experimental studies.

An ecologic study is relatively quick and easy to carry out but does not clarify cause and effect relationships between variables like prospective cohort studies or randomized studies (Frankfort-Nachmias et al., 2015). According to Frankfort–Nachmias et al. (2015), the following are the advantages of an ecologic cross-sectional study:

- The study is fast and inexpensive because group level data are publicly available. (Frankfort –Nachmias et al., 2015)
- It is useful in evaluating the impact of community-level interventions (Frankfort-Nachmias et al., 2015).
- It maximizes exposure difference between communities (Frankfort-Nachmias et al., 2015)..
- It can be useful in studying the effects of short-term variations in exposure within the same community (Frankfort-Nachmias et al., 2015).
- It is useful in answering question that involves health and genetics (Frankfort-Nachmias et al., 2015).
- It may also be useful in generating hypothesis (Frankfort-Nachmias et al., 2015).

Disadvantages of an ecologic study include the following:

- It is usually associated with the ecological fallacy which is an aggregation bias. It assumes that a group-level relationship applies or is true at individual levels Frankfort –Nachmias et al. (2015). However, a relationship identified at group may not be true at individual level.
- There are many confounding factors involved, and it is difficult to say exactly how one group characteristic affect the other with these confounders (Frankfort – Nachmias et al., 2015),
- There is no information on the level of exposure because of the use of groups (Frankfort –Nachmias et al., 2015).
- There is no confidence that the exposure preceded the outcome (Frankfort – Nachmias et al., 2015).
- It may not provide a direct measure of disease such as prevalence, odd ratio, relative risk, and incident rate as other research studies do (Frankfort –Nachmias et al., 2015).

The validity of this study depended on the rigor involved in the collection of the original data. Data for this study came from existing data collected by U.S. government institutions including the CDC, Justice Department, and the U.S. Census Bureau. Given that U.S. government institutions have some rigor in their data collection processes (U.S.Office of Research Integrity, 2000), I expected that the data for this study would not be biased. However, confounders can confuse the association between exposure and outcome as depicted by the disadvantages of the ecologic study (Pandis, 2014).

Nonetheless, I attempted to disprove or acknowledge the existing relationship between lead exposure at childhood and the prevalence of violence in the various states in the country. Thus, it will help to improve the knowledge base on a better understanding of the effects of lead exposure and subsequent public health problems at a later age. Such result will support decision making on whether or not further actions are indeed to foster lead exposure prevention programs in children.

Methodology

The description of the methodology of this study will be under the following subheading; population, sampling procedure and sample size, recruitment of participants, procedure for assess to archival data.

Population

This study is looking at the state by state prevalence of adolescent violence at the back ground of their surveillance blood lead levels, to find out whether there is any relationship. The studied population represents children below 18 years living in the 50 states of the country including the District of Columbia. However, aggregate state values of the prevalence of adolescent violence and their previous or present childhood surveillance BLLs will be useful in the study. The studied population is therefore adolescent children 10 to 17 years of age living in the United States in 2016. It is a descriptive study that will use states summary values for the prevalence of violence in the states and the summary values of childhood blood lead levels.

Children 10 to 17 years old in our nation's 50 states plus the District of Columbia constitute the target population. This study will be describing the aggregate prevalence of

adolescent violence for each state in relationship to childhood surveillance lead levels. The Department of Health and Human Services (2018) estimated that there are 42 million children aged 10-19 years in the country. In 2014, 54.1% were White, 22.8% Hispanics, 14.0% African American and 10.2 Asians and the rest ethnic group (Health and Human Services, 2018).

In 2015 there were 48, 043 (152 per 100,000) juvenile incarcerations in our juvenile detention facilities (OJJDP, 2017). The rate distribution among the various ethnic groups shows 433 per 100,000 for non-Hispanic African American, 142per 100,000 for Hispanic White, and 86 per 100,000 non-Hispanic white. The inequitable distribution of the arrest rate in disregard to the population is a prediction of risk factors besides social and socio-ecological factors.

Sampling and Sampling Procedures

The sample size is the number of observations that constitute the statistical sample from the population. Sample size analysis is the deliberation to determine the sample size from the desired participants necessary to generate statistically meaningful results. Ellis (2015) noted that the larger the sample size, the more precise would be the properties obtainable from the population.

This study will apply the G*Power analysis in determining the sample size. In generating the sample size, the G* Power takes into consideration the type of statistical test, power, effect size, alpha level, and other parameters depending on the statistical analysis in question (Ellis, 2015). The chosen statistical test was linear multiple regressions. The statistical power is the probability of detecting the real effect by a

statistical test when it exists (Burkholder, 2017). Cohen, as cited by Ellis (2015) recommended the setting of the statistical power at a level of .8 because higher power entails a reduction of type II error. And a type II error is the probability of not finding a correlation between the variables when it exists. Setting the power at .8 implies that the chosen sample size will produce the desired effect 80% of the time (Gary, n. d). It also implies that the null hypothesis will be under rejection 80% of the time (Burkholder, 2017). Higher statistical power may denote a decrease in the probability that the results are attainable by chance. On the other hand, the effect size is the magnitude of the result as it occurs or would be identifiable in the population (Ellis, 2015). The effect size is the mean difference divided by the standard deviation (Cohen as cited by Gary, n. d). The effect size ranges from zero to one. Zero implies no effect, and a one suggests that the result is unavoidable (Ellis, 2015). The study will adopt the effect size of .14 such that any real relationship will be detectable by the statistical test, which is multiple regression using its correlation coefficient, R^2. However, that will entail the use of a larger sample size.

The Alpha level shows the likelihood of finding an effect when none exist (Gary, n. d.). It is the probability of the result occurring by chance (Ellis, 2015). Trochim (2006) identified that the Alpha level by convention is set at .05, implying that there is a 5% rate of the effect occurring by chance. Using the G*Power analysis with a medium effect size of .14, Alpha level of .05, and power of .80 the minimum sample size required in this study is 395 (Heine, n. d.). Using the Necessary Sample Size Table from Public Health 9001, with the effect size of .1, Alpha value of .05, and a power of .80, the required

sample size is 781(Public Health 9001, 2017). On the bases of this analysis selecting 40 states with available data to participate in this study will provide statistically meaningful results because the absolute number of participants will be too high for comparison. See Appendix A for G*Power calculation used in this study.

Procedures for Recruitment, Participation, and Data Collection

In the 50 states and the District of Columbia, there are an estimated 42 million children aged 10 to 19 years old (HHS, 2018). This study will consider using all the various states in the country if data is available for the childhood surveillance lead levels and violence arrest rates for the adolescent children. Thus, if up to half of the states have ample data for analysis, the available population will be sufficient to provide statistically substantial outcome with practical significance.

Archival Data

Blood lead test in children is for diagnostic evaluation and screening purposes. Each state in the United States is required to monitor children BLLs and report values ≥ 5µg/dL as of 2012 (CDC, 2017). The references value is based on the 97.5th percentile for the National Health and Nutrition Evaluation Survey (NHANES) of blood lead distribution in children. The test results are satisfactory for venous blood taken once or for capillary blood taken twice. All laboratories that measure the BLLs in children have Contract Laboratory Program Requirements that drive all activities and restrict analytical protocols for procedures (CDC, 2017). All laboratory values are reportable directly to the state and to the child's doctor to take action if need be. At the end of the year, a summary report of children BLL from each state is sent to CDC for further analysis of the trends in

the country. A child with BLL higher than normal is immediately referred to appropriate quarters for the detoxification process and follow up. While the state checks BLL in the state, the National Health and Nutrition Examination Survey (NHANES) check BLL for all children throughout the country.

Recruitment for BLL screening. Children, one to six years of age are required by the states to provide at least one venous or two capillary blood samples for lead screening purposes. The need for further actions depends on this initial screening. The data that goes with this initial testing to the state includes parent's occupation, first and last name of the child, date of birth, social security and parent address including zip code. The physical address of the house may help in determining whether the house was built before 1078 lead law banding lead paints on housing. All records are handled in a database at the state level with the Department of Health and Humans Services. The NHANES summarizes all data for surveillance BLL in all states for the Center for Diseases Control and Prevention.

Recruitment for adolescent violence. All states in the United States have the Criminal Justice Department in charge of criminal arrests in the state. They have set rules for arrest of all criminal crimes in the state. The OJJDP follows up with all adolescent in each state arrested for crimes committed. The OJJDP summarizes and analyzes data committed for the various crimes by juveniles in all states throughout the country. From this data one can obtain the prevalence of the arrest rates for each data in each of the states in the country. The median arrest rate provided by the data will be useful in pointing out which states have high arrest rates. Arrest rates greater than the median

arrest rate for the nation will be considered as high and states with arrest rate less than median arrest will be considered as state with low arrest rates. The data provided by the OJJDP does not have children identifiable information and therefore is released to the public for use. All data to be used in this research are public data obtainable from appropriate government websites.

Data Analysis Plan

In the initial data analyzes plan for this project logistic regression (Logit Model) was useful model in the data analysis. However, after the acquisition of the data I found out that linear multiple regression was a better test for the data analyzes. In linear multiple regression both the predictor and the outcome variables are in the continuous scale. The independent variable which is the predictor in the analysis is the percentage of childhood BLLs $\geq 5\mu g/dL$. The dependent variable was the state crime arrest rate per 100,000 population. I performed bivariate correlation and linear multiple regression using the backward method to analyze data. The crime arrest rates were subdivided into drug abuse, robbery, larceny-theft, aggravated assault, and weapon arrest rates in the analysis. Figure 1 shows the data analysis plan for the study.

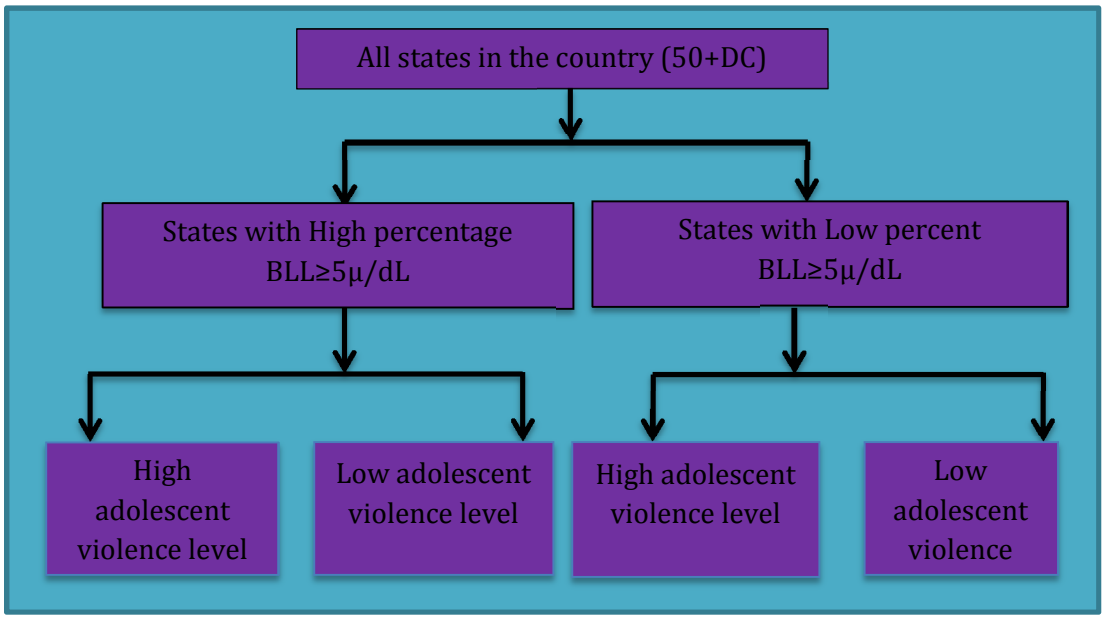


Figure 1. An outline of the design analysis plan BLL with the state percentage of confirmed childhood blood lead level. However, this outline was not very useful with the use of linear regression in the statistical analysis.

The program that was useful in the analysis is Statistical Package for the Social Sciences (SPSS). Field (2015) noted that when SPSS uses linear regression test statistic to measure the association between the outcome variable and the predictive variable, it uses the regression coefficient better (β). In the SPSS, β value in the output of the analysis depicts the number of standard deviation change in the outcome variable per unit standard deviation change in the predictor variable. On the other hand B coefficient of the SPSS output, (Exp B), predicts the change in the outcome variable per unit increase in the predictor variable (Field, 2015).

Assumptions in linear regression. In linear regression, there is the assumption of linearity where the dependent variable is assumed to have a linear relationship with one or more of the predictor variables (Field, 2015). One may use a scatter plot to check for linearity, and if not present, a logarithmic transformation may be necessary to meet this role. The natural logarithm may be useful in the transformation of the variables to meet the linearity assumption. Therefore, the model will be invalid with the violation of this assumption (Laureate Education, 2009).

Another assumption in in the regression model is normality, which is verifiable by using a histogram with a standard normal curve (Field, 2015). In this case, a skewed value divided by the standard error is greater than two signifies a violation of normality assumption. Morrow [video] (2016) noted that a large sample size or transformation of variables using the natural logarithmic scale could overcome deviations from the normality of data distribution. An alternate test for checking normality is the Kolmogorov-Smirnov (K-s) test (Field, 2015). That was not necessary in this analysis.

Multicollinearity violates the role of using regression model. Morrow (2016) indicated that a higher correlation of predictor variable higher than 80% or an engine value greater than or equal to an absolute value of o.8 is a violation of multicollinearity. In such a situation the researcher can eliminate one of the predictors with the correlation factor (Field 2015).

Another role to follow with when using regression model as a test is checking for linearity of Logit. That is, checking whether the outcome variable is entirely predictable by a predictive variable. Transforming the variables to natural logarithms can solve the

problem. Whence the p-value is less than 0.05 then there is a violation of linearity or complete separation that will create a significant error (Field, 2015). Rejection of such a predictor is necessary, thus, the need for checking of linearity of Logit.

Homogeneity of variance is also an assumption in regression model. For homogeneity of variance to be present the difference of the predictive variable is the same on all levels of the dependent variable and is tested using the Levene's test (Field, 2015). A breach of homogeneity of variance is ignored by setting a stringent Alpha value or by having a large sample size (Field, 2015). Homogeneity of regression is a test for significant interaction between the independent variables (covariates). The test for homogeneity of regression is by use of linear regression, and if it exists then that is a violation, there is the need to eliminate one of the variables (Morrow [Video]. 2016).

Morrow [Video] (2016) identified that when the standardized z-scores for an outlier is over 3.29, then it is a violation of the use of the logistic regression test. Such a score should be removed or replaced by the closest value of the data set to the outlier. Morrow [video] (2016) also indicated that missing variable for over 5% of the data is a violation of the assumption for the logistic regression test. Grand mean or group means may be useful to replace missing variable before performing the analysis. When all the assumptions for the use of multiple logistic regressions are met, then can the test of multiple logistic regressions be applicable on the data set.

Rationale for the use of multiple linear regression. To be able to apply multiple statistical tests to the data it is necessary that both variables under the estimate be in the continuous variables scale. In such a situation one can then use a statistical analysis that

uses continuous variable like the Pearson correlation coefficients, r, which measure the linear association between two study variables, and associated p-values, which determined the significance of the relationship (Cohen, Cohen, West, & Aiken, 2013). After that, the variable could be transformable to nominal scale for the use of multiple logistic regression models. For this study, the violence arrest rates variable is a continuous variable and, as such, linear regression model is a suitable test.

Even though linear regression lowers precision, it usually leads to less bias in the estimation of the relationship (Li et al. as cited by Yu et al., 2017). Notably, when the sample size is small the regression model shows inflated Type-I error rates, but the Classical regressions are conservative (Choi et al. 2017). Thus, a large sample size and low dispersion make Type-I error rates of all methods close to nominal alpha levels of 0.05. Van Smeden et al. (2016) found out that event per variable rules for binary logistic regression is weak probably due to sample size and suggested research need to guide sample size considerations for binary regression analysis. The expected sample size here is at least 1000 to avoid this situation. (Wang, Bartlett, & Ryan (2017) advised the correction of missing data before analysis, unlike non-response that did not result in substantial bias or alter the interpretation of the general result when using binary variables.

Rationale for inclusion of potential covariate. One potential covariate that will be an inclusion in this study is the average state income level. In a state with a high income level state, families will be able afford to maintain the standard that will help in the prevention of lead contamination in children. Younger children are more susceptible to

lead poisoning than older children because it is more intense in little kids than older children (Laidlaw, Filippelli, Sadler, Gonzales, Ball, & Mielke, 2016). Concern parents will be able to afford caregivers to monitor their children carefully and wisely to prevent lead contamination.

Interpretation of results. In this research study frequency tables, bar graph, and histograms will be necessary for analyzing the demographic variable. The statistical test section will identify the statistical test that will be useful in answering the research questions. The proposed analytical test is multiple linear regression. A standard result table will be designed to contain the result of the statistical analysis. The headings in this table will include independent variables, regression coefficient (B), standard error of B, standardized Beta (β), the t and p-values associated with the regression coefficient, as well as their 95% confidence intervals (Field, 2015). The R^2 value and its accompanied F ratio will be presented together with descriptive notes at the bottom of the table. Table 1 below is a sample table for the result table. The result will contain a statement stating whether or not there was a statistically significant correlation between the dependent variable, prevalence of adolescent violence at state level and surveillance BLL at childhood. Further findings will show whether the relationship between lead levels and adolescent violent level is modifiable by the state income level. Results of the analysis are shown on Table 9 through Table 16.

Treats to Validity

External Validity

From the above analysis, any lack of internal validity will also convey some degree of lack of external validity of the result generated. The degree of representativeness of the selection of the sample confers some degree of generalization of the result to the same population. However, the extension of the results out of the country to other countries may not be valid. . To obtain the same result one will have to use a similar population with the same demographic characteristics. This research is using existing data for secondary data analysis and results cannot be generalizable because of the use of different statistical analysis from the original design for the existing data (Chalamandaris et al., 2018). Thus, the use of existing data in data analysis may invalidate the generalizability of the result.

Internal Validity

Internal validity relies on the selection of the participants. The study uses a convenient sample for data that was already established. The study is not using a random selection of participants. The random sampling of participants in a study will convey a high degree of representativeness in the sample selected which is not the case in this study. Results of a statistical test from a random selection will transmit a high degree of internal validity to the conclusion (Willcutt et al. 2014). This study uses a very large sample size which will convey a high statistical significance if it was a primary study. Nothing about the history renders any problem on the selected sample. Thus, the result of the study may be valid for the population under the study because of the lack of selection bias and no prior historical

manipulation of selected sample (Willcutt et al., 2014). On the other hand, the use of existing data may affect the internal validity. Even though there are no manipulative changes, developmental changes between childhood and adolescent may also affect the internal validity (Chalamandaris et al., 2016). The lack of honesty in the keeping of the records may affect the internal validity of the results. Meanwhile, the use of a statistical test which is different from that used by the generator of the data is another reason to convey a lack of internal validity. The surveillance data has an initial aim of the diagnosis and monitoring lead poisoning in the community. But multiple regression analysis used in this research is to point out a relationship between two variables which were not taken in the same data survey. Thus, there is a lack of some degree of internal validity.

Construct Validity

The analytical test multiple linear regression has been used in many studies to find the relationship between continuous variables (Field, 2015). The validity of the result obtained from the construct is supported by significant correlations with a variety of measures that are theoretically related (Luglio et al., 2018). Thus, if the analytical test provides a positive correlation between the BLL and violence prevalence in adolescents one will believe that the relationship is a valid one. Otherwise some confounding variables may be behind the scene controlling the results.

Ethical Procedures

The secondary data useful in this study are public data provided by public institution for public usage. Even though data was requested from the government

institutions, all are public data available to the public. The data sets do not contain identifiable information and therefore are considered safe.

The data analyzed in this study was pulled out from three government institutions. These institutions are the Center for Disease Control and Prevention, the Juvenile Justice Department and the Census Bureau. Childhood Surveillance BLL for the various states will come from the data provided the Center for Disease Control and Prevention. Data for the state adolescent violence levels was obtained from the Juvenile Justice Department. Meanwhile, data from the Census Bureau will provide information for the juvenile population distribution in country. See Appendices B and C for documentation of the public domain status of the data used in the study.

The following procedures are necessary to maintain ethical standards in the acquisition of the existing data for this research process:

The Walden Institutional Review Board (IRB) is the only review board to handle this research project. The approval of this research project by the Walden Institutional Review Board is the necessary requirement for it to proceed to the data collection phase. Preliminary contacts with these government institutions have indicated the necessary data for this study can be obtain from websites or obtained freely upon request. There is no formal application requirement to obtain the data for the study.

Summary

The chapter started with a summary design of the study also illustrated diagrammatically in a data plan outline. Each of the fifty states in the U. S. constitute the unit of the analysis. Data is obtained from the NHANES, the OJJDP, and the Census

Bureau. The backward method of linear multiple regression was useful for the data analysis.

The detail analysis plan indicates how the assumption of multiple regressions will be handled during the actual data analysis. These assumptions include linearity, normality, avoidance of multicollinearity, checking for linearity of Logit, homogeneity of variance, outliers and missing variables to be less than 5% (Morrow [video], 2016).

The next section provided the rationale for the interpretation of the result. The demographic variables will use histograms, Bah charts, and tables to ease presentation. The standard result table will contain the independent variables, regression coefficient (B), standard error of B, standardized Beta (β), the t and p-values associated with the regression coefficient, as well as their 95% confidence intervals (Field, 2015). The result will contain a statement stating whether or not there was a statistically significant correlation between BLL as the independent variable and state adolescent violence as the dependent variable.

The last section deals with the validity of the results under internal, external, and constructs validities subheadings. The study results may be internally valid to the defined population but may not be generalizable to other communities. The chapter ends with the details of stripping personally identifiable information from the data so that the researcher receives only de-identified data for analysis. Chapter four is the next section detailing the actual data analysis process and how that results will try to answer the specific research questions.

Chapter 4: Results

Introduction

I conducted this ecologic, cross sectional study to trace the relationship between surveillance BLL at childhood and adolescent crime rates across the United States. I sought to describe possible effects in adolescent behavior (namely, juvenile arrest rates) when children are exposed to high BLL. My primary hypothesis was that, in states with a higher percentage of children with BLL (≥ 10µg/dL before 2012 or ≥ 5µg/dL after 2012), there would be a higher prevalence of juvenile arrest rates. My second hypothesis was that any relationship between state-level juvenile arrest rates and the state-level percentage of childhood BLL would vary by state income level. On the basis of these hypotheses, the first research question centered on whether states with a higher percentage of children with childhood BLL (i.e., ≥ 10µg/dL before 2012 or ≥ 5µg/dL after 2012) would subsequently have a high prevalence of adolescent violent behavior. The use of two BLL measures is because in 2012 the limit for childhood BLL levels was changed from 10µg/dL to 5µg/dL by the CDC (CDC, 2012). The second research question concerned whether any existing relationship between childhood BLL and adolescent violent behavior was tied to the state income level. This chapter begins with an overview of the data collection processes including the type and sources of the existing data that made up the data set for the study. Next is the results section, which includes the demographic characteristics of the sample and the sampling techniques followed by information on the data analysis procedures. In the results section, I also

summarize the results of each statistical test in relation to the research questions. The chapter ends with a summary of the pertinent results of the study and an introduction to Chapter 5.

Data Collection

I secured existing data from government websites which were either published in journals or compiled for public and government interest. These websites included the CDC, U.S. Census Bureau, OJJDP, and the NHANES. I obtained data for the surveillance childhood BLL from the published data of the NHANES and CDC. The OJJDP was the source of the data compiled for the various juvenile arrest rates by state. The U.S. Census Bureau website provided data for each state's median income level. All of these data are open to the public and did not require any special request or approval for usage. Data collection for this study took more than three months, which differs from the 2 months mentioned in Chapter 3. The data for BLL were mostly found as published data in the CDC's *Morbidity and Mortality Weekly Report* (CDC, 2013).

I intended to collect data to cover the entire U.S. population of 323.4 million as of 2016 with a population density of 92.6 per square mile (U.S. Census Bureau, 2018a). The unit of analysis was at the state level while considering only children below 18 years of age, who made up over 20.6% of the population in 2016 (U.S. Census Bureau, 2018a). According to the U.S. Census Bureau statistics (2018a), women and girls constituted 50.8% of the population and men and boys 49.2% in 2016. In this ecological study, I sought to identify whether there was any correlation between state crime rates in 2016 and childhood BLL from 1999 to 2005. I, therefore, examined the percentage of each

state's tested childhood BLL greater than the stipulated standard (10µg/dL or 5µg/dL) set by CDC against a state's crime rates in 2016. I further examined the relationship between state crime rates in 2016 and state percentages of confirmed childhood BLL ≥ 5µg/dL.

Data were available for all states' crime rates in the nation from the OJJDP. However, childhood BLL data were lacking for seven of the 50 states including Arkansas, Idaho, Mississippi, Nevada, North Dakota, South Dakota, and Tennessee. I did not include these seven states in the data analysis because of the lack of childhood BLL data. For the rest of the 43 states that were included in the data analysis, less than 5% and multiple imputations were useful in replacing the data in order to obtain meaningful results. The data collection procedure deviates significantly from what was described in Chapter 3. Notably, there was no distinction between female crime rate and male crime rate by state from the data. This is because the state percentages of BLL did not indicate the female and male ratios.

Variables

Independent variable: Blood lead level. I considered the childhood period for the adolescent in 2016 to be from 1999 to 2005. However, the childhood BLL data were only available for three of these years: 1999, 2000, and 2001. The available data were provided as the percentage of tested children in each state with BLL ≥ 10µg/dL. The average percentage for each of the 43 states considered for analysis is shown in Figure 2. Each of the 3-year ratio scale data was presented as a separate variable for the data analysis. Thus, there were four independent variables: the percentages of BLL for each state for the three years and average state BLL for the three years. More than 11.6% of

the states have their mean childhood BLL ≥ 10µg/dL for the three childhood years, 1999, 2000 and 2001. Maryland had the highest mean BLL for the 3 years followed by Oregon, California, Illinois and Pennsylvania. The states with lower mean BLL for the 3 years were Hawaii, Kentucky, Montana, Oklahoma, Utah, and Wyoming.

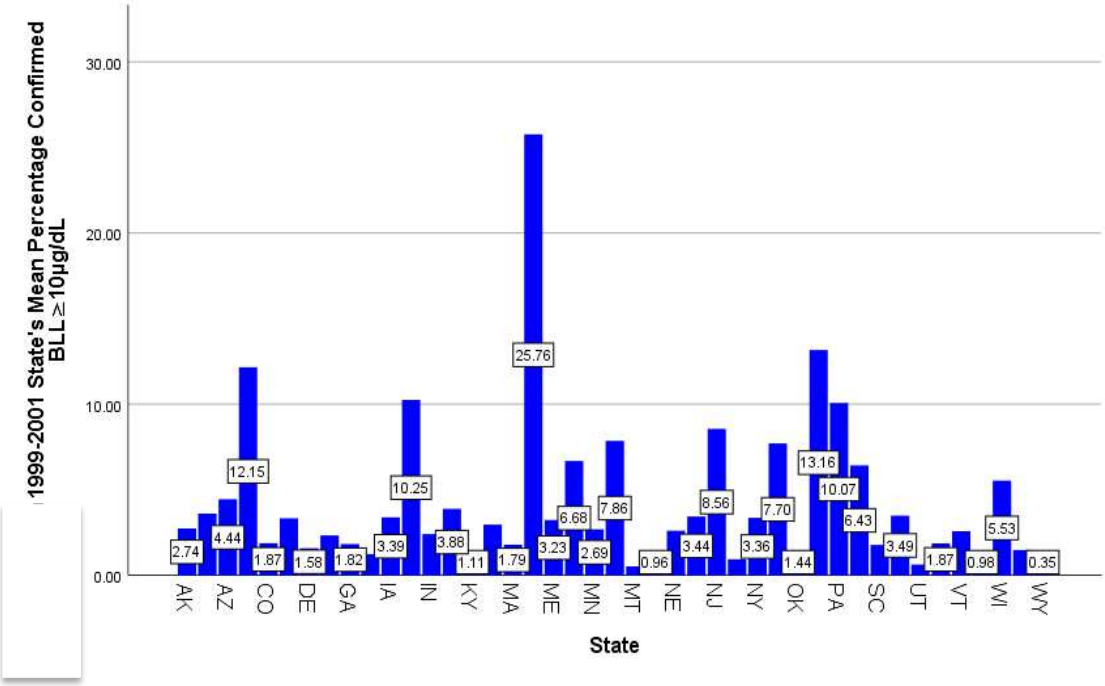


Figure 2. Histogram of 1999-2001 state mean percentages of confirmed blood lead levels ≥ 10µg/dL by state. I obtained these data from [Center for Disease Control and Prevention, (2014)].

Dependent variable: Crime arrest rates. I used the juvenile crime arrest rate per 100,000 persons to determine the arrest rate for each state in the ratio scale. For this study, five different types of crime rates were considered as registered by the 2016 OJJDP. The various crimes include robbery, aggravated assault, larceny-theft, drug abuse, and weapon-associated. Thus, six variables were considered including the total

crime arrest rate for each state. I divided the variables in this manner in order to assess the possible correlation between each of the various crime arrest rate and the childhood BLLs. Figure 3 shows the variation of the total crime rate in the United States for the 43 states under consideration. States with high crime arrest rates included Nebraska, Wyoming, West Virginia, and Illinois. States with very low crime rates included Wisconsin, Vermont, Massachusetts, and Alaska.

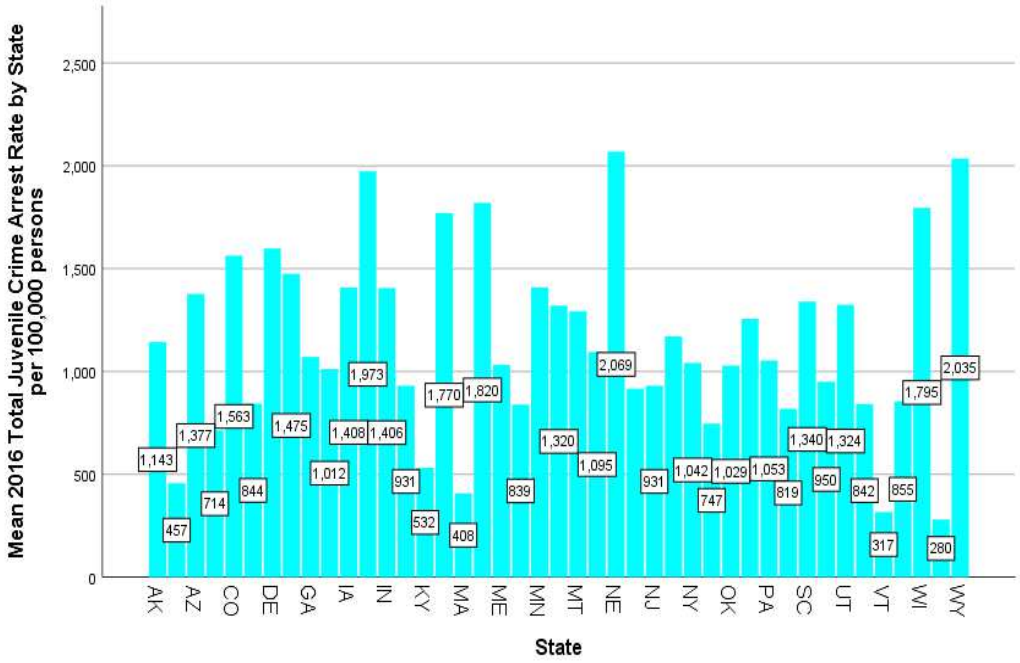


Figure 3. Total juvenile crime rate per 100,000 persons by state. I obtained these data from [Office of Juvenile Justice and Delinquency Program, 2018].

Covariate: Median income by state. The median income by state was useful in assessing whether the relationship between childhood BLL and state's crime arrest rates varies according to the state's income. The median income in the country in 2016 was 57,627 (Census Bureau (2017). For the 43 states considered in this study the median

income is 58,036 (SD 10,508.10), with a range between 44,061 to 78,916. This may imply that most of the 43 states under consideration have a higher median income in the country. Such may imply that richer states kept childhood BLL data better than the poorer states which may have not been included in the analysis. However, that was not the case because the average median income of the seven states that were not included was 58471. Some of the states with high median income include Alaska, Maryland, New Jersey, and Connecticut.

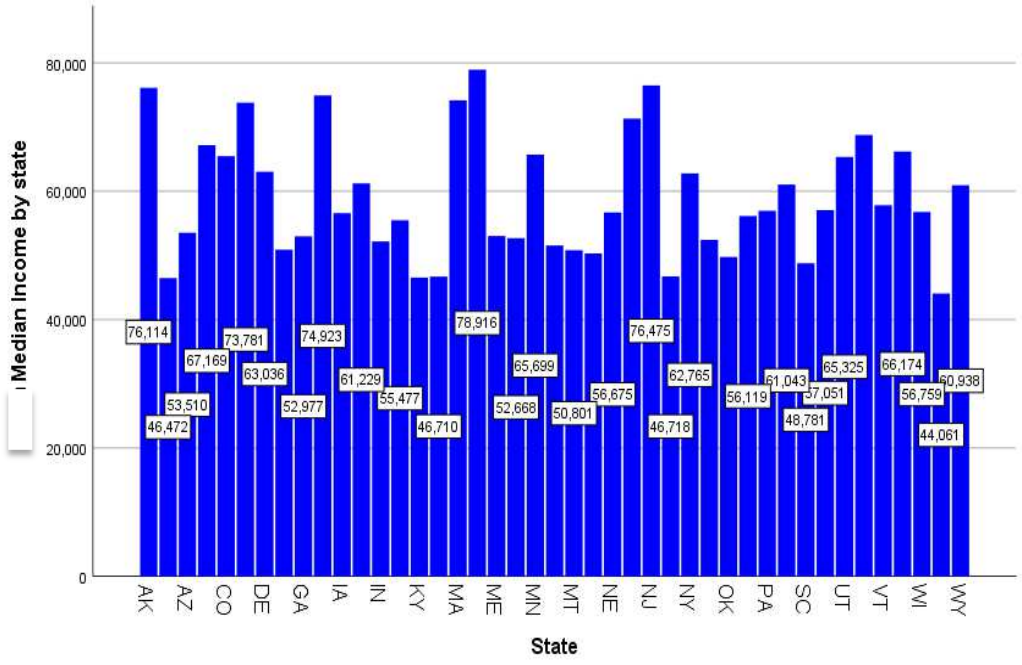


Figure 4. Median income distribution by state for the 43 states under consideration. Median income is measured in dollars. I obtained this data from [U.S. Census Bureau., 2017].

Further Analysis

In view of further analysis, the project also seeks to find out whether there is any relationship between 2012 to 2016 states confirmed childhood BLL ≥ 5µg/dL and the

2016 crime rate in the nation. While trying to perform this aspect of the analysis, I found out that childhood BLL data was not available for 24 of the 50 states. Thus, this part of the analysis only considered 26 states instead of the previous 43 states. Figure 4 below shows the state mean BLL of the four years for the various states under consideration. States having a high mean percentage childhood BLL include Louisiana, Illinois, New Hampshire, and Vermont. A state like Maryland which had the highest mean childhood BLL≥ 10µg/dL for the years 1999 to 2001 is among the states with lower childhood mean BLL≥ 5µg/dL as per standard set by CDC in 2012 (CDC, 2012).

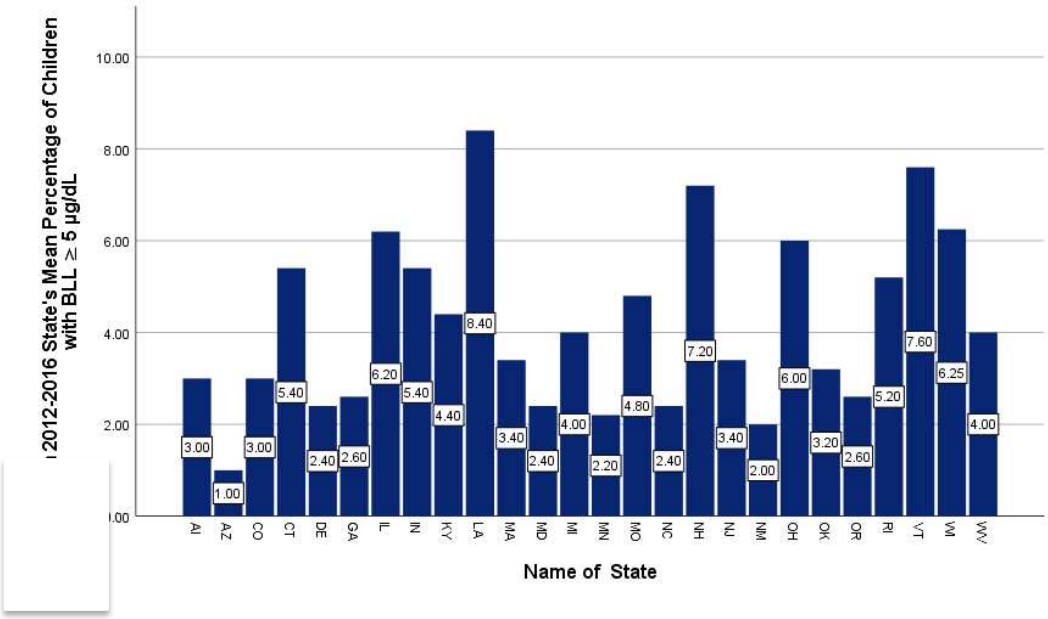


Figure 5.Mean childhood blood lead level for the considered 26 states (1999-2001). I obtained the data from [CDC Table 3, 2003].

Results

Descriptive Statistics

Independent variable. The independent variable is the Percentage childhood BLL ≥ 10µg/dL for the years 1999, 2000, 2001 and the mean for the three years. Table 1 shows the range, mean, and standard deviation of confirmed childhood BLL percentages for the various years. The highest mean percentage childhood BLL≥ 10µg/dL was registered in 1999 as 7.93 (SE, 1.66). The percentage dropped to 3.73 in 2000 and then to 3.02 in 2001. This shows some effort by the states toward the reduction of the childhood BLL poisoning.

Table 1

Descriptive Statistic for the Independent Variable

Variable	Minimum value	Maximum value	Mean		
			Statistic	Standard Error	Standard Deviation
1999-2001 State's Mean%	0.97	25.76	4.99	1.08	4.63
1999 State's Mean%	0.48	70.51	6.28	1.66	10.89
2000 State's Mean%	.25	21.89	3.73	0.60	3.95
2001 State's Mean%	0.27	9.68	3.02	0.39	2.59

Notes: % stands for the percentage childhood BLL ≥ 10µg/dL.

Dependent variables. The main dependent variable was the total crime arrest rate for each state. However, the different types of crime for the various states were identified to compare their relationships with the childhood blood lead level. The total crime arrest

rate for the 43 states was 1145.6 per 100,000 populations. However, the juvenile larceny-theft constituted more than half of the juvenile arrest rates in the nation. States with high crime arrest rates include Nebraska, Wyoming, West Virginia, and Illinois. Meanwhile, states with very low crime rates include Wisconsin, Vermont, Massachusetts, and Alaska. This information is illustrated on Table 2.

Table 2

Descriptive statistic for the considered dependent variables

Variable	Minimum value	Maximum value	Mean Statistic	Mean Standard Error	Standard Deviation
2016 Total Juvenile Crime Arrest [A]	280	2060	1145.6	68.10	446.53
2016 Juvenile Robbery [A]	1	220	51.65	6.83	44.76
2016 Juvenile Larceny-Theft [A]	130	1268	637.47	40.59	266.14
2016 Juvenile Aggravated Assault [A]	20	229	79.28	7.18	47.05
2016 Juvenile Drug abuse [A]	37	956	323.70	26.82	175.90
2016 Juvenile Weapons [A]	1	244	55.42	6.60	42.30

Notes: A = Arrest rate per 100,000 person.

Covariate. Median state income is the only covariate considered in this study. In 2016, the median income for the 43 states in the country considered for the analysis was $58,977.96 (SE, 1450.88). Figure 4 shows the median income distribution by state for the

various states under consideration. The high median income states include Alaska, Maryland, New Jersey, and Connecticut.

Descriptive statistics for 2012 to 2016 confirmed childhood BLL ≥ 5µg/dL. Each of the five years; 2012, 2013, 2014, 2015, and 2016 were considered as well as another variable as mean of the 5 variables. Table 3 below summarizes these findings only for the 26 states under consideration. For the five consecutive confirmed percentage range of childhood BLL≥ 5µg/dL was from 1 -17µg/dL. The mean percentage confirmed childhood BLL for the five years was 4.17µg/dL (SE, 0.38). There is a reduction of 0.895µg/dL from the previous mean of 4.99 for the years 1999 to 2001. The drop may indicate that considerable effort is being made by the state holder in the reduction of childhood lead poisoning. This information is displayed on Table 3.

Table 3

Descriptive Statistic for the 2012 to 2016 Confirmed Childhood BLL ≥ 5µg/dL

Variable	Minimum value	Maximum value	Mean Statistic	Mean Standard Error	Standard Deviation
2012-2016 Mean % Childhood BLL ≥ 5 µg/dL	1.00	8.4	4.17	0.38	3.42
2012 State % childhood with BLL ≥ 5 µg/dL	1.00	17.00	5.39	0.67	3.42
2013 State % childhood with BLL ≥ 5 µg/dL	1.00	9.00	4.23	0.39	1.97
2014 State % childhood with BLL ≥ 5 µg/dL	1.00	7.00	3.77	0.32	1.66
2015 State %					

childhood with BLL ≥ 5 µg/dL	1.00	6.00	3.69	0.30	1.52
2016 State % childhood with BLL ≥ 5 µg/dL	1.00	8.40	4.17	0.38	1.93

Note: % = Percentage of tested children below 72 months in the state with BLL ≥ 5 µg/dL.

Correlation between the various dependent variables, crime rates and the various independent variables. From Table 4, it is evident that most of the crimes rates were positively correlated with the percentage confirmed BLL ≥ 10µg/dL for the various years as well as with the mean confirmed BLL ≥ 10µg/dL for the years 1999-2001. More or less, significant correlations were identified between robbery arrest crime rate and weapon crime arrest rate with both the 1999 percentage confirmed BLL ≥ 10µg/dL and the mean percentage confirmed BLL ≥ 10µg/dL.

Table 4

Correlation Table Between the 2016 Various Crime Rates in the Nations and Childhood BLL From 1999-2001

Variables	1999 Percentage %Confirmed BLL≥10µg/dL	2000 Percentage %Confirmed BLL≥10µg/dL	2001 Percentage %Confirmed BLL≥10µg/dL	1999-2001 Mean % Confirmed BLL≥10µg/dL
Total crime +	0.20	0.03	-0.06	0.19
Robbery crime +	**0.62****	0.20	0.23	**0.60****
Aggra Assault+	0.22	0.01	0.12	0.21
Larceny-Theft+	0.09	-0.012	-0.06	0.04

Drug Abuse+	0.07	-0.12	0.06	0.06
Weapon +	0.35*	0.25	0.3	**0.40****

Notes: + = Crime arrest rate/ 100,000 persons; * = Correlation significant at the 0.01 level (2 tail); **= Correlation significant at the 0.05 level (2 tail). Aggra = aggravated.

Underlying Assumptions of Statistical Test

The statistical test for this analysis was linear multiple regression from the F-test statistic family. Using the G* Power analysis with medium effect size of 0.15, sample size of 43, and considering 4 predictors for the test, the power for the analysis was 0.81 and the critical F value was 1.57. See Figure 5, at the appendix section for the results of the G* Power analysis. This test statistic will be interpreted on the basis of regression coefficient (B), standard error of B (SEB), standardized Beta (β), the *t* test's p-values associated with the regression coefficient, as well as their 95% confidence intervals (Field, 2015).

Normality assumption. The mean of the main dependent variable, total crime arrest rate per 100,000 persons as shown on a normal distribution histogram as in Figure 6. The mean of 1145.63, median of 1071.00 and mode of 931 all lie midrange between the 280 and 2069. Thus, parameters and confidence interval generated from the data with this normal distribution may be accurate in their measurement (Field, 2015). When data achieve normality in this way the difference between the model and the data is frequently close to zero. Kolmogorov Smirnov (K-S) normality test is shown on Table 5.

Table 5

Normality Test for the Dependent Variables

	Kolmogorov-Smirnov (K-S)		
Variable	Statistic	Degree of freedom (df)	Sig.
2016 Total Crime [A]	0.080	43	**.200***
2016 Aggravated Assault [A]	0.161	43	.007
2016 Robbery [A]	0.162	43	.006
2016 Larceny-theft [A]	0.16	43	**.200***
2016 Drug Abuse [A]	.096	43	**.200***
2016 Weapon [A]	.16	43	.007

Notes; * = lower bound for the true significance for K-S normality test; A = Crime arrest rate per 100,000 persons; sig. = significance of K-S test.

2016 Total crime arrest rate, D (43) = .08, P = 0.2, did not deviate significantly from normal.

2016 Aggravated assault arrest rate, D (43) = 0.16, P < .01, is significantly non-normal.

2016 Robbery arrest rate, D (43) = 0.16, P < .01, is significantly non-normal

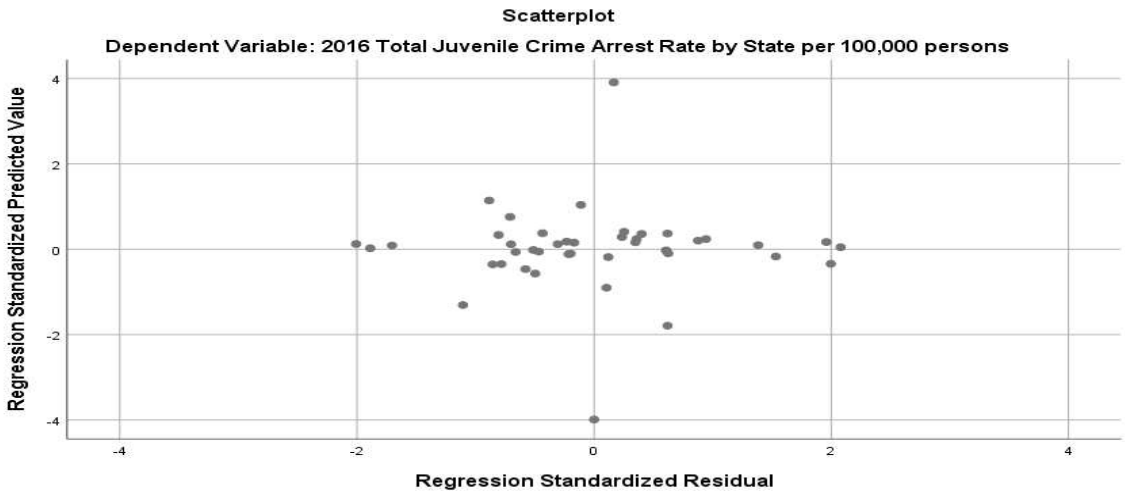
2016 Larceny-theft arrest rate, D (43) = 0.16, P =.200, did not deviate significantly from normal

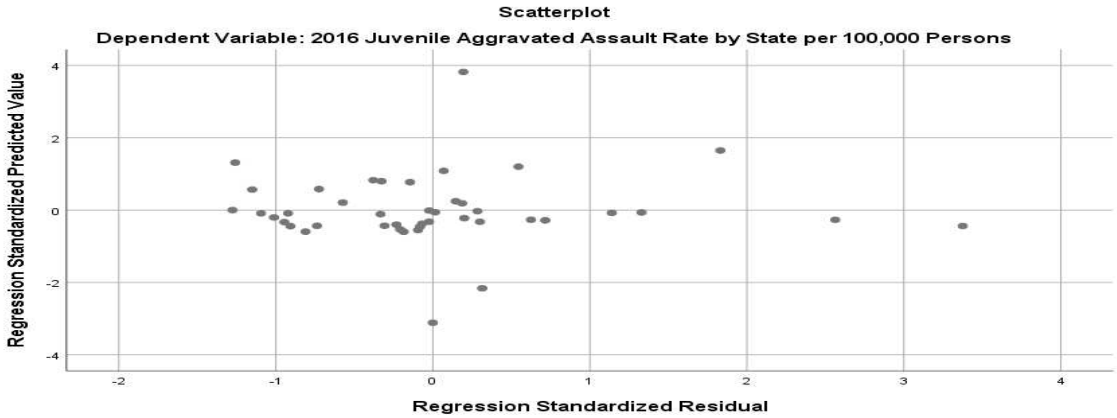
2016 Drug abuse arrest rate D (43) = .096, P =.200 did not deviate significantly from normal.

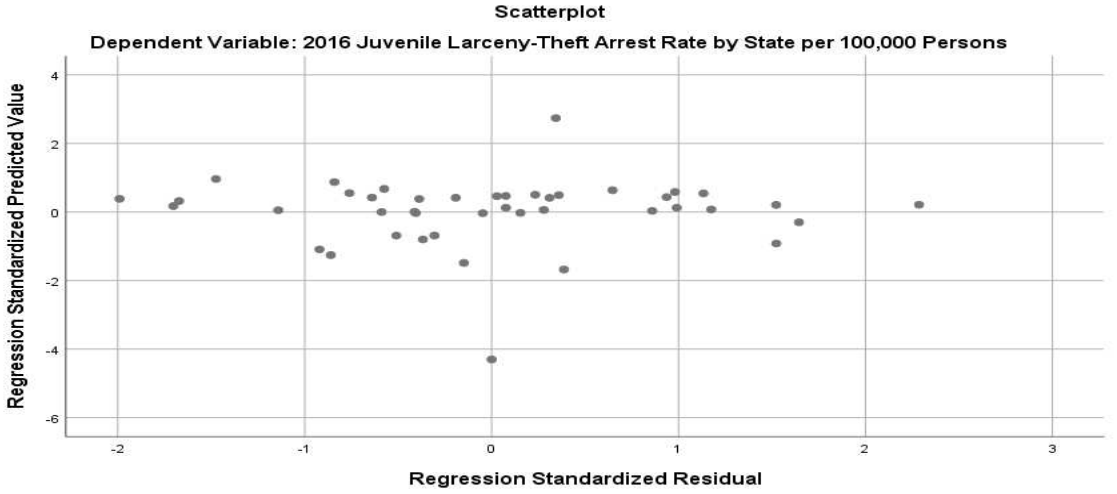
Thus the main dependent variable total state crime arrest rate, larceny-theft arrest rate and drug arrest rate variables all have a normal distribution by K-S test. Any test

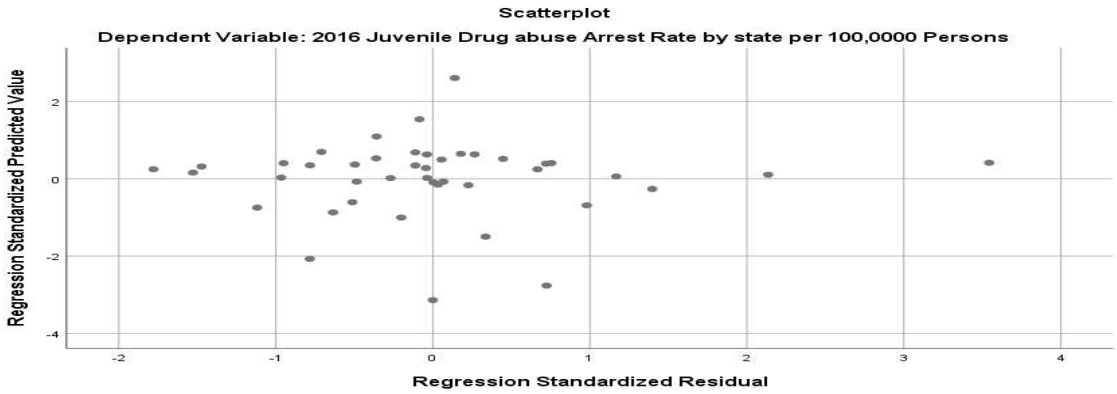
statistic that is conducted on these three variables will be accurate in their measurements as well as their confident intervals.

Linearity and heteroscedasticity assumption. Field (2015) indicated that linearity is one of the assumptions of multiple regression where the dependent variable should have a linear relationship with one or more of the predictor variables. . Linearity and heteroscedasticity both refer to the errors in the model and the fit in the model. The model is invalid if there is a violation of the linearity assumption. Scatter Plots of the standardized residuals against the predicted values for each of the five dependent variables and their BLL predictors are shown below. None of these graphs shows a funnel shape or a curve and the dots are concentrated more around the center (zero). There is no systematic relationship between errors in the model and what the model predicts. Thus, the assumption of linearity and heteroscedasticity are met.




Scatterplot
Dependent Variable: 2016 Juvenile Aggravated Assault Rate by State per 100,000 Persons
Regression Standardized Predicted Value
Regression Standardized Residual


Scatterplot
Dependent Variable: 2016 Juvenile Larceny-Theft Arrest Rate by State per 100,000 Persons
Regression Standardized Predicted Value
Regression Standardized Residual


Scatterplot
Dependent Variable: 2016 Juvenile Drug abuse Arrest Rate by state per 100,0000 Persons
Regression Standardized Predicted Value
Regression Standardized Residual

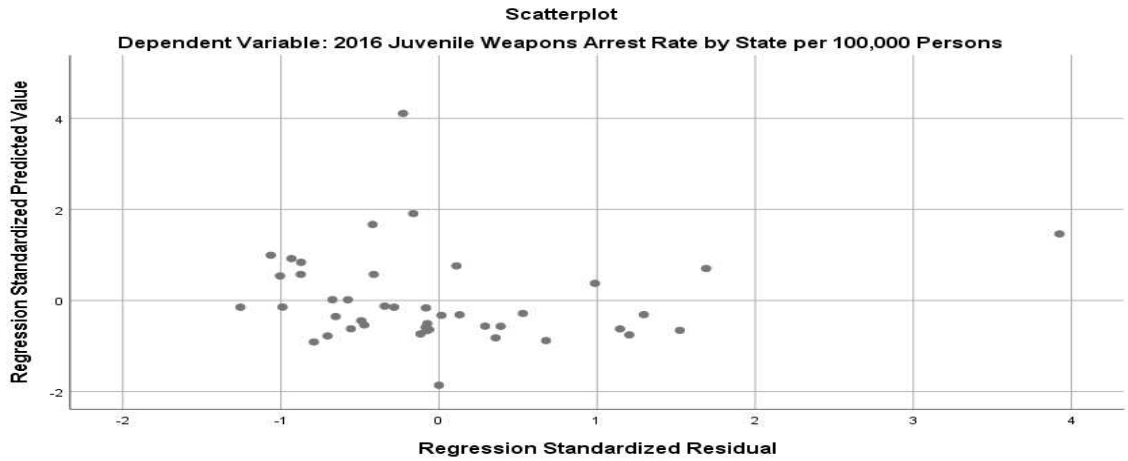


*Figure 6***.** Plots of standardized residuals against predicted values for the dependent variables**.**

Homogeneity of variance. Figure 6 above showing the plot of standardized residuals against predicted values also strongly indicates that there is homogeneity of variance. It indicates that the spread outcome scores are somehow equal at different points on the predictor variable.

Independent observation and independence of error. The production of each observation in any of the variables must be independent (Field 2015). That being the case there should also be independence in the errors. The Durbin-Watson test is useful in testing the independent errors. The Durbin-Watson test statistic provided a value of 2.1 indicating that the residues are uncorrelated. This is because accepted values for the Durbin-Watson test is between 1 and 3 (Field, 2015). The range for values for the Durbin-Watson test can vary from zero and four.

Variable types. All variable in this project are quantitative. Multiple linear regression requires that all dependent variables are quantitative continuous and

unbounded, even though, some independent variables may be categorical. However some variables were changed to categorical variable for graphical illustrations.

Multicollinearity. Among the predictor variables there should not be greater that two or more with high correlation of $r = .9$ as identified by Field (2015). From Table 6 below there are only two pairs of variables with a correlation value above .8 ($r < .9$). Thus, during the analysis I may look out for this to eliminate one of the variables which correlate highly with the other. Field (2015) noted that multicolinearity renders the b value untrustworthy, limit the size of the R value or make it difficult to know the importance of each predictor in the model.

Table 6

Pearson correlation between the predictor variables

	1999 State %	2000 State %	2001 State %	1999-2001 mean %	State Median income
1999 State % BLL ≥ 10µg/dL	1	.233	.224	.**892****	.335*
2000 State % BLL ≥ 10µg/dL	.233	1	**.861****	.633**	-0.004
2001 State % BLL ≥ 10µg/dL	.224	.**86**1**	1	.612**	.025
1999-2001 % BLL ≥10µg/dL	.**892****	.633**	.612**	1	.293
State Median income	.335*	-0.004	.025	.293	1

Notes: ** indicates significant correlation at the .01 level; * indicates correlation at the .05 level; % means percentage; BLL ≥ 10µg/dL

Missing values. Multiple regressions is very sensitive to missing data requiring less than 5% missing data. The problem of data collection in this project is that some states did not have BLL data and such states were eliminated from the analysis. Thus

analysis will be done only for the 43 states that all have data for the childhood BLL. For the entire project missing data was up to 6% but with the elimination of states with no BLL data, missing data was only 0.6%. The missing data was replaced using the multiple imputation method using SPSS.

These assumptions have a profound effect on the significance test and the confidence intervals. This is because inaccurate confidence intervals will render it difficult to make accurate inferences about the population.

Outlier. Looking at the available data there was no data point that was up to three standard deviations above the mean. Thus, the condition for the outlier assumption was met.

Results of Research Question 1

The results answer the question whether there is any relationship between state percentage confirmed childhood BLLs ≥ 10µg/dL and the state crime rate in the United States. The hypothesis is that the variation in state adolescent crime rate in the United States is explainable by the state percentage confirmed childhood BLL ≥ 10µg/dL before 2012 or ≥ 5µg/dL after 2012. The state crime rate as the dependent variable was subdivided into groups as outlined by the Office of the Juvenile Justice and Delinquency Prevention (OJJDP). These considered subgroups included Rubbery, Larceny-theft, Aggravated assault, Weapon, and Drug arrest rates as well as the state total arrest rates. Each of these groups were tested separately with four predictors, three childhood years of percentage confirmed BLL (1999, 2000, 2001) greater than 10µg/dL. The fourth predictor was the mean BLL for the three considered years.

The analysis was done using the stepwise multiple regression via backward elimination method. The choice of the steps depended on the SPSS choosing the best predictors and eliminating those that did provide any prediction of the dependent variable in the next step. Before applying this method, bootstrapping method was used because of its robustness to eliminate non-conformable predictors, to overcome any unidentified violations of the model assumptions. It also provides confident interval and other model parameters.

The following tables summarized the results of the linear multiple regression analysis between the predictors and each of the dependent variables.

Table 7 provides results for the prediction of total juvenile arrest rate from childhood BLL.

Table 7

Predicting Total Juvenile Arrest Rate per 100,000 persons from State Percentage Childhood Confirmed BLL ≥ 10μg/dL at 95% confident interval

				95% Confident interval	
Model	B (SEB)	β	Sig.	Lower Bound	Upper Bound
Model 1					
Constant	933.28 (125.3) ***		$p < .001$	674.16	1192.39
1999-2001 State%	34.34 (17.38)	.37	$p = .06$	-1.53	70.21
Model 2					
Constant	1040.38 (175.9) ***		$p < .001$	-35.87	31.54
1999-2001 State %	320.15 (289.71)	3.45	$p = .35$	282.33	922.63
1999 State %	-95.71 (96.86)	-2.66	$p = .33$	297.14	105.73
2001 State %	-160.64((131.96)	-.79	$p = .24$	-435.06	113.75
2000 State %	-64.79 (107.5	.59	$p = .55$	288.10	158.81

Notes: B stands for statistics coefficient b; SEB = Standard Error of B in the analysis; *** is $p < .001$; ** is $p < .01$ and * is $p < .05$. Sig identify the T-test significant value for the analysis: % stands for State percentage confirmed childhood BLL ≥ 10µg/dL. R square for step1 is .374 and ΔR = .444.

From Table 8, it is evident that the state mean percentage confirmed childhood BLL ≥ 10µg/dL has a high positive correlation to the total state crime rate. At 95% confident interval this positive correlation is near statistically significant, ($p = .06$). Even though this is not statistically significant, it might have some practical significance especially as it is close to the significant value of .05. However, from the B values, the 1999, 2000, and 2001 childhood confirmed BLL has a negative correlation to the state totals crime rate. The step 1 model identifies from the R square value that state percentage confirmed childhood BLL could explain 44.4 % of the variation in state crime rate, if it was significant.

Table 8 shows results for the prediction of the juvenile robbery arrest rate from childhood BLL.

Table 8

Predicting Juvenile Robbery Arrest Rate per 100,000 persons from State Percentage Childhood Confirmed BLL ≥ 10µg/dL at 95% confident Interval

Model	B (SEB)	β	Sig.	95% Confident interval Lower Bound	Upper Bound
Mod. 1 Const.	**31.35 (15.81)***		***p* < .060**	674.16	1192.39
1999 State%	**2.42(0.65) ****	.37	***p* = .001**	1.06	3.77
2000 state%	-2.35(4.23)	-.20	*p* = .58	-11.11	6.411
2001 State%	5.39 (7.72)	0.24	*p* = .49	-10.61	21.40
Mod. 2 Const.	**33.92 (14.89) ***		***p* = .03**	2.29	64.72
1999 State %	**2.4 (0.64)*****	**0.16**	***p* = .001**	1.07	3.73
2001 State%	1.62 3.6)	0.07	*p* = .66	-5.87	9.11

Mod. 3 Const.	**38.91(9.69) *** **		***p* < .001**	18.96	58.87
1999 State%	**2.43(0.63) *** **	**.62**	***p* < .001**	1.14	3.73
Mod. 5. Const.	**28.87(12.04) ***		***p* = .03**	4.02	53.70
Sep. anal.)					
1999-2001 Mean%	**5.79(.67) *** **	**.58**	***p* < .001**	3.35	9.23

Notes: B stands for statistics coefficient b; SEB= Standard Error of B in the analysis; *** is $p < .001$; ** is $p < .01$ and * is $p < .05$. Sig identify the T-test significant value for the analysis: % stands for State percentage confirmed childhood BLL ≥ 10µg/dL. R square for step1, 2, 3, and 4 are .317.337,.359, and .335 respectively. Mod. = model. Sep = separate; anal. = analysis.

The 2016 juvenile arrest rate could also be predictable from the 1999 -2001 mean state childhood percentage confirmed BLL ≥ 10µg/dL. The significant B value here is 5.79 ($p < .001$) implying that for every unit increase in mean 1999-2001 state percentage confirmed childhood BLL ≥ 10µg/dL, the juvenile arrest rate increase by 5.79 unit, all others kept constant. Alternately, for a one SD (5.30) increase of mean 199-2001 percentage BLL ≥ 10µg/dL, the juvenile arrest rate increased by 0.58SD (0.58 X 53.08). That is, for every 5.30 µg/dL increase of BLL, the juvenile arrest rate increased by 30.78 per 100,000 persons. The mean 1999-2001 was done separately because of the high collinearity of .9 between this predictor and the 1999 BLL predictor. That particular model was a fit showing that 33.5% of the robbery arrest rate can be explained by variation in the mean 1999-2001 BLL, keeping all else constant.

The B value of the 1999 BLL (B = 2.43, $p < .001$) predicts that for every unit increase in state percentage confirmed childhood BLL ≥ 10µg/dL the juvenile robbery arrest rate increases by 2.43 units per 100,000 population, all else remaining constant. Alternatively, using the Beta value, ($\beta = .62$, $p < .001$), it is predictable that for a one standard deviation (SD) increase of 1999 state BLL (13.53), the juvenile robbery arrest

rate will increase by 0.62SD (.62 X 53.08). That is an increase of 31.85 for every 13.53 BLL increase. The R square value (.359) for the model indicates that 35.9% of the variation of robbery arrest rate can be explained by the variation of the 1999 state BLL.

However, 2000 percentage confirmed childhood BLL has a non-significant negative correlation with the 2016 robbery arrest rate B = -2.25, p = 58). Meanwhile, the 2001 percentage confirmed childhood BLL has a non-significant positive correlation with the 2016 state robbery arrest rate.

Table 9 illustrates the results for the prediction of the juvenile aggravated assault arrest rate from BLL.

Table 9

Predicting Juvenile aggravated assault Arrest Rate per 100,000 persons from State Percentage Childhood Confirmed BLL ≥ 10µg/dL at 95% confident interval

				95% Confident interval	
Model	B (SEB)	β	Sig.	Lower Bound	Upper Bound
Step 1 (Constant)	**95.43 (17.37) *****		**p < .001**	59.41	131.45
1999 State%	0.89(0.72)	0.25	p = .23	-.06	2.38
2000 state%	2.93(4.64)	0.27	p = .53	-6.70	12.56
2001 State%	-9.87 (8.48)	-0.49	p = .26	-27.46	7.71
Step 2 (Constant)	**92.23 (14.89) *****		**p < .001**	58.32	126.14
1999 State %	0.91 (0.71)	0.26	p = .21	-0.55	2.38
2001 State%	-5.17(3.99)	-0.26	p = .21	-13.41	3.08
Step 3 (constant)	**97.41(16.11) *****		**p < .001**	64.16	130.66
2001 State%	-4.56(4.01)	-0.23	p < .27	-12.85	3.72

Notes: B stands for statistics coefficient b; SEB = Standard Error of B in the analysis; *** is p < .001; ** is p < .01 and * is p <.05. Sig identify the T-test significant value for the analysis: % stands for State percentage confirmed childhood BLL ≥ 10µg/dL. R square for step 1, 2, and 3 are .113,.115, and .051 respectively.

From the F-statistic functions, all the model values show no significance and therefore the model is not a fit to explain the variation of aggravated assault as a function of the childhood BLL. From the positive B values of 1999 state percentage confirmed childhood BLL (B = .91, p = .21) and 2000 state percentage BLL (B = 2.93, p = 26), there is a positive correlation between juvenile arrest rate and BLL which is not statistically significant. The 2001 state percentage confirmed childhood BLL has a negative correlation to juvenile arrest rate but it is not statistically significant in the model prediction (B -9.89, p = .26).

Table 10 shows the results for the prediction of the juvenile larceny-theft arrest rate from BLL.

Table 10

Predicting Juvenile Larceny-theft Arrest Rate per 100,000 persons from State Percentage Childhood Confirmed BLL ≥ 10µg/dL at 95% confident interval

				95% Confident interval	
Model	B (SEB)	β	Sig.	Lower Bound	Upper Bound
Step 1	570.27 (104.98)		$p < .001$	352.52	787.52
(Constant)	***				
2000 State%	13.33(28.06)	0.21	$p = .64$	-44.85	71.52
1999 state%	4.04(4.34)	0.19	$p = .36$	-4.96	13.45
2001 State%	-13.18 (51.25)	-0.11	$p = .79$	-119.48	99.11
Step 2	554.09 (82.24)		$p < .001$	383.75	724.43
(Constant)	***				
2000State %	6.99 (13.09)	0.11	$p = .61$	-20.10	34.07
1999State%	4.02(4.25)	0.19	$p = .35$	-20.10	34.07
Step 3 (constant)	581.10(63.98) ***		$p < .001$	449.04	713.15
1999 State%	4.31(4.16)	0.21	$p < .31$	-4.27	12.88

Notes: B stands for statistics coefficient b; SEB= Standard Error of B in the analysis; *** is $p < .001$; ** is $p < .01$ and * is $p < .05$. Sig identify the T-test significant value for the analysis: % stands for State percentage confirmed childhood BLL ≥ 10µg/dL. R square for step 1, 2, and 3 are .057,.055, and .043 respectively.

From the R square values of the models on Table 11, the model is not a fit because low percentage of 5.7%, 5.5%, and 4.3% for the explanation of the variation of the juvenile larceny-theft arrest rate as a function of the variation of the three steps in the model analysis for step 2, 2 and 3 respectively. However, the model also indicates that the positive correlation of the 2000 and 1999 state percentage confirmed childhood BLL and juvenile larceny-theft arrest rates are not statistically significant. For 2000 state BLL the B value is 13.33 (p = .64) and the B value of 1999 is 4.33 (p =.31).

Table 11 shows the results for the prediction of the juvenile weapon arrest rate from BLL.

Table 11

Predicting Juvenile Weapon Arrest Rate per 100,000 persons from State Percentage Childhood Confirmed BLL ≥ 10µg/dL at 95% confident interval

				95% Confident interval	
Model	B (SEB)	β	Sig.	Lower Bound	Upper Bound
Mod.1(Constant)	36.13(9.9) **		p = .001	16.09	56.17
2001 State%	4.96(4.8)	0.30	p = .31	-4.75	14.66
2000 state%	-0.83(3.15)	-0.08	p = .80	-7.20	5.55
1999 State%	1.18(0.60.25)	0.30	p = .06	-0.03	2.39
Mod 2(Constant)	36.37 (9.75) **		p < .001	16.67	56.07
2001State %	3.88 (2.47)	0.23	p = .12	-1.12	8.88
1999State%	1.17(0.59)	0.19	p = .054	-0.02	2.35
Mod 3 (constant)	46.79(7.26) ***		p < .001	32.12	61.46
1999 State%	1.37(0.58) *	0.35	p **= .02**	0.20	2.55
Mod 4 (constant)	39.16(8.39) ***		p < .001	22.21	56.11
1999-2001 mean%	3.77(1.34) **	0.40	p **= .007**	1.08	6.48

Notes: B stands for statistics coefficient b; SEB = Standard Error of B in the analysis; *** is p < .001; ** is p < .01 and * is p <.05. Sig identify the T-test significant value for the analysis: % stands for State percentage confirmed childhood BLL ≥ 10µg/dL. R square for step 1, 2, 3 and 4 are .172, .170, .119, and .163 respectively.; The underlined constant show a separate analysis.

From Table 12, the model's prediction of the weapon arrest rates from BLL is statistically significant (p =.007). For 1999 BLL the model explains 11.9% of the variation and for 1999-2001 mean state BLL the model explains 16.3% of the variation in weapon arrest rate. The first model shows that the 2000 BLL has a negative correlation to weapon arrest rate which is not statistically significant (B = -.83, p = .80).

The model predicts a statistically significant correlation between 1999 BLL and weapon arrest rate (B = 1.37, p = .05). It also predicts a significant correlation between the 1999-2001 mean BLL and weapon arrest rate (B = 3.77, p =.007). The prediction is that for every unit increase in the 1999 state percentage confirmed childhood BLL ≥ 10µg/dL, there is a 1.37 (B) unit increase in weapon arrest rate per 100,000 population. Alternatively, for one SD (4.63) increase of 1999 state percentage confirmed childhood BLL ≥ 10µg/dL, there is a 0.35 SD (.35 X 43.30) increase in weapon arrest rate (15.16, p = .02). This is true if all others things are kept constant.

In respect to the 1999-2001 mean state percentage confirmed BLL ≥ 10µg/dL the model predicts that for every unit increase 1999-2001 mean state percentage confirmed BLL ≥ 10µg/dL, there is an increase of 3.77 units of weapon arrest rate per 100,000 persons. Alternatively, for an increase of one SD(4.63) of the 1999-2001 mean state percentage confirmed BLL ≥ 10µg/dL, there is an increase of 0.4SD (.4 x 43.3 = 17.3) in weapon arrest rate.

The 2000 and 2001 BLL have a negative and a positive correlation respectively which are not statistically significant.

Table 12 shows the results for the prediction of the drug arrest rate from BLL.

Table 12

Predicting Juvenile Drug abuse Arrest Rate per 100,000 persons from State Percentage Childhood Confirmed BLL ≥ 10µg/dL at 95% confident interval

Model	B (SEB)	β	Sig.	95% Confident interval Lower Bound	Upper Bound
Mod. 1 (Constant)	358.44(41.87) ***		$p < .001$	273.68	443.20
2001 State%	**-87.64(39.79) ***	-1.29	p = **.034**	-169.18	-7.10
2000 state%	-18.01(37.12)	-0.40	p = .63	-93.16	59.13
1999 State%	-42.23(34.12)	-2.62	p = .223	-111.20	26.84
1999-2001 state mean%	130.65 (102.27)	3.44	p = .21	-76.38	337.69
Mod. 2 (constant)	**355.99 (41.14) ***		p **< .001**	272.75	439.23
2001 State %	**-74.96(29.72) ***	-1.10	p = **.016**	-136.08	-14.85
1999 State%	**-26.82(12.36) ***	-1.66	p = **.036**	-51.82	-1.81
1999-2001 mean state %	**84.24(35.86) ***	2.22	p **=.024**	11.71	156.77

Notes: B stands for statistics coefficient b; SEB= Standard Error of B in the analysis; *** is p < .001; ** is p < .01 and * is p <.05; Sig identify the T-test significant value for the analysis: % stands for State percentage confirmed childhood BLL ≥ 10µg/dL. R square for model 1 =.150 and ΔR for model 2 = .145; Mod. = model

From Table 12, Results show that 14.5% (ΔR for model 2) prediction of the variation in drug abused arrest rates is due to variation in 2001, 1999, and 1999-2001 mean state percentage confirmed childhood BLL ≥ 10µg/dL. It is predictable that for a unit increase in 2001 State % confirmed childhood BLL ≥ 10µg/dL there is a -74.96 (p = .016) decrease in drug abuse arrest rate (model 2) when other variables are constant. Also, for a unit increase in 1999 state % confirmed childhood BLL there is a 26.82 (p = .036) decrease in drug abuse arrest rate (B = -26.82). Keeping all other conditions constant. On the other hand, a unit increase in 1999-2001 mean state confirmed

childhood BLL ≥ 10µg/dL predicts a 2.22 unit increase in drug abuse arrest rate when other variables are kept constant.

A linear equation can be generated from this model thus

Drug abuse arrest rate = 355.99 -1.10SD of 2001 state% - 1.66SD of 1999 state% + 2.22 SD of mean 1999-2001(Where 355.99 is the intercept on the y-axis).

Conclusion of results for Hypothesis 1. The linear multiple regression analysis of the predictive variables 1999, 2000, and 2001 state percentage confirmed childhood BLL ≥ 10µg/dL against the various depended variables shows that

1. There is a statistically significant positive correlation between 1999 State percentage childhood confirmed BLL ≥ 10µg/dL and 2016 robbery arrest rate in 2016 (B = 2.43, $p < .001$). For a unit increase 1999 State percentage childhood confirmed BLL ≥ 10µg/dL, there is a 2.43 unit increase in Robbery arrest rate.
2. There is a statistically significant positive correlation between state mean of the years 1999-2001 percentage confirmed childhood BLL ≥ 10µg/dL and 2016 Robbery arrest rate (B = 5.79, $p < .001$). For a unit increase in mean of the 199-2001 State mean percentage confirmed childhood BLL ≥ 10µg/dL there is a 5.79 unit increase in robbery arrest rate.
3. There is a significant predictive correlation between the 1999 state percentage confirmed childhood BLL ≥ 10µg/dL and the 2016 weapon arrest rate (B = 1.37, $p = .02$). The prediction is that for a unit increase in 1999 state

percentage confirmed childhood BLL ≥ 10µg/dL; there is a 1.37 unit increase in weapon arrest rate.

4. There is a predictive positive correlation between the mean 1999-2001 state confirmed childhood BLL ≥ 10µg/dL and 2016 weapon arrest rate (B = 3.77, p = .007). The prediction is that for a unit increase in mean 1999-2001 state percentage confirmed childhood BLL ≥ 10µg/dL, there is a 3.77 unit increase in weapon arrest rate.
5. There is a significant positive correlation between 2016 drug abuse crime arrest rate and mean 1999-2001 state percentage confirmed childhood BLL ≥ 10µg/dL (B = 84.24, p = .024). For a unit increase in mean 1999-2001 state percentage confirmed childhood BLL ≥ 10µg/dL, there is an 84.24 unit increase in drug abuse crime arrest rate.
6. There is a significant negative correlation between 2016 drug abuse crime rate and 1999 state percentage confirmed childhood BLL ≥ 10µg/dL (B = -26.82, p =0.036). For unit increase in 1999 state percentage confirmed childhood BLL ≥ 10µg/dL, there is decrease of 26.82 unit of drug crime abuse rate.
7. There is also a significant predictive negative correlation between the 2016 drug abuse crime rate and 2001 state percentage confirmed childhood BLL ≥ 10µg/dL (B = -74.96, p = 0.016). For a unit increase in 2001 state percentage confirmed childhood BLL ≥ 10µg/dL, there is a decrease of 74.96 units drug abused crime rate.

Thus, it is conclusive that the various significant correlations between the predictive BLL and the various juvenile crime arrest rates rules out the null hypothesis, which states that, there is no relationship between state percentage confirmed childhood BLL ≥ 10µg/dL and juvenile crime arrest rate in the United States. Thus, the alternate hypothesis holds true that there exist a positive correlation between BLLs and adolescent violence.

Results of Research Question 2

Research Question 2 tests whether median income level by state has any bearing with the relationship that exists between state percentage confirmed childhood BLL and state adolescent crime rates. The null hypothesis denies any significant modification of the relationship between the states percentage confirmed childhood BLL and the states adolescent crime rates**.** In the model analysis the median income was introduced as an independent variable and as a product with the 2012-2016 states percentages confirmed BLL ≥ 5µg/dL. That was to test how it modifies the relationship already found between 2012 -2016 BLL and the total crime rate by state. The results of the analysis was summarize on Table 13.

Table 13

Predicting Income Modification of The Relationship Between 2016 Total Juvenile Crime Rates and 2012-2016 State's Mean Percentage Confirmed Childhood BLL ≥ 5µg/dL

Model	B (SEB)	β	Sig.	95% Confident interval	
				Lower Bound	Upper Bound
Mod.1(Constant)	-804.71(1609.1)		$p < .62$	-4151.02	2541.610

2012-2016 State% BLL	415.19(352.4)	1.69	$p = .25$	-317.73	1148.12
Median income by state	0.033(.03)	0.67	$p = .26$	-.03	.09
2012-2016 BLL*Income by state	-0.007(.006)	-1.18	$p = .25$	-0.02	.01

Notes: B stands for statistics coefficient b; SEB= Standard Error of B in the analysis; *** is $p < .001$; ** is $p < .01$ and * is $p < .05$. Sig identify the T-test significant value for the analysis: % stands for State percentage confirmed childhood BLL ≥ 5µg/dL. R square for model = .064.

Looking at the product of the 2012-2016 BLL ≥ 5µg/dL and income by the state on table y, findings suggested that income did not show a statistically significant modification of the relationship that existed between 2012 state percentage confirmed BLL ≥ 5µg/dL and the total juvenile crime rate (B = -.007, p = .25). I decided to use the centered variables of the independent variables to check these findings. That was because the correlation that existed between 2012-2016 State% BLL and the product of the 2012-2016 BL and income by the state was too high (r = .93). Table 14 summarized the linear regression analysis using the centered independent variables and their produce to check for the modification of the relationship found.

Table 14

Predicting of The Income Modification Of The Relationship Between 2016 Total Juvenile Crime Rates and 2012-2016 State's Mean Percentage Confirmed Childhood BLL ≥ 5µg/Dl Using Centered Independent Variables.

				95% Confident interval
Model	B (SEB)	β	Sig.	

				Lower Bound	Upper Bound
Mod.1(Constant)	1086.06(100.1)***		$p < .001$	877.88	1294.25
2012-2016 State% BLL centered	-17.01(54.8)	-0.07	P = .75	-130.885	96.87
Income by state centered	0.001(.01)	0.03	P = .90	-.02	.02
2012-2016 BLL*Income by state centered	-0.007(.001)	-0.26	P = .25	-0.02	.01

Notes: B stands for statistics coefficient b; SEB= Standard Error of B in the analysis; *** is p < .001; ** is p < .01 and * is p <.05. Sig identify the T-test significant value for the analysis: % stands for State percentage confirmed childhood BLL ≥ 5µg/dL. R square for model = .o64.

From Table 14, there is a negative interaction between median state income and 2012-2016 state's mean percentage confirmed childhood BLL ≥ 5µg/dL using the centered values for the independent variables. But the state's income did not show a statically significant modification of the relationship that exists between 2016 crime rates and the average percentage confirmed BLL ≥ 5µg/d (B = -.007, p = .25).

I decided to use a scatter plot graph to find out whether it will provide any inside on the result of the linear regression obtained above. Figure x, shows the scatter plot obtained from the graph analysis.

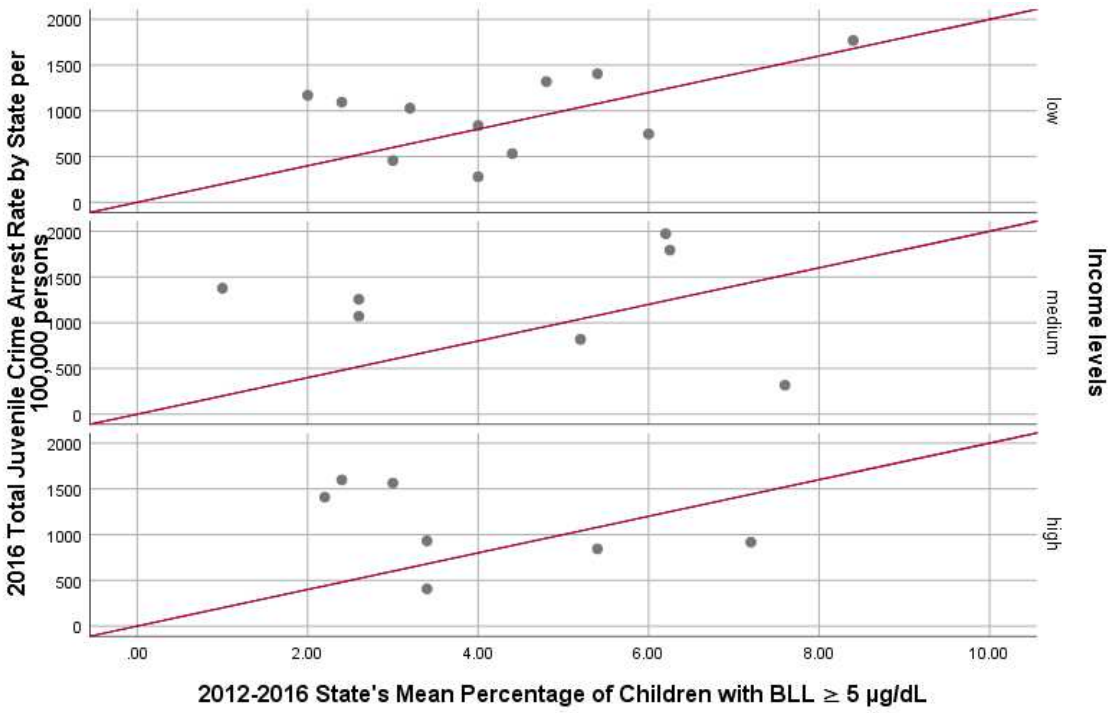


Figure 7. Scatter plot of income modification of the relationship that exists between 2016 total juvenile crime rates and 2012-2016 state's mean percentage of childhood BLL ≥ 5 µg/dL.

Figure x showed that the 2012-2016 state's mean percentage confirmed childhood BLL ≥ 5µg/dL has a positive correlation with the 2016 total juvenile crime arrest rate in the United States. Meanwhile, median income by the state has a negative association with the 2016 overall teenage crime arrest rate. That is, a state with a high income had low childhood blood lead levels, and a state with a low income had high BLL. However, the parallel lines showed how the total juvenile arrest rates correlate with 2012 -2016 state's mean percentage childhood BLL ≥ 5 µg/dL at the different income levels (low, medium, and high). Such findings indicated that income does not modify the correlation between BLL and arrest rates. The slop of the lines could have changed if such modification existed.

Conclusion on the analysis of research question 2. There is a positive correlation between 20012-2016 BLL and 2016 crime rates and a negative relationship between the 2016 income by state and 2016 state crime rates in the United States. However, both linear regression findings and the graphical method demonstrated no statistically significant modification of the relationship that exists between 20012-2016 state percentage BLL ≥ 5 µg/dL and the state crime rates in the United States. Thus, holding true the null hypothesis of research question 2, that income does not modify the existing relationship between 2012-2016 state mean percentages confirmed BLL ≥ 5 and total state crime rate in the United States of America.

Further Analysis

Further analysis looked at 2016 crime rate in the United States and percentage confirmed childhood BLL for the years 2012-2016. In this analysis only 26 states were included because of the lack of childhood BLL for the rest of the states. This lack of data was attributed to lack of funding for the surveillance childhood blood BLL program. The results of this analysis are summarized in the following table.

Table 15

Predicting 2016 Crime Arrest Rate From 2012 To 20016 State Mean Percentage Childhood Confirmed BLL ≥ 5µg/dL At 95% Confident Interval

				95% Confident interval	
Model	B (SEB)	β	Sig.	Lower Bound	Upper Bound
Mod. 1 (Constant)	1207.81(221.75)***		$p < .001$	746.66	1666.96
2012-20016 Mean State%	35.17(15.43)*	0.4	$p = .033$	1.223.09	67.67
2012 State%	79.89(36.30)*	0.58	$p = .039$	4.40	155.39

2014 State%	-198.54(77.45)*	-.68	$p = .018$	-359.60	-37.48

Notes: B stands for statistics coefficient b; SEB = Standard Error of B in the analysis; *** is $p < .001$; ** is $p < .01$ and * is $p < .05$. Sig identify the T-test significant value for the analysis: % stands for State percentage confirmed childhood BLL ≥ 10µg/dL. The R square in this model is .355.

Table 15 shows from the R square value that the data fits well in the model, indicating that 35.5% of the variation in states' juvenile arrest rate is predictable from the variation of the 2012 to 20016 state mean percentage childhood confirmed BLL ≥ 5µg/dL. The model indicates that for every unit increase in 2012- 2016 states mean percentage confirmed childhood BLL ≥ 5µg/dL there is a 35.17 unit increase in the total juvenile crime arrest rate per 100,000 persons. Alternatively, for every one standard deviation (5.41 µg/dL) increase in the 2012 -2016 state mean percentage confirmed childhood BLL ≥ 5µg/dL, there is an increase of 0.4 x 475.6 (190.24) in total crime arrest rate in the country. This result affirms the invalidation of the null hypothesis that there is no relationship between states percentage confirmed childhood BLL ≥ 5µg/dL and states juvenile crime rate in the nation. Holding true the existence of a significant positive correlation between childhood BLL ≥ 5µg/dL and adolescent violence in the United States.

Summary

This present study is an ecologic cross sectional study that was seeks to determine whether there was any relationship between states crime rate in 2016 and percentage confirmed childhood BLL ≥ 10µg/dL before 2012 or ≥ 5µg/dL after 2012. It therefore looked at the crime rates in 2016 as the dependent variable against the state percentage confirmed childhood BLL ≥ 10µg/dL for the childhood years 1999 to 2005. For further analysis, the project proceeded to assess the relationship between 2016 state crime rate

and the state percentage confirmed childhood BLL ≥ 5µg/dL for the 2012 to 2016 years. It also assessed whether the existing relationship between state percentages confirmed childhood BLL ≥ 10µg/dL from 1999 to 2005 and state crime rate in 2016 has any correlation with the states' median income. The test statistic in the analysis was multiple linear regression using the step wise backward eliminatory method that depended of the SPSS program for its functionality.

The results predicted a statistically significant positive correlation between 1999 State percentage childhood confirmed BLL ≥ 10µg/dL and robbery arrest rate in 2016 (B = 2.43, $p < .001$). Implying that for a unit increase in 1999 state percentage childhood confirmed BLL ≥ 10µg/dL, there is a 2.43 unit increase in robbery arrest rate. There was a statistically significant positive correlation between state mean 1999-2001 percentage confirmed childhood BLL ≥ 10µg/dL and robbery arrest rate (B = 5.79, $p < .001$). Also, the result predicted a positive correlation between the 1999 state percentage confirmed childhood BLL ≥ 10µg/dL and weapon arrest rate (B = 1.37, $p = .02$). It further predicted a positive correlation between states mean 1999-2001 childhood confirmed BLL ≥ 10µg/dL and weapon arrest rate (B = 3.77, $p = .007$). There was a similar prediction between states mean1999-2001 childhood confirmed BLL ≥ 10µg/dL and 2016 drug abuse crime rate. Thus, the null hypothesis which states that there is no relationship between states percentage confirmed childhood BLL ≥ 10µg/dL and crime rate in the United State was nullified. The first hypothesis then holds true that there exist relationships between the states percentage confirmed childhood BLL ≥ 10µg/dL and crime rate in the United States.

The results also demonstrated a statistically significant relationship between 2016 states total crime arrest rate and the states mean 2012 to 2016 percentage confirmed childhood BLL ≥ 5µg/dL. This result further confirms the invalidation of the first null hypothesis and accepting the alterative hypothesis. However, the analysis retained the null hypothesis in the second research question, holding true that there is no effect of income on the relationship between states percentage confirmed childhood BLL ≥ 10µg/dL before 2012 or ≥ 5µg/dL after 2012 and crime rate in the United States. The chapter that follows (chapter 5) will include important details in the interpretation of these findings. It will include a discussion on the limitations and implication of the findings as well as further recommendations for future studies.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

Juvenile violent crime rates in the United States have been on a continuous decline since 1996 (OJJDP, 2018). Despite this decrease, youth violence continues to be a public health issue in the United States (Salas-Wright et al., 2017). The OJJDP (2018) noted that more than 809,700 juveniles were arrested in 2017. Researchers have linked externalization behavior in children to factors that include genetics (Longman et al., 2016), media exposure (Plante &Craig, 2015), school environment (Bao et al., 2015), child abuse (Voith et al., 2016), and gender differences (Wong et al., 2016). However, very few researchers have examine the relationship between lead exposure and adolescent violence and suggested need for further research to elucidate this fact (Mielke et al., 2012; Rauh et al., 2016; Reyes, 2015; Taylor et al., 2016). The purpose of this ecologic, cross-sectional study was to identify whether there is a relationship between early childhood BLLs (≥ 10µg/dL before 2012 or ≥ 5µg/dL after 2012) and crime arrest rates in U.S. states. I examined existing data on youth violence and BLL from the FBI and the CDC, respectively for my secondary data analysis. The independent variable was the states' confirmed childhood BLL (≥ 10µg/dL before 2012 or ≥ 5µg/dL after 2012). The dependent variable was the state crime arrest rate per 100,000 population. I performed bivariate correlation and multiple linear regression using the backward method to analyze data.

The results indicated a significant positive correlation between state-level percentages of confirmed childhood BLL ≥ 10µg/dL from 1999 to 2001 and state-level

robbery, weapon, and drug abuse arrest rates in 2016. Further analysis indicated that the total state crime rate per 100,000 population has a significant positive correlation to the mean 2012-2016 state percentage of confirmed childhood BLL ≥ 5µg/dL (B = 35.17, p = 0.03). Understanding the relationship between childhood BLL and subsequent violence in adolescents may help public health professionals to make informed decisions on how to efficiently address higher BLL in childhood. These findings may also prompt public health and medical care providers to develop targeted interventions to further alleviate the effects of lead contamination in children. In this chapter, I will provide an in-depth interpretation of the results of this study. I will also discuss the limitations of the study, offer recommendations for future studies and practice, consider the implications of this research, and provide a conclusion to the study.

Interpretation of Findings

I designed this ecologic cross-sectional study to clarify the relationship between states' juvenile crime rates and state percentages of confirmed childhood BLLs above the action level established by the CDC. I used existing data compiled by the OJJDP for state crime rates. Data collected by the CDC for the state percentage of confirmed childhood BLL (≥ 10µg/dL before 2012 and ≥ 5µg/dL after 2012) were also useful. I sought to trace the relationship between high BLL in children and the crime rate for adolescents at the state level. The design was intended to show the correlation, if any, between state crime rate and BLL above the stipulated standard by CDC.

I made use of the backward eliminatory method of multiple linear regression for the analysis. The results showed a highly significant positive correlation between the

states' percentage of confirmed BLL ≥ 10µg/dL for the years 1999 to 2001 and the states' robbery arrest rates. During this period, the state BLL also had a significant positive correlation with drugs and weapon arrest rates. The state average percentage of confirmed childhood BLL ≥ 10µg/dL for 1999 -2001 was near statistical significance with the 2016 total crime rate in the United States (B = 34.34, p = .06).

Furthermore, the test statistic predicted a robust positive correlation between the states' total crime rate and the states' average percentage of confirmed childhood BLL ≥ 5µg/dL from 2012 to 2016 (B = 35.17, p = 0.03). Answering the second research question required determining whether there was any interference of the state income level in the relationship established between state crime rates and state percentage of confirmed childhood BLL higher the stipulated value by CDC for action. The test statistic did not predict any significant interference of the state's median income level with the relationship established between states' crime rate and state percentage of confirmed childhood BLL above the average level. The summary nature of the data might have some influence in the results so obtained.

The association between environmental lead toxicity and behavioral issues was established as far back as 1943 when 19 out of 20 children treated for lead poisoning later developed aggressive behavior (Byers & Lord, as cited by Marcus et al., 2010). Even though scientists did not react to this finding to establish the causality, it was at least documented. However, in the late 1960s, scientists decided to take a preventive approach when lead toxicity became a societal issue, killing children and causing stillbirth, anemia, and lead encephalopathy among other adverse outcomes (Hernberg, 2000). Researchers

developed newer methods to detect toxic lead levels in the blood a limit of 60µg/dL as the poisonous lead level in the blood beyond which action was needed to detoxify or treat lead toxicity in children (U.S Agency of Toxic Substances and Disease Registry [ATSDR], 2019). This level was brought down to 40µg/dL in 1973 when it was perceived that the even lower level below 60µg/dL still led to toxicity (U.S. ATSDR, 2019). In 1975 the CDC brought down the nontoxic BLL standard to 30µg/dL and then to 25 µg/dL in 1985 (U.S. ATSDR, 2019).

Deliberations between the World Health Organization, the CDC, and the Environmental Protection Agency in 1986 led to the establishment of a safe limit for blood lead level at 15µg/dL (Hernberg, 2000). The CDC, later in 1991, re-established a safe blood limit for lead at 10µg/dL (CDC, 1994). In 2006, the National Institutes of Health (NIH) further identified the need to bring down the levels to 2µg/dL (NIH, 2006). However, the CDC was only able to bring down the toxic BLL to5µg/dL in 2012 (CDC, 2012). Even lower nontoxic levels of lead toxicity according to this standard have been found to cause behavioral problems in children (CDC, 2012; Huang et al., 2016). Hernberg (2000) pointed out that lead does not have any essential part to play in the human system, and, as such, the standard for safe BLL could be brought down as low as possible.

Continuous research in lead toxicity led to the gradual decrease in the level of BLL considered to be toxic. Marcus, Fulton, and Clarke (2010) noted in a landmark study that children with lead toxicity have a decrease in brain volume. Further findings by Li et al. (2016) provide evidence that early childhood lead exposure results in sex-dependent

and gene-specific DNA methylation differences in the peripheral blood of adult victims. This idea led to the postulation that the decrease in the brain volume of children with lead poisoning was caused by DNA methylation in the brain. Cai and Calisi (2016) identified that lead toxicity is one of the human-induced rapid environmental changes that can cause neurodevelopmental disorders (Cai & Calisi, 2016). In a recent study in Canada, Taylor, Forbes, Opeskin, Parr, and Lanphear (2016) identified a significant positive relationship between childhood lead exposure and subsequent rates of aggressive behavior.

Despite these associations between lead toxicity and sociobehavioral problems, there is a need to incorporate dimensional approaches including longitudinal studies on neurotoxic exposures for a better assessment (Rauh & Margolis, 2016; Taylor et al., 2016). This study engages with the existing research findings on lead toxicity and behavioral problems. The results show a robust positive correlation between states with a higher percentage of childhood BLL above the stipulated value by the CDC and higher crime rates. This association is not causal but may have more practical significance considering that data for the study covers a broader population of the United States. I hope that the results of this study will act as a catalyst to stimulate further studies in the field towards the eradication of lead poisoning in children. Study findings may also support the CDC taking action to further reduce safe limits of BLL in children to 2µg/dL, as recommended by the NIH in 2016.

The study points out that lead toxicity may be behind higher crime rates in certain parts of the country. That is supported by the data fit in the model of the test statistic

indicating that 35.5% of the variation of state crime rates is due to the difference in percentage confirmed childhood BLL ≥ 5µg/dL. It entails that any action taken by the government toward a reduction in lead toxicity in children may indirectly be reducing crime rate in the community. The juvenile crime rate is a burden to society both morally and financially. In this wise, a community diagnosis of higher crime rate should not fail to assess environmental lead toxicity in the community. For example, a community like the Dallas community in Texas with a crime rate of about 1.5 times the average crime rate in the United States (City of Dallas, 2016), may require a lead toxicity community diagnosis to rule out lead toxicity as part of the problem. That is true, according to Luglio et al. (2018), who identified that accurate results obtained from a construct also supports significant correlations with a variety of measures that are theoretically related. The linkage of BLL and crime rate supports actions by public health practitioners in making informed decisions on how to help youths identified with antisocial behavior. Thus, the result will have both national and international implications.

The study did not show any meaningful interference of the state median income on the robust correlation that existed between high BLL at the state level and the state crime rate. That might be true because the statistical coefficient B was too low 00.003 (p = .65). The non-significant effect of income on the correlation between childhood lead levels and crime rate may be due to the summary nature of the data. However, practical influence may be present at the local community level but not at the state level.

Interpretation of Results Based on the Theoretical Foundation

The theoretical foundation of this study was the ecosocial theory founded by Krieger in 1994. This theory seeks to explain the inequality in the distribution of disease and health in the population by integrating social and biological reasoning, alongside the dynamic of history and ecology of the environment (Krieger, 1994). Chronic disease such as lead poisoning has a vivid interaction occurring between people, society, and the ecosystem. This theory uses the web of causation model to explain how the agent, host, and environment interact in multifactorial ways to lead to the distribution of the disease in the population. In this study, lead is the agent, and humans are the host. For a person to have lead poisoning, he or she will come in contact with the agent, and the social and physical environment must play a part to permit progression of the lead contamination to a disease condition and or complications.

The result of the study indicates a correlation between states with a higher percentage of childhood BLL $\geq 5\mu g/dL$ having a higher rate of crim. This relationship cannot have a direct explanation, as there are many stages to pass through to explain how this correlation is possible. The dependent variable in this dissertation is the adolescent violence crime rate, with a disproportionate distribution among the various racial groups in the population. In 2016, the juvenile arrest rates among the diverse ethnic groups included 5,142.5 per 100,000 for non-Hispanic African Americans, 3,783.7 per 100,000 for Hispanic white, and 1,980.9 for non-Hispanic Whites. However, the population distribution shows non-Hispanic Whites 60.4%, Hispanic white 16.1%, and African Americans 13.4% (Census Bureau, 2018). The Ecosocial theory, which uses multifaceted

factors in the explanation of the distribution of the disease is capable of explaining this unequal distribution of the crime rate in the country. Juvenile violence has a multifactorial origin including genetic (Longman, Hawes, & Kohlhoff, 2016); gender (Bogart et al., 2013); media (Plante and Craig, 2015); and School environment (Bao, Li, Zhang, Wang, 2015). Child abuse can also lead to aggressive behavior leading to violence (Voith et al., 2016). The identification and treatment of a disease with a multifactorial origin and an unequal distribution in the population groups needs a modern theory like the Ecosocial theory to elucidate its multifaceted aspects (Krieger, 1994; Krieger, 2017; Kirkengen et al., 2016). Each element of the theory plays a rule in the development of antisocial behavior in individuals, as well as the distribution of aggressive behavior in the community.

The independent variable is the state percentage confirmed childhood BLL ≥ 5µg/dL, which depends on childhood lead contamination and toxicity. The various degrees of toxicity depend on the childhood exposure sources and degree of contamination that varies according to the type of environment with social factors playing a part. Children might be exposed to lead because they live in houses built before 1978 that still have lead paint (CDC, 2014). Some children may be exposed to lead through drinking lead-contaminated water from lead pipes (Kennedy, 2014). Other children may have been affected because parents had occupational exposure to lead during pregnancy or parents bring home leads on their clothing (La-Llave-León et al., 2016). Children may be living in lead dust environment or merely living in an urban area with high lead levels in the air (Carrel et al., 2017). These different means of lead contamination affects

different communities in a varied way. Even after exposure, the lead toxicity acts differently in different individuals because of genetic factors. For example, two children may have the same exposure, but one will survive while the other dies from the toxicity. Thus, lead exposure in children has a multifaceted origin and has an unequal distribution among population groups which may equally include social factors. Philips, as cited by Philips et al. (2013), noted that the Ecosocial theory values the perspectives of all stakeholders in the community. Most chronic diseases have a vivid interaction that occurs between people, society, and the ecosystem. Decision making in a nation that favors particular groups of people may eventually lead to an unequal distribution of specific diseases in society. Krieger (2014), using the Ecosocial theory, demonstrated that there is robust and consistent evidence linking discrimination and health outcome distribution in a population. The Ecosocial theory is, therefore, a good base in the explanation of the causal mechanisms between the prevalence of juvenile violence and BLL in the United States. Krieger, 2012 identified that for population sciences to broaden knowledge on whom and what makes population and means, it is necessary to clarify causal inference and actions in the promotion of health equity in the society.

Limitations of the Study

The study was designed to use existing data from three distinct federal departments. The summary data for the surveillance BLL for children born from 1999 to 2006 was to come from the Center for Disease Control and Prevention, compiled in collaboration with the National Health and Nutrition Examination Survey (NHANES). However, the data for the surveillance of childhood BLL was only available for the years

1999 to 2001. This limitation of data availability may also affect the result of the study. In this wise, seven states did not have blood lead level data, which led to their exclusion from the study. That further jeopardized the generalization of the results of the research to the entire country to include those states.

The project is an ecologic cross-sectional study which is limited in interpretation. Like most cross-sectional studies, it has a limit to provide a correlation between variables rather than cause and effect analysis.

Data for the state arrest rates comes from the database of the Federal Bureau of Investigation, particularly the Office of Juvenile Justice and Delinquency prevention. The Census Bureau, on the other hand, provided data for income level for the various states in the country as well and the population distribution in the country. The scope of this study is limited by the data available from these institutions. The validity of the results depends on the efficient methods of data collection techniques. Considering that the government is directly involved in the collection and summarization of data in all three databases, their data collection methods are acceptable and valid for this project. There is no guarantee that the modality of data collection was rigorous and similar in all the various states.

The project included 43 of the 50 states in the United States of America and data collection for BLL included children born from 1999 to 2001. The involvement of more than three quarters of the country in the data analysis confers internal validity to the studied population and other similar populations. However, it may not command generalizability to other communities. Not all children from the various states provided

blood for surveillance lead level, and not all states may follow the necessary protocol of monitoring childhood BLL.

In the analysis of the 2012- 2016 BLL, missing data was a problem. Data for childhood BLL was not available for 24 of the 50 states. Considering the deletion of cases due to the lack of data, that led to a reduction in the sample size and the statistical power of the study (Ellis, 2015). Data analysis with more than 5% missing data may not be valid for the said population (Morrow, 2016). The multiple imputation method in the Statistical Package of the Social Sciences program was useful in dealing with the missing data.

Ethical guidelines are of scientific validity, respect for participants, and respect to the vulnerable population (Bernabe et al., 2016). All data in this project did not contain identifiable information, and therefore, consent acquisition was not a limitation. Another limitation of this project is the lack of the differentiation data into male and females. Thus, data was not analyzable based on gender.

Recommendations

Recommendations for Research

The result of the ecologic cross-sectional study shows a statistically significant correlation between states percentage confirmed childhood BLL ≥ 5µg/dL and state adolescent crime rate. There is a need for other studies, such as longitudinal studies to establish this association with a causal relationship.

The findings in this study associate states with higher childhood BLL to higher crime rates. These findings suggest that in a state with a high adolescent crime rate, there

is a need for a community diagnosis for lead toxicity, to rule out childhood lead toxicity as a possible cause.

The result urges health care practitioners to always have blood lead toxicity at the back of their minds when evaluation juvenile with antisocial behavior. Children might have had high BLL in the blood during childhood as the cause of antisocial behavior.

The results of this study call for further research to foster the recommendations of the National Institute of Health (NIH) in 2006. The NIH identified the need to reduce the safe limit of childhood blood lead level to 2µg/dL to avoid lead toxicity in children (NIH, 2006). Hernberge (2000) recommended that the safe limit of lead in the blood should be brought down to zero µg/dL, since lead itself does not have an essential function in the human system. Furthermore, lead toxicity affects nearly every functioning system in the human body (NIH, 2015).

I will suggest further research towards the application of the findings of this project in the assessment of juveniles with antisocial behavior. It is not just good enough to say that health care practitioners should include BLL test in the management of children with antisocial behavior. Specific protocols must be met for the implementation to be effective. The development of such modalities must be through research findings.

It is, therefore, necessary that the CDC should continue the funding for the childhood lead surveillance program. The reason is that 25 states did not have childhood surveillance data because of the lack of funds to continue with the program. There cannot be any effective monitoring of lead level in children if funding is not available to boost the running of the program.

The advice to foreign countries is to set up a surveillance program to monitor blood lead levels in children who are less than 72 months. That may help in childhood lead surveillance as well as community diagnosis of environmental lead toxicity.

The public health professionals should not relent any effort in sensitizing the public on the ill effect of lead poisoning in our community.

Recommendations for Practice

The result of this study is significant in community diagnosis of lead toxicity in children. In a community where antisocial problems in youths are prominent, there will be a need to conduct a childhood lead poisoning community diagnosis to know whether lead poisoning is at the background of the problem.

I will recommend that the Center for Disease Control and Prevention should consider reducing the safe limit of childhood blood lead level to 2µg/dL as advocated by the NIH in 2006. This is to avoid the neurodegenerative effect lead has in growing children that propagates antisocial behavior.

Health care practitioners, during the evaluation of a child with antisocial behavior, should think of lead contamination as a possible cause of the problem.

I will advocate for the practical reinforcement of lead laws as well as the reinforcement of OSHA safety procedures to prevent occupational lead poisoning.

Implications

Positive Social Change Implications

The results of this current study are insightful and I strongly believe they will have empirical and practical application toward a positive social change in our society.

The positive social change will prevail across all societal level including individual and family, organization and at policy level. This study broadens understanding on how a single agent in our environment can be associated with a tremendous burden in our society that drains us both financially and morally. The linkage of lead in our environment to crime rates in the entire country shows the destructive nature of the agent to organisms.

In this section the positive social change implications of the study will be discussed at several societal levels including individual and family, organizational, and government or policy levels. The section will also dwell on the empirical and practical application of the research findings.

Individual and family-level implications. Families need continuous education on the destructive nature of lead and how child lead contamination and lead poisoning occurs. Lead poisoning in children can occur through their interaction with things like lead paint in houses built before 1978 (Hwan-Cheol et al. 2015), toys, lead batteries, and lead dust in the environment. Individuals working in lead industries like the car battery industry should be aware of the need for protection from occupational lead poisoning. Thus, lead poisoning is not only limited to children but it also affects adults.

Organizational-level implications. Organizations need information on lead poisoning and how to prevent lead poisoning in their environment. The industries that use lead material in their workplace must follow the Occupational Safety and Health Administration (OSHA) guidelines to protect their workers from occupational lead poisoning. Workers in lead factories should also be aware that childhood lead poisoning

can occur from factory clothing brought into their houses (Gebrie, Tessema & Ambelu, 2017).

Societal- or policy-level implications. Korfmacker and Hantey (2013) noted that lead laws had a tremendous impact on the reduction of childhood lead poisoning. I will advocate for the reinforcement of these laws and the creation of new laws that will match the advancement in technology to allow the use of lead. The result indicates that reducing lead poisoning reduces crime as well as deaths from depression as a result of antisocial behavior (Poirier et al., 2016). Policies that allow equitable distribution of resources in the community could prevent the unequal distribution of certain disease states in the community

Methodological, Theoretical, and Empirical Implications

This study is an ecologic cross-sectional study using existing data for secondary data analysis to find the relationship between state percentages confirmed childhood BLL and state crime rates in the country**.** The study applies the Ecosocial model to direct and explain findings. The model advances that the health of a population is an interaction between many factors in the community and its ecological environment, which are different in different localities (Krieger, 2012). It embraces the Biomedical model and Social-Ecological model. It is broader to explain how a single agent, lead, will interact with genetics, as well as social and ecological environment to bring about inequity in the distribution of the crime rate in the society. The result shows a strong significant correlation between state crime rate and state percentage confirmed BLL higher than average recommended by the CDC. This result increases the knowledge-base in the field

since findings from a properly designed study can never be negligible. However, practitioners and policymakers will find this information very useful in program design and implementation to bring about positive changes in society.

Conclusion

I conducted an ecologic cross-sectional study using existing data for secondary data analysis to examine the relationship between states juvenile crime rate and states percentage confirmed childhood BLL higher than the average recommended value. It also examined whether the states' median income has any modification of the relationship between the prevalence of state juvenile crime rate and states percentage confirmed childhood BLL greater than the recommended value by CDC. Data for the childhood BLL was extracted from the CDC website. Meanwhile, data for the states juvenile crime rates were obtainable from the Office of Juvenile Justice and Delinquency Prevention website. The website of the Census Bureau provided data for the states median income. All data was open to the public and did not require any formal request for use. The study used the Ecosocial theory to direct the methodology and to explain the findings. The basis of the use of the Ecosocial theory was because of the inequality in the distribution of crime rates among the various ethnics groups in the country. The data was analyzed using the backward method for multiple linear regression in the Statistical Package for Social Sciences (SPSS).

The result identified a strong positive correlation between 2012 to 2016 states mean percentage confirmed childhood BLL $\geq 5\mu g/dL$ and 2016 states total juvenile crime rate ($B = 35.17$, $p = .03$). The results entail that for every unit increase in the average

of 2012-2016 state percentage confirmed childhood BLL ≥ 5µg/dL, there is an increase of 35.17 units per 100,000 total state juvenile crime rates in 2016. The result identified a significant positive correlation between states percentage confirmed childhood BLL ≥ 10µg/dL from 1999 to 2001 and robbery, weapon, and drug abuse rates in 2016. There was no interference of the state median income in the modification of this relationship. The results provide a knowledge-base, which can be useful in decision making to foster positive social change in the country. On the other hand, these findings will prompt public health and medical care providers to develop targeted interventions to alleviate the effect of lead contamination in children further.

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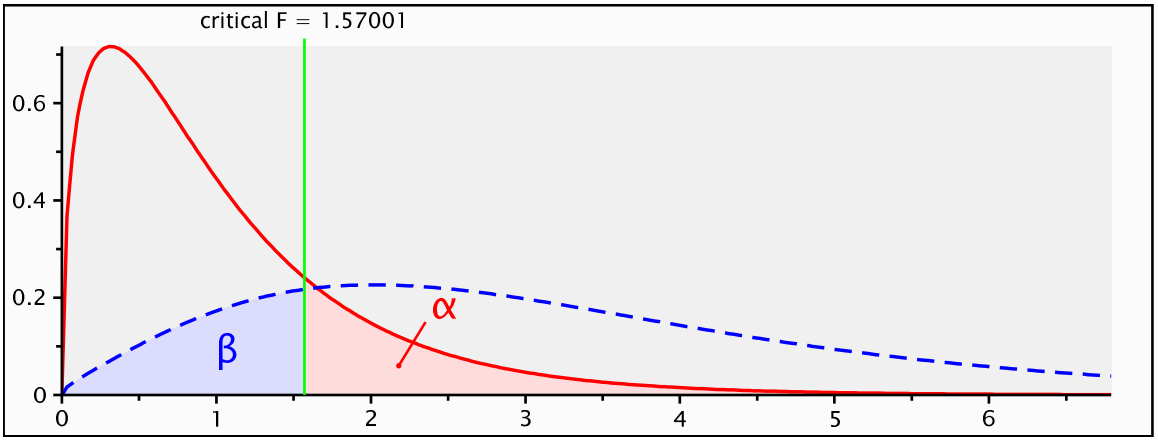
Appendix A: G*Power Analysis for the Test Statistic Linear Multiple Regression



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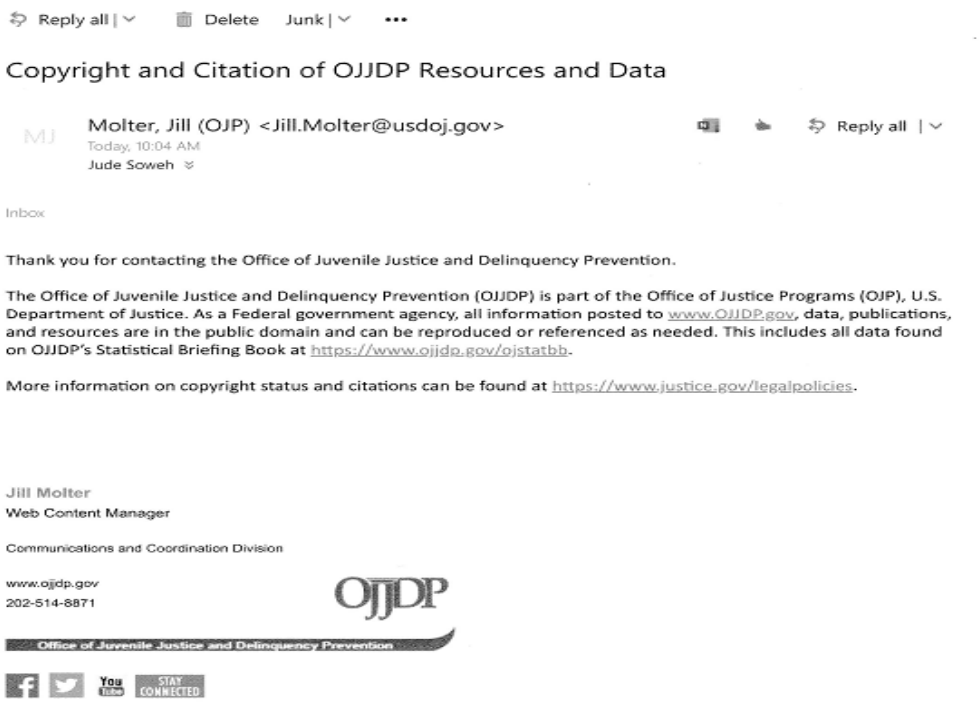

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