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Marijuana Legalization and Traffic Fatalities Involving Cannabinoids

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Abstract

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MA, Kaplan University, 2013

BS, Marylhurst University, 2003

Dissertation Submitted in Partial Fulfillment

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Abstract

Washington State and Colorado were the first states to legalize recreational marijuana. According to the Washington Traffic Safety Commission, the number of drivers who tested positive for marijuana in traffic fatalities increased 48% from 2013 to 2014, and marijuana legalization may have influenced this increase. Since marijuana legalization is new to the United States, the effects of this change in policy are untested in the literature. The purpose of this quantitative study using a regression point displacement design was to examine the relationship between traffic fatalities involving cannabinoids in Washington State before and after marijuana legalization. Rational choice theory and perceptual deterrence theory provided the framework for the study. Existing state level data of traffic fatalities from the National Highway Traffic Safety Administration's Fatality Analysis Reporting System were analyzed using regression point displacement. Pre and post legalization Washington state fatalities were compared against 43 control groups where marijuana has not been legalized for recreational use. Results from ANCOVA analysis indicated no statistical difference between Washington State and other nonlegalized states in traffic fatalities involving cannabinoids. This is one of the first studies exploring the effects of marijuana legalization on public safety. These results suggest marijuana legalization may not contribute to the increase in traffic fatalities. Findings may provide legislators and traffic safety stakeholders with information in creating legislation legalizing marijuana as well as strategy and a research agenda to address traffic fatalities.

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Dedication

I wish to dedicate this dissertation to my loving wife, Ginger, and to my darling daughter, Stephanie. You provided unselfish support when I worked on this research study through birthdays, anniversaries, holidays, and special gatherings over the course of several years. Your unwavering support and taking on extra tasks to assist me did not go unnoticed. Your support and encouragement helped me work above and beyond my duties within a law enforcement capacity and still come home and work on completing this dissertation. For my daughter, Stephanie, I hope the completion of this dissertation encourages you to reach for the stars for when you put your mind to something, you can complete anything. I encourage you to reach for the stars and attain your goals regardless of the distance or the struggle. One might say this dissertation completes my educational goals, but I only see this as the beginning of a new path for me and for us as a family. I also wish to thank my father; Dad, without your support this dissertation would not have been accomplished. I am a first generation in our family to complete this process, and without your help I could not have accomplished this dissertation. I also wish to say thank you to my father and mother-in-law, Steve and Sue; thank you for your support in furthering my education.

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Chapter 1: Introduction to the Study

In 1906 the United States passed legislation creating the Federal Foods and Drugs Act to control and prevent, "the manufacture, sale, or transportation of adulterated or misbranded or poisonous or deleterious foods, drugs, medicines, and liquors, and for regulating traffic therein, and for other purposes" (U.S. House of Representatives, para. 1, n.d.). According to the U.S. Drug Enforcement Agency, 2003, this piece of legislation was originally designed to address deplorable standards in the meat packaging industry, but the legislation also laid the foundation for legislators to enact additional laws to regulate and control a number of narcotics and address criminal drug activity such as the manufacture, sale, and possession of controlled substances. The largely unregulated drug trade in the United States quickly led to the Narcotics Act of 1914, commonly known as the Harrison Act, which implemented misdemeanor criminal penalties for illegal possession of drugs (U.S. Drug Enforcement Agency, 2003). In 1968, President Johnson asked Congress to pass tougher laws, and a comprehensive regulatory agency was created to ensure enforcement of these new laws (U.S. Drug Enforcement Agency, 2003).

President Johnson's call for action subsequently led to the enactment of the Controlled Substances Act (CSA) as part of Nixon's Comprehensive Drug Abuse Prevention and Control Act of 1970. This sweeping regulation classified drugs, their substances, and the chemicals used to make them into five distinct schedules based on their potential for abuse, whether there was a currently accepted medical use in the United States, and a lack of accepted safety for use leading to psychological and physical dependence. With this act, President Nixon declared in a nationally televised speech the

federal government's war on drugs (Thompson, 2014). Since 1970, the federal government's attempt to stem marijuana cultivation, black market sales, and drug use has shifted as society's tolerance and acceptance of marijuana has grown.

Society has grappled with policy decisions to address marijuana use in the United States. Damrongplasit and Cheng (2009) noted that marijuana policies have attempted to address two specific goals, namely substance abuse from a health and safety standpoint and societal costs. However, these goals appear to be at odds with each other. The policy was consistent with Nixon's war on drugs, through vigorous enforcement of marijuana laws and the creation of mandatory sentencing through the judicial system. However, the societal costs through aggressive enforcement of marijuana laws and mandatory sentencing have led to prison overcrowding, and advocates of decriminalization have characterized this drug policy as failed. Proponents of decriminalization have posited that shifting public policy from criminal charges to civil penalties will alleviate costs and demands on law enforcement, including the judicial and prison system (Damrongplasit & Cheng, 2009).

Suggs (1981) stated that as early as 1969, the State of Nebraska opted to move to decriminalization, making possession of one pound of marijuana a misdemeanor with a fine of not more than $500 and/or a sentence of up to 7 days in jail. This shift from a felony level crime to a misdemeanor was consistent with the argument that a felony conviction was too great. Suggs noted that in 1978, legislators made marijuana possession of less than one ounce a civil penalty for the first offense and a misdemeanor for additional offenses. This early research suggested decriminalizing marijuana would

not lead to an increase in marijuana use in the short term and would create significant savings resulting from fewer individuals being processed through the court system (Suggs, 1981). Decriminalization did not legalize marijuana possession and use but instead made them civil infractions.

Although advocates in Nebraska argued that decriminalization would result in significant fiscal savings, they failed to examine the impact of marijuana use on society through criminal acts such as driving under the influence (DUI). The State of California took a different approach by maintaining criminal penalties and mandatory sentencing guidelines, yet opted to legalize medical marijuana through the Compassionate Use Act of 1996 (California Department of Public Health, 2016). The California Department of Public Health (2016) noted this legislation approved medicinal marijuana prescription by a physician for severe medical conditions and allowed patients to possess up to 8 ounces of dried marijuana or to cultivate six mature and 12 immature plants. Ryan-Ibarra, Induni, and Ewing (2015) found that marijuana use for medicinal purposes aided patients, but their research was limited through self-reporting. Additionally, their findings suggested potential abuse of medicinal marijuana by those with no true medical conditions (Ryan-Ibarra et al., 2015). Pollini, Romano, Johnson, and Lacey (2015) found an increase in drugged driving and marijuana impaired traffic fatalities. The approach taken in Nebraska, California, and other states to decriminalize marijuana for personal possession or medical use has placed these states at legal odds with the federal government's continued stance that marijuana is a Schedule I drug.

The State of Washington and Colorado took decriminalizing marijuana one step further by legalizing its recreational use. Washington voters enacted Initiative-502 in 2012 to legalize marijuana for recreational use and to regulate and tax it by the state government. Advocates argued that there would be significant savings to law enforcement, the judicial system, and corrections by decriminalizing marijuana possession and use by individual users. A cost-benefit analysis conducted by Archambault, McNelley, and Roe (2013) indicated a revenue income from taxation of $2 billion during the first 6 years of legalization. Their analysis also indicated an increase in vehicle collisions would cost an additional $9.1 million due to marijuana legalization (Archambault et al., 2013). The cost-benefit analysis did not address the relationship between the legalization of marijuana and traffic fatalities involving cannabinoids.

Although researchers have noted an increase in marijuana-impaired driving related to decriminalizing marijuana for medicinal purposes, little is known about the relationship between marijuana legalization and traffic fatalities involving cannabinoids (Bogstrand & Gjerde, 2014; Pollini et al., 2015; Salomonsen-Sautel, Min, Sakai, Thurstone, & Hopfer, 2014). With several states facing fiscal budget constraints, it is possible legislators might view the potential revenue source from taxing legalized marijuana and society's shifting attitude toward its use as a means to reduce budgetary shortfalls. However, little knowledge exists about the relationship between legalized marijuana and traffic fatalities involving cannabinoids. Findings from this study may be used to educate stakeholders concerning the development of legislation legalizing

recreational marijuana and may provide insight into reducing marijuana-related traffic fatalities.

Background

The Controlled Substances Act (CSA) of 1970 was heralded as a balanced approach to an increasing problem of marijuana, cocaine, and psychedelic drugs such as LSD being used as recreational drugs. Congress chose to take a tougher stance on drug reform with a combined approach to the scheduling of narcotics and penalties tied to the scheduling, and with distinguishing between personal use and possession with the intent to distribute. As a result, the government classified marijuana as a Schedule I drug, making its manufacture, importation, possession, use, and sale illegal (U.S. Food and Drug Administration, 2009). The government created five drug schedules. Schedule I drugs are considered the most dangerous, and Schedule V drugs have a low potential for abuse. With the classification of marijuana as a Schedule I drug, the federal government in 1970 declared marijuana to have no currently accepted medical use, a high potential for abuse, and the potential for severe psychological and physical dependence on it.

Since the enactment of the CSA and Nixon's declaration of a war on drugs, the United States has spent over $1 trillion in various programs to combat this problem. Government agencies have dedicated themselves to prevent drugs such as marijuana from entering the country and has placed millions of people in prisons and jails for distributing marijuana or possessing it (Thompson, 2014). Although the federal government continues to classify marijuana as a Schedule I drug with no medical purpose and the high potential to be abused, there is a shifting trend of social acceptance of marijuana by the general

public in the United States. Despite the willingness to decriminalize and legalize marijuana use in the State of Washington, the American Medical Association (AMA) continues to view marijuana as a Schedule I drug. The AMA noted that further research into marijuana for medical purposes was necessary if it were to change its stance toward classification as a Schedule I drug, and also noted that the federal government would have to lift restrictions to allow experimental research to be conducted (Fan, 2015).

Over the last several years some states have opted to decriminalize small quantities of marijuana possession to alleviate the growing burden on jails and prisons. Other states have legalized marijuana for medicinal purposes despite the lack of research in this area. According to Leyton (2016), a significant number of risks about marijuana use exist ranging from neurobiological differences within the brain, connectivity, and certain functions. Furthermore, Leyton that posited marijuana might precipitate and accelerate the onset of schizophrenia. However, Leyton also stated that marijuana might have clinical implications for nausea, different types of pain, and patients with multiple sclerosis. Additionally, Leyton noted the difficulty in determining whether marijuana has any other medicinal purpose because most research has relied on anecdotal evidence from patients seeking prescriptions for marijuana. Despite the federal government's classification of marijuana as a Schedule I drug and the lack of empirical studies on marijuana, several states such as Colorado, Washington, Oregon, and Alaska have legalized marijuana for recreational use.

The federal government tasked the National Safety Council (NSC, 2013) with guiding the general public, local, and state governments through their Committee on

Alcohol and Other Drugs. The NSC argued that it was unsafe to operate a motor vehicle or heavy equipment while impaired by marijuana and those who operated motor vehicles or heavy equipment posed an increased risk of death or injury to themselves and others. Bogstrand and Gjerde (2014), noted that when it came to drug-impaired driving, marijuana was found to be the most commonly used illicit drug among impaired drivers. Additionally, further studies have shown that college students viewed smoking marijuana and driving as significantly less dangerous than if they were drinking alcohol and driving (Glascoff, Schrader, & Haddock, 2013). Research also showed that college students were more likely to ride as a passenger with an individual who had smoked marijuana compared to a driver who had been drinking alcohol (Kohn, Saleheen, Borrup, Rogers, & Lapidus, 2014). These studies suggested that marijuana-impaired driving has become more acceptable and viewed as less dangerous than alcohol-impaired driving.

Since Colorado legalized marijuana in 2012, there has been an increase in the number of marijuana-impaired traffic fatalities, while alcohol-impaired traffic fatalities have remained at the same level (Salomonsen-Sautel et al., 2014). Although studies have been conducted on decriminalizing marijuana and shifting attitudes toward marijuana, a gap in the literature exists regarding the relationship between legalization of recreational marijuana and traffic fatalities involving cannabinoids. The current study addressed the relationship between legalized marijuana and traffic fatalities involving cannabinoids. Although Colorado's study showed an increase in marijuana-related fatalities since marijuana commercialization of medical marijuana, limited knowledge exists as to

whether legislation legalizing recreational marijuana has contributed to an increase in traffic fatalities involving cannabinoids.

Problem Statement

With several states facing shrinking revenue over the past several years, the legalization of recreational marijuana and its taxation in the State of Washington has gained momentum with legislators and registered voters. The Washington Traffic Safety Commission (WTSC) noted that from 2008 to 2012, there were 1,160 impaired-driver-involved deaths in the State of Washington. The WTSC further noted that 34% of those deaths involved drug impaired drivers, 40% were impaired by alcohol, and 26% were impaired by both drugs and alcohol. Other studies showed that motorists and in particular teen drivers were more than likely to be driving under the influence of marijuana than alcohol because marijuana has become more acceptable (Freeman, Maxwell, and Davey, 2011; Maxwell, Freeman, and Davey, 2009). Although these results showed the involvement of marijuana in driver fatalities, previously described research studies examined the problem through the context of substance abuse and not underlying decision-making such as marijuana legalization or perceived perceptions of deterrence.

Currently, literature exists with regards to alcohol-impaired driving, but little attention has been given to the relationship between legalized recreational marijuana and traffic fatalities involving cannabinoids. Failure to understand the relationship between recreational marijuana and marijuana-related traffic fatalities may endanger communities. Additionally, other than the loss of life, an increase in marijuana-related traffic fatalities impacts society through socioeconomic costs. The current study addressed whether a

relationship exists between marijuana legalization and traffic fatalities involving cannabinoids. The results of this research study may provide valuable information to legislators considering laws to legalize recreational marijuana and strategies to reduce traffic fatalities involving cannabinoids.

Purpose of the Study

The purpose of this quantitative study was to examine the relationship between the legalization of recreational marijuana and traffic fatalities involving cannabinoids in the State of Washington. The theories of rational choice and perceptional deterrence offered a framework to examine any possible relationship. The quantitative study included a quasi-experimental regression point displacement design to examine the relationship between pre- and postlegalization of recreational marijuana and its impact on marijuana-related traffic fatalities. Publicly available aggregated data from the National Highway Traffic Safety Administration's (NHTSA's) Fatality Analysis Reporting System (FARS) database was collected for this study. The data were analyzed and compared through a pre-post analysis of Initiative-502, in which voters legalized recreational marijuana in the State of Washington in 2012.

Research Questions

The following questions were used to guide this study to examine the connection between legalized marijuana and traffic fatalities involving cannabinoids in the State of Washington.

RQ1: Does a relationship exist between marijuana legalization and traffic fatalities involving cannabinoids in the State of Washington?

RQ2: Does rational choice theory help explain any possible relationship between marijuana legalization and traffic fatalities involving cannabinoids in the State of Washington?

RQ3: Does perceptual deterrence theory help explain any possible relationship between marijuana legalization and traffic fatalities involving cannabinoids in the State of Washington?

H_a: There is a significant relationship between marijuana legalization and traffic fatalities involving cannabinoids in the State of Washington.

H_o: There is no significant relationship between marijuana legalization and traffic fatalities involving cannabinoids in the State of Washington.

Theoretical Foundation

The theory of rational choice and the theory of perceptional deterrence provided a useful criminological and social lens to examine the relationship between variables. The rational choice theory was developed by Cornish and Clarke in 1986 drawing from the traditional approach in which individuals make a conscientious decision to commit a crime. According to Cornish and Clark (as cited in Lilly, Cullen, & Ball, 2011) rational choice theory involves the offender making a deliberate choice, which differs from the traditional social and political contexts through several other theories have been developed. Cornish and Clarke (as cited in Lilly et al., 2011) noted this type of rationality is not perfect. Lilly et al. described the social deviant as a person who made choices based on "limited information, based under pressure, insufficiently planned, and/or attentive only to the immediate risks of apprehension rather than to the long-term

consequences of their actions" (p. 342). This approach refers to the classical school of criminology, which views criminals as calculating their actions based on free will and a hedonistic desire (Lilly et al., 2011). The theory of rational choice offered valuable insight regarding why an individual might use marijuana and operate a motor vehicle, a high-risk behavior that leads to traffic fatalities.

The rational choice theory was developed by Monachesi in 1955, who noted an early theory of crime to be a result of free will. Steele (2015) stated that in addition to free will, offenders use a rational decision-making process when committing a crime. Cornish and Clarke (as cited in Lilly et al., 2011) narrowed the scope of this theory and stated that rational choice was limited as offenders weighed satisfying certain needs such as money, status, revenge and pleasure against negative consequences such as being arrested. These underlying factors help to explain the choices an individual makes before his or her decision to drive impaired by marijuana and possibly become involved in a traffic fatality.

Perceptual deterrence theory also follows the classical approach and is similar in roots to rational choice theory. According to perceptual deterrence theory, an offender's decision to commit a crime is not a rational choice but instead is based on the individual's perception of costs versus benefits. Lilly et al. (2011) stated that early research studies indicated that deterrence, such as traditional legal sanctions, was a useful tool when it came to deviant behavior but was limited due to the bivariate variables studied and cross-sectional timeframe (Lilly et al., 2011). The current study addressed the relationship

between two variables while controlling for additional variables, both pre- and postenactment of I-502.

In 2000, the WTSC (2014) adopted a strategy to reduce the number of traffic deaths and serious injuries on roadways to zero by the year 2030. The WTSC (2014) identified impaired driving as a leading cause of traffic fatalities. Marijuana-impaired driving directly contributes to traffic fatalities, but the relationship between marijuana legalization and traffic fatalities had not been fully explored (WTSC, 2014). As part of their strategy to address impaired driving, the WTSC identified traffic safety emphasis patrols as a viable method to address this problem and partnered with local media to announce specific dates and times these patrols would be operating (WTSC, 2014). The theory of perceptual deterrence explains how the perception of a DUI arrest and punishment for a crime is shaped by the offender and helps provide possible insights to reduce traffic fatalities involving marijuana through legislation and deterrence.

The application of these theories to this study helped me identify factors that shape an individual's decision to operate a vehicle under the influence of marijuana. Rational choice theory and perceptual deterrence theory both advanced the criminological context necessary to examine whether a relationship existed between legalized recreational marijuana and traffic fatalities involving cannabinoids. The underlying theoretical focus of these two theories helped me explain the situational dynamics the offender was presented with and the choices he or she made based on a bounded rationality and perceptual deterrence at the time of driving impaired by marijuana.

Nature of the Study

I chose a quantitative quasi-experimental approach using publicly available aggregated data collected by law enforcement agencies and submitted to the NHTSA's FARS. A quantitative approach is consistent with examining the relationship between the dependent variable of traffic fatalities involving cannabinoids and the independent variable of legalized recreational marijuana. Control variables including breath alcohol concentration (BrAC), blood alcohol content (BAC), cocaine, heroin, PCP, methamphetamine, prescription drugs, and other chemical substances, individual drugs, or metabolites were accounted for as a poly-drug combination. Marijuana poly-drug combinations were considered as raising the risks associated with traffic fatalities. This quasi-experimental quantitative study included data from pre-Initiative-502 and post-Initiative-502 to determine whether there had been an increase in traffic fatalities involving cannabinoids as a direct result of legalizing recreational marijuana. I used a regression point displacement design, a variation of the quasi-experimental method, which was well suited for analyzing public policy research problems.

The justification for using a quasi-experimental design was the fact that I had no control over when and to whom the stimuli of recreational marijuana was introduced, unlike a true experimental research design. Traffic fatalities rely on blood and urine toxicology to help determine impairment, but the manner in which impairment is defined, tested, and analyzed varies from state to state. The collected data were aggregated, publicly available secondary data collected through FARS, which has a standardized approach for collection and analysis and is the best resource for data to determine

whether marijuana legalization has influenced traffic fatalities involving cannabinoids. The quasi-experimental design is appropriate in determining whether a relationship exists between the two variables while controlling for others. The control group was drawn from the entire population of each state, and although the design was not a true experimental design, the available aggregated data and method were appropriate for analyzing policy and treatment impacts on a particular group.

Definitions

Driving under the influence (DUI): For the purpose of this study, driving under the influence was defined by Washington State Legislature (2016) as:

> RCW 46.61.502 - Driving under the influence.
>
> (1) A person is guilty of driving while under the influence of intoxicating liquor, marijuana, or any drug if the person drives a vehicle within this state:
>
> (a) And the person has, within two hours after driving, an alcohol concentration of 0.08 or higher as shown by analysis of the person's breath or blood made under RCW 46.61.506; or
>
> (b) The person has, within two hours after driving, a THC concentration of 5.00 or higher as shown by analysis of the person's blood made under RCW 46.61.506; or
>
> (c) While the person is under the influence of or affected by intoxicating liquor, marijuana, or any drug; or
>
> (d) While the person is under the combined influence of or affected by intoxicating liquor, marijuana, and any drug.

(2) The fact that a person charged with a violation of this section is or has been entitled to use a drug under the laws of this state shall not constitute a defense against a charge of violating this section.

(3)(a) It is an affirmative defense to a violation of subsection (1)(a) of this section, which the defendant must prove by a preponderance of the evidence, that the defendant consumed a sufficient quantity of alcohol after the time of driving and before the administration of an analysis of the person's breath or blood to cause the defendant's alcohol concentration to be 0.08 or more within two hours after driving. The court shall not admit evidence of this defense unless the defendant notifies the prosecution prior to the omnibus or pretrial hearing in the case of the defendant's intent to assert the affirmative defense.

(b) It is an affirmative defense to a violation of subsection (1)(b) of this section, which the defendant must prove by a preponderance of the evidence, that the defendant consumed a sufficient quantity of marijuana after the time of driving and before the administration of an analysis of the person's blood to cause the defendant's THC concentration to be 5.00 or more within two hours after driving. The court shall not admit evidence of this defense unless the defendant notifies the prosecution prior to the omnibus or pretrial hearing in the case of the defendant's intent to assert the affirmative defense.

(4)(a) Analyses of blood or breath samples obtained more than two hours after the alleged driving may be used as evidence that within two hours of the alleged driving, a person had an alcohol concentration of 0.08 or more in violation of

subsection (1)(a) of this section, and in any case in which the analysis shows an alcohol concentration above 0.00 may be used as evidence that a person was under the influence of or affected by intoxicating liquor or any drug in violation of subsection (1)(c) or (d) of this section.

(b) Analyses of blood samples obtained more than two hours after the alleged driving may be used as evidence that within two hours of the alleged driving, a person had a THC concentration of 5.00 or more in violation of subsection (1)(b) of this section, and in any case in which the analysis shows a THC concentration above 0.00 may be used as evidence that a person was under the influence of or affected by marijuana in violation of subsection (1)(c) or (d) of this section. (Washington State Legislature, RCW 46.61.502, 2016)

Legalized marijuana: For the purposes of this study, legalized marijuana possession was defined by Initiative-502 and regulated by the Washington State Liquor and Cannabis Board (2015) as follows:

Individuals 21 years of age or older are legally authorized to possess and use:

- One ounce of usable marijuana
- 7 grams of marijuana concentrate/extract for inhalation
- 16 ounces of marijuana infused product in solid form
- 72 ounces of marijuana infused product in liquid form
- Marijuana-related drug paraphernalia. (para. 6)

Marijuana: For the purposes of this study, "marijuana or marihuana means all parts of the plant Cannabis, whether growing or not, with a THC concentration greater

than 0.3 percent on a dry weight basis; the seeds thereof; the resin extracted from any part of the plant; and every compound, manufacture, salt, derivative, mixture, or preparation of the plant, its seeds or resin. The term does not include the mature stalks of the plant, fiber produced from the stalks, oil or cake made from the seeds of the plant, any other compound, manufacture, salt, derivative, mixture, or preparation of the mature stalks (except the resin extracted therefrom), fiber, oil, or cake, or the sterilized seed of the plant which is incapable of germination" (Washington State Legislature, 2018, para. 1).

Other variables: For the purpose of this study, the control variables were alcohol, cocaine, heroin, LSD, methamphetamine, morphine, and over-the-counter and prescription drugs within a poly-drug combination as determined by the Washington State Toxicology Laboratory. These variables were controlled for through the regression point displacement design.

Traffic fatalities involving cannabinoids: For the purpose of this study, a traffic fatality involving cannabinoids included all fatalities in which the presence of cannabinoids was determined and any marijuana poly-drug combination.

Assumptions

Washington State Legislature (2016) stated that a driver is driving under the influence of marijuana if the driver has within two hours after driving a THC concentration of 5.00 nanograms per milliliter (NG/ML) of whole blood or higher (Washington State Legislature, RCW 46.61.502, 2016). A certified peace officer within the State of Washington must have probable cause to arrest an individual for driving under the influence. Probable cause for a DUI arrest may be based on a combination of

observations such as the vehicle in motion, the driver's statements and admissions, a standardized field sobriety testing (SFST), advanced roadside impaired drug evaluation (ARIDE), and evaluation by a drug recognition expert (DRE). Although a trained officer may be able to determine marijuana-impaired driving and make an arrest, thereby taking the high risk driver off the road, determining if impairment is the cause of a fatality is slightly more difficult as states have different marijuana laws, testing, and collection of data. One state may test for the presence of THC compared to another stated that tests for the level of THC. However, the control group comprised those states where recreational marijuana is illegal and where cannabinoids were present in the decedent.

Contributing variables such as the availability of marijuana geographically and by cost, marijuana absorption rates, differing levels of THC concentration of marijuana, roadway design, and vehicle safety devices potentially contributed to traffic fatalities involving cannabinoids. However, for the purpose of this study, blood and urine draws provided unique insight whether the individual had the presence of cannabinoids within his or her system. Washington State has a specific definition of per se impairment that requires a driver to have a specific level of Delta-9 THC in their system to be determined as driving under the influence of marijuana, whereas as Oregon State uses impairment to define marijuana-impaired DUI. The per se differences within those states where recreational marijuana is legal, potentially impact traffic fatalities by discouraging marijuana-impaired driving through a zero tolerance of THC.

In comparison to a decedent, an arrestee once arrested undergoes a DUI booking process and is requested to submit to a breath test to determine his or her alcohol

concentration. I assumed that poly-drug use would occur where alcohol and marijuana impairment and/or other drugs were present. Furthermore, I acknowledged that if the alcohol concentration in an arrestee's breath test was .08 or more, a blood draw conducted by a search warrant may not have been conducted by the arresting officer, thereby missing other contributing impairment factors. It is possible that if indicators of alcohol were present during a fatality, poly-drug combinations may have been missed.

I also noted that marijuana poly-drug combinations were potentially aggregated as part of the testing for the presence in control groups. Wood and Salomonsen-Sautel (2016) noted that policymakers accepted the per se level of 5.00 ng/ml of THC as a compromise between toxicologists concerned about the safety of the general public about impairment and marijuana advocates arguing that the THC level is too strict. Additionally, the use of poly-drug combinations was prevalent and made it difficult to determine underlying causes of traffic fatalities (Wood & Salomonsen-Sautel, 2016). Despite the possible poly-drug combination and lower level of THC, I also acknowledged that the time between the traffic fatality and the blood draw may have been several hours. The time delay may have resulted in a lower THC level than the designated per se level but still presented a factor regarding impairment of the driver.

Limitations

I used a quasi-experimental multiple time series design. The rationale for using this design was based on the collection of publicly available aggregated secondary data from traffic fatalities involving cannabinoids pre and post I-502 legalizing marijuana in

Washington State. Although similar to the pre- and posttest design, this research design included annually aggregated data collected from NHTSA's FARS.

Another limitation of the quasi-experimental design is the inability of the researcher to use random assignments of individuals to particular groups. In this study, I collected secondary data to measure traffic fatalities involving cannabinoids. Dimitrov and Rumrill (2003), noted that quasi-experimental multiple time series designs are widely used in comparing nonrandomized groups resulting from both a pre- and postexperimental change. A fundamental difference between experimental and quasi-experimental designs is the experimental design is stronger in internal validity.

Three specific threats to internal validity existed in the study, namely history, maturation, and statistical regression. These threats to internal validity were mitigated through the grouping of aggregated data over a protracted period, thereby strengthening the design and validity of the regression point displacement design. Maxfield and Babbie (2011) stated that careful administration of control variables and identification of these specific threats allows the researcher to account for them. Lastly, I also recognized my professional biases and experiences as a law enforcement officer in the course of this study. I mitigated this bias by using publicly available, aggregated secondary data, criminological theories, and scientific and theoretical analysis.

Significance

This study was unique due to the relatively recent legislation enacted by voters to legalize recreational marijuana in the State of Washington. At the time of study, there had been limited research in this area due to the small number of states in which recreational

marijuana has been legalized and varying per se laws for marijuana-impaired driving. Although studies have shown marijuana-impaired driving has significantly impacted traffic accidents and fatalities in the State of Colorado, findings were based on legalization of medical marijuana commercialization. Additionally, there was limited research on the possible relationship between marijuana legalization and traffic fatalities involving cannabinoids in Washington State (NHTSA, 2015; Pollini et al., 2015; Salomonsen-Sautel, et al. 2014;). Advocates presented Initiative-502 as a way to reduce costs for law enforcement agencies while generating tax revenue that would provide marijuana education, substance abuse counseling, and a health plan. No additional funding was provided to law enforcement to address any additional impact on the criminal justice system such as marijuana-impaired driving enforcement or investigations of traffic fatalities involving cannabinoids (Archambault et al., 2013).

The results of this study may provide legislators and key stakeholders with valuable insights about marijuana legalization and traffic fatalities involving cannabinoids. Furthermore, this study may help administrators address a fiscal policy change to provide valuable marijuana detection training to law enforcement officers and increase emphasis patrols in partnership with key stakeholders from the perspective of perceptual deterrence. This study promoted positive social change through informed decision-making in legislative policy, where a void currently exists to address how the criminal justice system can effectively address marijuana-impaired driving, a dangerously high risk behavior, which leads to traffic fatalities involving cannabinoids. Lastly, this

study contributed to the existing body of knowledge where limited research currently exists due to the small number of states where recreational marijuana has been legalized.

Summary

Since the CSA of 1970, marijuana was classified as a Schedule I drug, indicating it is a highly dangerous drug with no currently accepted medical use, as well as a high potential for abuse by users, with potentially severe psychological as well as physical dependence on it. Although the federal government's stance on marijuana was to criminalize this drug, some states have enacted legislation to allow the drug to be used for medicinal purposes despite its Schedule I classification and the American Medical Association's continued support of marijuana's classification. Other states have enacted legislation to decriminalize marijuana and make its possession a civil infraction with a monetary penalty instead of the misdemeanor crime. Recently, with several states facing fiscal dilemmas, marijuana advocates have posited legalizing marijuana and regulating cultivation, sales, and possession similar to their state's liquor laws thereby generating tax revenue for the state.

Voters in Washington State enacted Initiative-502 in November of 2012, legalizing recreational marijuana. Marijuana advocates posited the state would receive approximately $2 billion during the first 6 years from tax revenue and would free up limited resources for law enforcement, the judicial system, and corrections (Archambault et al., 2013). The initiative was designed to direct tax revenue toward a health plan, marijuana education, and substance abuse counseling. This study addressed the possible relationship between marijuana legalization and traffic fatalities involving cannabinoids,

which may help legislators and public policy administrators develop a comprehensive approach to reducing marijuana-related traffic fatalities and improving the safety of citizens in communities.

Chapter 2: Literature Review

The 91st U.S. Congress passed into law the Controlled Substance Act of 1970 (CSA). This legislation designated marijuana as a Schedule I drug, considered to be the most dangerous of illegal narcotics having no medically accepted use, a high potential for abuse of the drug by users, and the potential of psychological and physical dependence on it (Cornell University Law School, n.d.). Since the passage of the CSA and despite the American Medical Association's continued stance adhering to the CSA, several states have shifted from the federal government's legislative directive of criminalizing marijuana and have legalized the use of medical marijuana. Other states have decriminalized marijuana and have made it a civil infraction, and a growing number of states have recently moved to legalize recreational marijuana. On November 6th, 2012, with the CSA of 1970 remaining unchanged, voters in the State of Washington passed Initiative-502 by 55% to 45%. Washington State joined Colorado in legalizing marijuana for recreational use.

A group of legislators and marijuana advocates posited that Initiative-502 would create cost savings to law enforcement agencies, the judicial system, and corrections. Advocates further posited that by legalizing recreational marijuana the state may levy a tax and generate a revenue of almost $2 billion upon its implementation over a period of 5 to 6 years (Archambault et al., 2013; Washington State Legislation, 2012). Heralded by proponents as a means to generate revenue from marijuana taxation, the initiative also proposed to free up limited resources in law enforcement, the judicial system, and

corrections through its legalization, but little is known as to its impact on traffic fatalities involving cannabinoids.

The National Safety Council (2013) stated that operating a motor vehicle after using marijuana posed a significant risk of injury or death. A recent study in Colorado showed an increase in the number of marijuana-related traffic fatalities since medical marijuana became commercially available, although alcohol-impaired traffic fatalities remained at the same level (Salomonsen-Sautel et al., 2014). Despite these concerns, additional states such as Oregon, Alaska, California, Nevada, Maine, and Massachusetts pressed forward with legalizing marijuana. Research has been done on alcohol-impaired driving, but little attention has been given to the relationship between legalized marijuana and traffic fatalities involving cannabinoids.

Failure to understand the relationship between recreational marijuana and marijuana-related traffic fatality rates poses a risk to society from marijuana-impaired drivers. Knowing more about the relationship between marijuana legalization and traffic fatalities involving cannabinoids would allow legislators and public policy administrators to develop a comprehensive approach to address this problem. The purpose of this quantitative study was to examine the relationship between the legalization of recreational marijuana and traffic fatalities involving cannabinoids in Washington State. Additionally, the study addressed whether the theories of rational choice and perceptional deterrence offered guidance to explain any possible relationship.

Literature Search Strategy

My literature research was conducted using peer-reviewed journals, information and data from government websites, and scholarly books. The following databases were used: Thoreau Multi-Database, Academic Search Complete, ProQuest Central, ProQuest Criminal Justice, and the Bureau of Justice Statistics, Criminal Justice Database, Dissertations and Theses at Walden University, EBSCO ebooks, Google Books, ProQuest Dissertations and Theses Global, SAGE journals, SAGE Research Methods Online, and Walden Library Books. Key words and phrases used as search terms included *marijuana-impaired fatalities*, *marijuana and polydrug combinations, polydrug combinations and driving under the influence*, *driving under the influence*, *marijuana-impaired driving*, *drugged-driving*, *Washington State legalized marijuana*, *legalized marijuana*, *marijuana taxes*, *rational choice theory*, and *perceptual deterrence theory*. The resources used in this literature review were on peer-reviewed and contained relevant information for study.

Theoretical Foundation

The search to explain deviant behavior has been traced back to the 1700s, where two schools of thought were created leading to a number of theories to explain criminal behavior. According to Lilly et al. (2011), the early positivist school developed by Lombroso described social deviancy through biological observations. Lilly et al. (2011) stated, Lombroso posited that the criminal deviant differed from noncriminals and could be characterized by the slope of foreheads, the length of arms, and twisted noses. By today's standards, Lombroso's theories may seem archaic; his scientific approach to

examining and documenting criminal behavior laid a solid foundation for future scholars to build on. Lombroso is considered by many scholars to be the founder of the scientific study of criminology (Lilly et al., 2011).

Although the positivist school of criminology sought to explain criminal behavior through the characteristics of an individual, it was an Italian named Beccaria developed the classical school that sought to explain criminal behavior through calculable decisions (Lilly et al., 2011). Beccaria's anonymous publication was written during a period when he feared persecution for his views, and his work laid the foundation for the development of today's criminal justice system. Lilly et al. (as cited in Vold, 1958; Radzinowicz, 1966) summarized Beccaria's argument and noted that due to the restrictions placed on individuals through the creation of criminal laws, these laws should be restricted in scope. Furthermore, Beccaria posited that an individual should be presumed innocent until proven guilty with the rights of the accused protected. Beccaria also posited that criminal laws and penalties should be written with punishments corresponding to the crime, not going further than was necessary for the prevention and deterrence of the crime. Beccaria argued punishment should not be considered part of reformation but instead "the offender should be viewed as an independent and reasonable person who weighed the consequences of the crime" (as cited Lilly et al., 2011, pp. 21). These basic premises of Beccaria's work can be seen in the U.S. criminal justice system with written laws and penalties, Miranda warnings, and the presumption of innocence.

Beccaria's writings and theories were developed during a period of a tyrannical rule with existing laws and punishments being inconsistently applied by the ruling class.

Out of fear of reprisal, Beccaria penned his criminological studies anonymously as his writings were influenced by what he felt was a corrupt and unfair justice system. However, Beccaria did not place all of the blame on the judicial system; he also examined the relationship between the justice system and criminal deviancy. Beccaria argued that individuals made calculable decisions based on free will guided by a hedonistic approach.

Rational Choice Theory

Rational choice theory asserts individuals make decisions based on certain possible outcomes limited by the circumstances that affect them. Steele (as cited in Cornish & Clarke, 1987) suggested that individuals go through a deliberate decision-making process, weighing the options and possible outcomes of their decisions against their potential individual benefits. Steele (2015) also noted that Akers had posited that individuals would not commit crimes directly as a result of fear of the possible punishment they would incur as a result. Scholars have posited the decision-making process and contemplation of possible adverse outcomes suggest rationality is present throughout the process, including choosing to decide to drive impaired by marijuana and possibly being involved in a traffic fatality.

Rational choice theory has been applied to research topics such as participating in corporate crimes, sexual assaults, shoplifting, and tax evasion. Research has also shown these hypothetical study models to be reliable when applied to nonoffenders and offenders, thereby further strengthening this theory (Lilly et al., 2011). The underlying assumptions of rational choice theory specifically note that criminal deviancy is based on

the nature of the crime and costs involved (Bouffard, Exum, & Collins, 2010; Mason & Monk-Turner, 2010). Although Bouffard et al.'s (2010) research demonstrated a conscious decision-making process, the small sample of undergraduates in a Midwestern university limited generalization to the larger population. Further research within this area would strengthen the theory's insight into understanding criminal deviancy. Rational choice theory's underlying assumption of weighing the costs and benefits of committing a crime may be applied to understand criminal deviancy.

Deterrence has long been a centerpiece of the criminal justice system and has been at the forefront of criminal justice policy making. However, deterrence is not the sole variable in weighing the costs and benefits of committing a crime or the study and development of criminal justice theories. Opponents of the death penalty noted that deterrence has failed to deter individuals from murdering in states such as Texas. Piquero, Piquero, Gertz, Bratton, and Loughran (2012) noted there are two types of deterrence used in the criminal justice process. Specific deterrence refers to certain, swift, and severe penalties designed to prevent individuals from committing crimes, and general deterrence is designed to prevent others from committing crimes. Deterrence assumes that a person carefully weighs the risks and benefits through a rational decision-making process in determining whether to commit a crime (Piquero et al., 2012). This two-pronged approach assumes that offenders must be aware of not only of the penalties but also of the probability of being caught and the certain, severe, and swift punishment.

Lilly e al. (2011) noted that an individual's rights at times afford a delay in specific deterrence, and the effect of certain, swift, and severe punishment is lessened and

thereby ineffective when it comes to examining and developing criminal justice policies to address criminal deviancy. Lilly et al. noted some scholars highlighted racial disparity and differing sentencing for individuals as a result. Opponents have stated that patrols conducted by law enforcement agencies unfairly target ethnic minorities due to the increased presence in specific communities. The WTSC (2014) argued that patrols deter marijuana-impaired driving. Opponents point to rising prison rates in the United States as unfairly targeting minority populations where marijuana is prevalent (Office of National Drug Control Policy, n.d.).

The possible perception that individuals are not caught for driving under the influence of marijuana or swiftly punished potentially has negative connotations for rational choice theory. Mason and Monk-Turner (2010) compared an individual's moral values to rational choice theory and found that an individual is more likely to refrain from driving under the influence when weighing the cost and benefits to the individual of committing a crime. This research suggested that individuals who knew of people driving under the influence that were not caught, were more likely to drive under the influence themselves. The findings suggested punishment alone was not sufficient enough to deter an individual from criminal deviancy. This mindset provides an insight of the offender's decision-making process when they weigh the option to drive under the influence and potentially become involved in a traffic fatality.

The theoretical concept of deliberate decision-making through free will and the variable of deterrence dates back to the early works of Beccaria, in which he argued all criminal laws should be clearly written and subsequent punishment should correspond to

the crime that was committed (Lilly et al., 2011). Lilly et al. noted some scholars have argued rational choice theory failed to adequately explain an individual's propensity toward committing a crime. They stated opponents of rational choice theory have argued research studies of individuals using marijuana were impaired, and their impairment would not allow them to act rationally. As a result, they were incapable of fully understanding the consequences of their decision to rationally choose to commit a crime such as marijuana DUI and thereby marijuana-impaired traffic fatalities (Hayward, 2007; Mason & Monk-Turner, 2010). Legally, impairment is not a defensible position when it comes to marijuana-impaired driving. Driving under the influence and its penalties are a widely known crime within the U.S. Scholars have argued individuals make rational decisions based on the facts at hand and thereby bounded in their decision making (Lilly et al., 2011). This would suggest driving under the influence is based upon existing knowledge that it is a crime with associated penalties and despite this an individual still rationally chooses to drive while impaired.

Hug (2014) noted rational choice theory assumes that an individual will act in their self-interest. He noted rational choice theorists have suggested the decision to commit a crime that is in the person's self-interest may be in and of itself be considered rational. However, Lilly et al. (2011) aptly noted the theory of rational choice and an individual's rationality are "bounded," and the decisions they make were limited at the time. The authors placed this into context and stated an individual makes decisions on limited information at the time, with little thought as to the possible consequences they may incur as a direct result of their actions (Cornish & Clarke, 2014, Lilly et al., 2011).

The rational choice model essentially weighs an individual's needs with the information at the time and considers the possible outcomes, which results in a rationally based action. Therefore, a person can choose to commit a particular crime based upon the limits of time, ability, and limited information. Despite arguments made by opponents of rational choice theory, impairment is forwarded through the bounded rationality that confronts an individual in making a rational decision.

The concept that an offender's rationality is "bounded" at the time due to limited information on hand was explored further in Apel's (2013) research. Apel noted an individual's decision to offend may not always be apparent in terms of benefit but instead their lack of comprehending the criminal penalties associated with committing a particular crime. His research study found most individuals understood the criminality of specific actions but underestimated the criminal penalties related to the offense (Apel, 2013). Based on Apel's research study, the underestimation of the sanctions involved with marijuana DUI arrests may also be a part an individual's decision-making process. An individual's underestimation of the criminal penalties when weighing the costs and benefits of marijuana-impaired driving may contribute to traffic fatalities involving cannabinoids. The importance of this research suggests greater public outreach is necessary to educate the public not only of the dangers associated with marijuana-impaired driving but the criminal penalties associated with doing so.

One might argue rational choice theory is an individual's choice to commit a crime as a result of mere opportunity. However, Cornish & Clarke (2014) as cited in Simon (1978) noted that despite the bounded theory of rational choice, a person's

purposive behavior that benefited them was still rational regardless of opportunity. This would suggest rational choice theory was not limited but encompassed the argument that individuals take into account perceived minimal risks and benefits. Rational choice theory also encompasses those that reacted to impulse, to include individuals under the influence of drugs, alcohol and strong emotions (Cornish & Clarke, 2014). Rational choice theory considers not only the longstanding sociological approach to crime but also explains why crimes occur despite society's legislative deterrence.

Rational choice and perceptual deterrence theories have been a theoretical model for legislators in the past, many of whom advocated for a get tough on crime policy while campaigning. This in turn has led to the development of mandatory sentencing and three strike laws. Additionally, these laws have led to mandatory sentencing guidelines leading to high prison populations. Legislators have routinely used deterrence as a means to address social deviancy with tougher penalties to curb criminal deviancy. Lilly et al. (2011) noted criminologists during the 1980s and 1990s tried to understand how rational decision making influences criminal behavior in order to criminal behavior. Steele (2015) conducted a qualitative research study with 46 participants convicted of at least one crime ranging from shoplifting to murder. While the study was limited in size, notable findings found the majority of offenders did consider the consequences of their actions before committing the offense but felt the likelihood of arrest as being relatively low (Steele, 2015). This study would suggest an individual's perception of perceived risks helps explain criminal behavior.

However, Steele's (2015) conclusion points once again to the fact of weighing the benefits against the swift and certain punishment as a means to deter criminal behavior. When applied to traffic fatalities involving cannabinoids, rational choice theory explains how an individual might weigh the benefits and the costs in deciding to operate a motor vehicle impaired by marijuana. The perceived benefit of driving home after smoking marijuana may be deterred by the perception that they will be caught. Bertelli and Richardson (2008) in their qualitative research study found that individuals needed to perceive that there was a greater likelihood they would be stopped and arrested for driving under the influence than the perceived benefit of driving home.

If legislators desire to mitigate marijuana-impaired driving and thereby marijuana related traffic fatalities, understanding how rational choice theory applies to this criminal behavior is vital. Offenders are more likely to refrain from such behavior if there is a high degree of certainty they will be stopped and arrested for driving under the influence. Rational choice theory can provide policy administrators and legislators a greater understanding of traffic fatalities involving marijuana and help to address this problem.

Perceptual Deterrence Theory

The basic principles of perceptual deterrence theory like rational choice theory can also be dated back to the works of Cesare Bonesana Marchese de Beccaria (1738-1794). The development of written laws and associated punishments are a part of the criminal justice foundation. Paternoster (2010) stated, Beccaria argued everyone possessed the motivation to commit criminal deviancy but refrained from doing so based upon self-interest and society's ability to deter deviant behavior through education and

punishment. Paternoster stated, Beccaria proposed punishments should be proportionate to the level of crime committed as well as be sure and swift. These basic premises were adopted into the U.S. Bill of Rights ratified by Congress on December 15th, 1791 (National Archives, 2018). Additionally, Beccaria posited along with certain and swift punishment came the need for education through self-restraint (Paternoster, 2010). Overtime, Beccaria's proposals have since been adopted and adapted eventually leading in part to the basis of the United States criminal justice system that we see today. The basic principles of both rational choice theory as well as perceptual deterrence theory provide several applications when put into practice within the creation of criminal justice statutes to address marijuana-impaired driving.

The concept of deterrence in criminal justice legislation may be described as making the cost of committing a crime high enough to outweigh the benefit of having committed the crime. However, opponents of perceptual deterrence theory point to states like Texas that have the death penalty and argued that it has failed to deter people from committing murder. Mendes (2004) noted while the severity of punishment plays a significant factor it is only one part of the theory. Mendes posited the key element in perceptual deterrence theory is the *perceptual likelihood* of being caught and arrested. If an individual believes if they drive under the influence they will be caught, arrested and punished, it is more likely the cost outweighs the benefit of committing the crime, and potential offenders may then decide to not drive reducing traffic fatalities. Perceptual deterrence theory and rational choice theory go hand in hand in explaining this deviant behavior and provided insight to legislators considering legalizing recreational marijuana.

While Beccaria is undoubtedly the founder of the classical school deterrence theory, it early on received little attention and was rejected by some theorists due to a lack of empirical research. Gibbs (as cited in Paternoster, 2010) noted that in his research where swift and certain punishment was sure, crime rates such as homicide was lower compared to other states. Furthermore, Williams and Hawkins (as cited in Paternoster, 2010) conceptually expanded upon perceptual deterrence theory and argued the inhibition of criminal behavior was directly or indirectly brought about as a result of perceived deterrence. This would suggest perceived deterrence was impacted by the perception of being caught and receiving swift and certain punishment.

Since Beccaria argued that everyone is motivated by self-interest, he also suggested there was no difference between those who commit criminal deviancy to those that do not (Lilly et al., 2011). According to Lilly et al., perceptual deterrence theorists have proposed, when an individual commits a crime, they have weighed the potential benefits and determined they outweigh the possible penalties, similar in nature to the theory of rational choice. This classical school approach would suggest individuals utilize rationality in their decision-making process based upon an individual's perception of consequences balancing risks and rewards. Society's perception and attitude toward marijuana impaired driving may affect an individual's decision to abstain from doing so. Media campaigns such as Mothers Against Drunk Driving and public outreach through Target Zero to address alcohol-impaired driving, appear to have shown some success by attempting to change perceptions that if you drive impaired you will be caught and prosecuted (WTSC, 2016).

Lilly et al. (2011) in comparing rational choice theory aptly noted its premise was situational compared to perceptual deterrence theory. The decision to offend is primarily based in part upon a person's perception of costs and benefits compared to the comparison of risk versus reward as in rational choice theory (Lilly et al., 2011). As such perceptual deterrence would suggest a correlation between specific deterrence and perceived punishment exists. The importance of operationalizing the costs, deterrence, and benefits are vitally important as an individual's perception may be subjective and change over time based upon external socioeconomic variables amongst other outside factors. These factors should also be taken into consideration when developing strategies and policies to reduce traffic fatalities involving cannabinoids.

When applied to the legalization of marijuana and marijuana related traffic fatalities, perceptual deterrence theory may help to explain why an individual drives impaired by marijuana. The likelihood a driver opts to drive impaired by marijuana believing they will be involved in a traffic fatality is slim. With many states exploring the legalization of marijuana as a method of generating revenue, law enforcement administrators and legislators must grapple with limited resources and how to apply them to address marijuana-impaired driving to reduce traffic fatalities involving cannabinoids. Perceptual deterrence and rational choice theory, may provide not only an explanation but a method in addressing growing trends in traffic accident fatalities involving cannabinoids. While policy administrators have worked to develop strategies in addressing alcohol-impaired driving, little is known about the impact of legalizing

marijuana and traffic fatalities involving cannabinoids. Currently, a significant gap exists within the literature to address this critical concern to the safety of our society.

Literature Review

The legalization of marijuana in the State of Washington through Initiative-502 occurred despite the federal government's classification of marijuana as a Schedule I drug through the Controlled Substances Act of 1970. Since then several other states seeking to legalize marijuana have had the extensive debate between proponents and opponents of this legislation. Saco (2014) stated during the late 19th century and early 20th century, doctors were able to prescribe drugs like cocaine and morphine for pain management. However, due to the drug's potential for abuse and risk of psychological and physical dependence, society's growing concern about the use of these drugs as a social problem within the United States led to strict regulation (Sacco, 2014). During this early period, the federal and state governments had a "hands off" attitude towards the regulation of importers, manufacturers, and distributors of such narcotics. McBride, Terry-McElrath, Harwood, Inciardi, & Leukefeld (2009) stated, "The *Sears Catalog* of 1897 advertised Peruvian Wine of Coca, guaranteeing that the product would provide energy, reduce fatigue, and enable workers to be productive under any conditions" (p. 72). Society's lack of understanding about how these drugs adversely impacted an individual led to such claims but failed to mention any associated risks.

Society's attitude toward these drugs would soon shift to one of regulation. Society began to increasingly become concerned about drug abuse, dependence, and an associated belief that problems about criminal deviancy were connected to illicit drug

use. In 1906, Congress sought to bring under control deplorable standards within the meat packaging industry and passed the Federal Food and Drug Act to create standards for food, drugs, medicines, and liquors (U.S. Food and Drug Administration, 2009). The creation of this legislation paved the way for greater regulation of the pharmaceutical industry. Society believed the lack of regulation to be the cause of widespread drug abuse, which in turn led to growing criminal behavior. Legislators believed by regulating the drug industry they in turn would be able to address chemical dependency issues as well as criminal deviancy. The consequences of this legislation and strict regulation would lead to what would soon become characterized as the war on drugs.

Sacco (2014) stated the Harrison Narcotics Act of 1917, required drug importers, manufacturers, and distributors to register and be taxed as well as maintain specific records as to its issuance. As a result, many physicians no longer prescribed those specific drugs and as a result the black market found a sizeable customer based within the United States (Sacco, 2014). Federal and state government began to address society's concerns and shift from a laissez-faire attitude to one of regulation and taxation. As an indirect result, the government created a black market that would impact society to this present day.

During the 1920s, the Department of Justice conducted prohibition enforcement for alcohol, and as a result, an internal department called the Federal Bureau of Narcotics was created to deal with narcotics enforcement (Chemerinsky, Forman, Hopper, & Kamin, 2015). Marijuana growth and use were legal under federal law at this time despite the Harrison Narcotics Act of 1917. Previous users of cocaine and opium were forced to

seek out the black market for the purchase and continued use of these drugs while others simply turned to the unregulated marijuana market (Carnevale & Murphy, 1999; Sacco, 2014). Congress quickly took note of this shifting trend, and during hearings, the Commissioner of the Federal Bureau of Narcotics testified to Congress that the primary criminal offender was the drug addict (Chemerinsky et al., 2015). Additionally, the racial divide within the country and xenophobia became associated with marijuana use further spurring advocates to press for greater regulation of the marijuana industry (Chemerinsky et al., 2015). Legislators believed greater regulation in conjunction with tougher criminal statutes for harvesting, transporting and possession would mainly stem a growing drug abuse problem within the United States. However, the opposite unintendedly resulted with the growth of the black market within a society with high demand and low supply.

Shortly after, the Marihuana Tax Act of 1937 was passed requiring a federal tax stamp on cultivation and distribution of marijuana (Carnevale & Murphy, 1999; Sacco, 2014). While the federal government did not explicitly prohibit marijuana, the regulated taxation was so high that the tax stamp was rarely issued and shortly after individual states moved to make the possession of marijuana illegal (Carnevale & Murphy, 1999; Sacco, 2014). State and federal government quickly shifted from a hands off approach toward strict regulation and taxation, which eventually led to making marijuana illegal. Under the Marijuana Tax Act of 1937, marijuana was dropped from the U.S. Federal Pharmacopoeia, the list of approved pharmaceuticals physicians were permitted to prescribe (Chemerinsky et al., 2015).

During the 1960s, marijuana use began to grow in popularity with drug users raising concern about criminal behavior associated with it. In 1970, President Nixon attempted to stem black market marijuana cultivation, sales and drug abuse with a sweeping reform known as the Comprehensive Drug Abuse Prevention and Control Act of 1970, also known as the Controlled Substance Act of 1970. Nixon's nationally televised speech to the nation declared a war on drugs by creating five schedules of drugs, with Schedule I being the most regulated (Cornell University Law School, n.d.). The American Medical Association (AMA) initially opposed the reclassification of marijuana, but since the Federal Bureau of Narcotics Commissioner's testimony before Congress associating drug abusers as the primary criminal deviant within society, advocates for greater regulation had grown (Sacco, 2014; Thompson, 2014). As a result, marijuana became reclassified as a Schedule I drug, considered to have no medical value with the most stringent restrictions placed on it. Marijuana was classified along with heroin and cocaine as a Schedule I drug as one which had no currently accepted medical use, a high potential for drug abuse and chemical dependency, and a lack of accepted safety under medical supervision (Cornell University Law School, n.d.). While the AMA opposed the reclassification of marijuana they suggested to continue scientific testing on the drug but with the restrictions placed upon marijuana through the CSA. With the Schedule I restrictions on marijuana, strict regulations made this difficult.

Sacco (2014) noted with marijuana's reclassification as a Schedule I drug came enhanced criminal penalties and the creation of a new federal agency to enforce the Controlled Substance Act. The Federal Bureau of Narcotics within the Department of

Justice dissolved, and in 1973, President Nixon created the Drug Enforcement Agency (Sacco, 2014). Touted as a more streamlined approach in the war on drugs, the agency specifically addressed organized crime and illicit drug trafficking, coordinating with state and local agencies (Sacco, 2014; Thompson, 2014). In 1973, the DEA had 1,470 special agents with a budget of $74.9 million, employing chemists, analysts, and investigators. By 2014, this number had risen to over 9,000 personnel with a budget of almost $2.0 billion (Sacco, 2014). This increase in staffing and cost from 1973, was brought about as many politicians sought a get tough on crime policy and desired to send a message as society's perception continued to blame criminal activity as primarily being drug related.

Just as President Nixon declared war on drugs, President Reagan continued this approach to combating drug abuse. Reagan's (1986) address to the nation on September 14th highlighted his campaign against drug abuse, which stated:

> From the beginning of our administration, we've taken strong steps to do something about this horror. Tonight I can report to you that we've made much progress. Thirty-seven Federal agencies are working together in a vigorous national effort, and by next year our spending for drug law enforcement will have more than tripled from its 1981 levels. We have increased seizures of illegal drugs. Shortages of marijuana are now being reported. Last year alone over 10,000 drug criminals were convicted and nearly $250 million of their assets were seized by the DEA, the Drug Enforcement Administration. (p. 421)

Despite the increased spending and drug seizures, marijuana continued to be grown domestically as well as transported across U.S. borders. Legislators continued to forward

their get tough on crime policies toward marijuana through new criminal statutes and enhanced sentencing guidelines in order to curb marijuana drug use. President Reagan's speech highlighted a number of factors that opponents eventually seized upon to propose marijuana legalization. Proponents argued increased spending by the Federal government against the war on drugs created a burden on local law enforcement agencies with limited budgets (Archambault et al., 2013). Furthermore, they argued strict regulation and targeted enforcement of marijuana was at the root of jail and prison overcrowding for what proponents argued were low-level offenses with long-term mandatory sentencing (Office of National Drug Control Policy, n.d.; Sundt, Salisbury & Harmon, 2016).

The Bureau of Justice Statistics (BJS) in 1990, published the results of a survey conducted in 1983 of incarcerated inmates, which noted 73% of prisoners self-reported marijuana use before committing their crime. The survey noted 53% admitted they were under the influence of drugs or alcohol or both at the time they committed the offense (BJS, 1990). Advocates for tougher legislation and enhanced sentencing guidelines pointed to these results for escalating the war on drugs. As a result, public opinion continued to be swayed negatively against marijuana drug use as it became synonymous with criminal deviancy. This attitude would continue until marijuana legalization proponents would take advantage of society's dissatisfaction of decades of increased spending to fight the war on drugs with what appeared to be little return on investment.

Data from the Monitoring the Future survey showed marijuana to be the most commonly used illicit drug in the United States. Johnston, O'Malley, Bachman, & Schulenberg (as cited in Collins, Vincent, Yu, Liu, & Epstein, 2014) stated that for adults

between 19 and 30 years of age, 57% reported lifetime use, 27% reported annual use. Furthermore, the study found men were more likely to smoke marijuana than women (Collins et al., 2014). They also noted minority groups were more likely to use marijuana than non-minority groups (Collins et al., 2014). Similar results were observed in a research study conducted by the Substance Abuse and Mental Health Services Administration (SAMHSA) in 2014, found that 7.3% of Americans reported using marijuana within the last year making it the most commonly used substance behind alcohol and tobacco. This study showed a higher percentage than the average use estimated by the United Nations in 2011 of a World average between 2.8% and 4.5% (Ducatti Flister, 2012; Scherf, 2015). The continued use of marijuana had not been curtailed by the federal government's classification of marijuana as a Schedule I drug and despite its rigorous enforcement to reduce the black market economy. Marijuana use has become more socially acceptable as several states enacted medical marijuana laws and decriminalized marijuana possession making it a civil infraction similar to a speeding ticket.

While the initial focus of the federal government had been to curtail the cultivation, transportation, and sale of marijuana, in light of criminal behavior in association with marijuana use, the government sought a two prong approach to curbing marijuana use. In addition to actively seeking out marijuana growers and dealers, the United States Sentencing Commission put forth mandatory sentencing guidelines for federal drug offenses. Sacco (2014) stated the commission took into consideration the quantity and type of drug involved. Naturally Schedule I drugs were a priority as they

were considered highly addictive, dangerous, and served no medicinal purpose. Further sentencing consideration was given if the crime also involved a case of violence. Lastly, the sentencing guidelines took into account the history of the offender (Sacco, 2014, ONDCP, n.d.). Proponents of legalizing marijuana were quick to argue that the less severe offense of marijuana possession and mandatory sentencing guidelines were to blame for jail and prison overcrowding.

Proponents incorrectly argued half of those incarcerated were for low-level drug offenses and the majority of those were only recreational marijuana users. Furthermore, supporters suggested mandatory sentencing unjustly imprisoned recreational marijuana users who posed no threat to society, thereby leading to jail and prison overcrowding on what proponents described as a failed government policy. The Office of National Drug Control Policy (ODNDCP, n.d.) in a response published *Who's really in prison for marijuana?* During 2002, an estimated 8,400 state inmates were serving time for marijuana possession of any amount, while less than half of them were first-time offenders. Additionally, the ODNDCP, (n.d.) estimated of the 1,200,000 inmates in state prisons; only 3,600 were incarcerated for first-time marijuana possession. While prison overcrowding existed, it was not as a result of first-time recreational marijuana users as suggested by proponents of legalizing marijuana.

The Bureau of Justice Statistics in Figure 1 noted there had been a steady increase of incarcerated individuals since 1980 within state and federal prisons. However, since 2010 there had been a small decline in incarceration overall. The incarceration rates are indicative of society's desire to deter criminal deviancy through regulation and criminal

statutes, as well as enhanced sentencing measures for an overall attitude to get tough on crime that many elected officials touted during their election run. Proponents highlighted the fiscal savings in legalizing marijuana. Kopel and Burrus (2012) stated Colorado spent $36.6 million annually in drug enforcement with 89.5% dedicated to enforcement of marijuana possession. Additionally, the state spent $20.7 million in court costs and $18 million to incarcerate individuals for drug offenses alone (Kopel & Burrus, 2012). Furthermore, the federal government spent $3.4 billion per year in marijuana enforcement, adjudication and incarceration alone (Kopel & Burrus, 2012). Legalizing marijuana for personal use quickly gathered steam in Colorado and Washington state in 2012, by appealing to the electorate's vote for government cost saving and generating tax revenue. Since then additional states have followed suit based in part on the ability to generate a substantial tax revenue source.

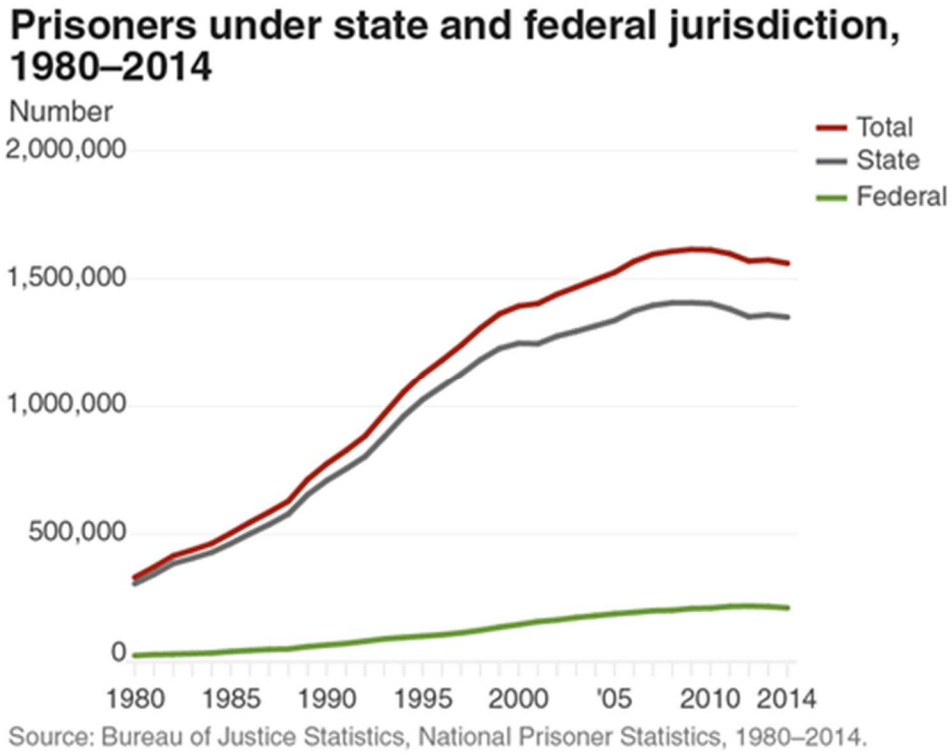

Figure 1. Prison population growth 1980–2014.

In 1970, the Federal Bureau of Narcotics Commissioner's testimony before Congress alleged drug abusers were the primary criminal deviant within society. The Department of Justice (as cited in Shepard & Blackley, 2007) stated a report by the Drug Enforcement Agency, which narrowed the commissioner's statement stated, "[…] Most violent crime are committed not because people want to buy drugs, but because people are on drugs" (p. 406). Local, state and federal law enforcement agencies had worked cooperatively to curb marijuana growth and sales in an attempt to create a shortage of marijuana within the black market. The government had dedicated billions in dollars to this war on drugs and up to this point had failed to address the criminal behavior of the marijuana user themselves. While a few states had decriminalized marijuana possession

making it a civil infraction, several continued to prosecute and incarcerate individuals for marijuana possession.

Economics of Marijuana

State governments initially followed federal guidelines imposing strict regulation and criminal penalties, opponents additionally argued that the war on drugs had failed to cite the growing use of marijuana within society and movement to legalize marijuana. Advocates to legalize recreational marijuana pointed to overcrowded jails and prisons due to mandatory sentencing guidelines, the ability to negate the black market through legalization, and the generation of tax revenue for cash strapped states through taxation (Archambault et al., 2013). As early as the 1970s, several states took steps to separate themselves from the federal government's growing regulation and enforcement of marijuana laws. In 1973, Oregon became the first state to decriminalize marijuana possession and made it a civil infraction with a monetary penalty.

While President Reagan's address in 1986 to the nation cited, spending had tripled since 1981, by 2007 it was estimated criminal justice resources were spending an estimated $8 billion a year enforcing marijuana laws (Shepard & Blackley, 2007). As costs continued to rise, numerous states looked to decriminalize marijuana; others opted to legalize marijuana for medical use. Colorado and Washington would eventually become the first to legalize marijuana for personal use, followed quickly by several other states. Archambault et al., 2013 noted Washington's limited resources and growing costs to address marijuana criminal behavior and marijuana legalization proponents began to

find favor in cash strapped states where society's attitude began to shift toward controlled sales of marijuana as a revenue source.

Three years later enforcement costs had tripled providing marijuana proponents another opportunity to forward legislation to the ballot box to legalize marijuana. Miron and Waldock (as cited in Scherf, 2015) estimated on average local and state governments spent $25 billion on law enforcement, the judicial system, and corrections as a whole enforcing marijuana laws throughout the United States (p. 129). During an economic downturn for the majority of states, proponents aptly argued how cash strapped states would benefit in legalizing marijuana freeing limited criminal justice resources and generating revenue through taxation (Archambault et al., 2013). Proponents suggested that by legalizing marijuana cultivation and sales, prices would drop below current black market prices thereby eliminating the black market entirely. Advocates suggested limited resources could be directed elsewhere such as education and transportation and generate revenue through taxation of legalized marijuana (Archambault et al., 2013).

Opponents argued that a drop in prices would increase demand for marijuana consumption as an entirely legal new market opened up to new consumers. Collins, Vincent, Yu, Liu and Epstein (2014) conducted a quantitative study about the elasticity of pricing and its relationship to supply and demand. The study showed that marijuana consumers were sensitive to price increases and instead proposed, states that legalized marijuana use might be able to benefit by stabilizing prices through taxation (Collins et al., 2014). Furthermore, similar to alcohol and tobacco taxes, it was argued higher taxation would raise pricing and thereby reduce and control marijuana use through

taxation (Collins et al., 2014). Proponents argued that states would be able to balance marijuana pricing while at the same time discourage increased marijuana use and eliminate the black market while still generating revenue for the state through taxation.

Washington State quickly followed the State of Colorado where voters enacted Initiative-502, to legalize the possession of recreational marijuana, despite its federal classification as a Schedule I drug under the Controlled Substance Act of 1970. Advocates argued legalizing marijuana would lead to a substantial cost savings to law enforcement agencies, the judicial system, and corrections (Archambault et al., 2013). Archambault et al., suggested agencies would no longer have to divert limited budgetary funds to investigate and prosecute marijuana possession. Additionally, proponents argued the correctional system would no longer be overburdened with individuals convicted of low-level offenses involving marijuana (Archambault et al., 2013; Washington State Legislation, 2012;). Proponents instead argued that a more restrictive legislature, along with mandatory sentencing guidelines, and government's continued pursuit to regulate marijuana created a cost prohibitive enforcement model that was draining already limited resources.

As a direct result, marijuana advocates successfully seized upon the growing cost of fighting the war on drugs. Advocates suggested by legalizing marijuana Washington state could potentially levy a marijuana tax and generate a revenue of almost $2 billion upon its implementation over a period of five to six years (Archambault et al., 2013; Washington State Legislation, 2012). During an economic time where several states faced shrinking revenues and budgetary shortages, the ability to tax and regulate what

was once a black market became economically viable and socially acceptable. The Washington State Office of Financial Management (WAOFM) also noted Washington State was one of a few states that did not have a personal or corporate income tax and thereby depended heavily on excise taxes, such as general sales and use tax, gross receipts and selective sales taxes (WAOFM, 2015). The economics of marijuana provided voters a strong stimulus to adopt legislation to legalize it as a revenue source. However, difficulty arose in conducting a financial analysis if the state were to legalize and tax marijuana due to the nature of the black market. Instead, proponents argued a substantial revenue source would be generated on approximate tax percentages established at each phase of manufacture and retail.

Legislators initially chose an excise tax of 25% on all wholesale and retail sales by a licensed grower, processor, and retailer, with all funds generated by the excise tax deposited into the newly created Dedicated Marijuana Fund (WAOFM, 2012). In addition to the state excise tax, any general state tax and local sales tax applied to marijuana are deposited into the State General Fund, similar to business and occupation taxes (WAOFM, 2012). Legislators quickly grasped onto the economics of marijuana to fill a void in an economy with shrinking tax revenues. Proponents also lucratively suggested generated tax revenue could backfill previous cuts to educational funding, highway improvements and other programs through money once spent on marijuana enforcement (Archambault et al., 2013).

The Washington State Office of Financial Management (WSOFM) conducted a Fiscal Impact Statement of I-502 (2012), to estimate state and local revenue impact from

FY 2013 through FY 2017. The lower revenue growth during FY 2013 and FY 2014 are as a result of the Washington State Liquor and Cannabis Board's direction by legislators to establish licensing requirements and designated certified cannabis testing laboratories. The WSOFM (2012) impact statement also shows the loss of $368,000 in Federal Grants since marijuana continues to be classified as a Schedule I drug. The loss of federal grant funding is outweighed by the generation of state revenue through marijuana taxation.

Table 1

State Revenue Impact

State Revenue Impact	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Dedicated Marijuana Fund	$0	$248,639,000	$434,201,000	$447,213,000	$460,615,000
Total State General Fund	$0	$47,418,000	$97,682,000	$100,611,000	$103,630,000
Fingerprint Identification Account	$8,000	$8,000	$8,000	$8,000	$8,000
Impaired Driver Safety Account	$48,000	$82,000	$83,000	$83,000	$84,000
Highway Safety Account	$505,000	$832,000	$839,000	$846,000	$853,000
Federal Grants	$0	-$368,000	$0	$0	$0
State Total	$561,000	$296,611,000	$532,813,000	$548,761,000	$565,190,000

Additionally, the WSOFM (2012) estimated local revenue generated through sales tax and business and occupational tax revenue through marijuana taxation. This lucrative source of income potentially provided state agencies and local governments the ability to

fund programs that had been rolled back during the fiscal crisis of previous years. While generated revenue would go to the state general fund, excess funds in the designated marijuana fund would be moved to the state general fund where they could potentially be utilized for other programs (WSOFM, 2012). The WSOFM (2012) estimated a surplus revenue of almost $100 million in the designated marijuana fund from FY 2015 through FY 2017 that could potentially be moved to the state general fund and fund previously cut programs. These surplus tax revenues proved to be a critical point marijuana advocates highlighted in passing Initiative-502. Several counties and municipalities had a moratorium on marijuana production and sales within their jurisdiction regarding this tax surplus incentive. They argued neighboring areas with retail marijuana stores may potentially lead to increased marijuana-impaired driving.

Table 2

Local Revenue Impact

Local Revenue Impact	FY 2014	FY 2015	FY 2016	FY 2017
Total Local Sales Tax Revenue	$15,856,000	$32,664,000	$44,644,000	$34,653,000
Total Local B&O Tax Revenue	$403,000	$830,000	$855,000	$881,000
Local Total	$16,259,000	$33,494,000	$34,499,000	$35,534,000

Marijuana Legalization and Driving Under the Influence

Archambault et al., (2013) conducted a cost-benefit analysis and estimated a potential tax revenue of $2 billion over five to six years. They aptly noted the difficulty in

determining the impact of marijuana legalization on marijuana-impaired driving and its associated consequences of vehicle collisions, fatalities, property damage and fiscal costs associated with the criminal justice system to address this issue (Archambault et al., 2013). With some states seeking to justify the legalization of recreational marijuana the impact of marijuana-impaired driving and subsequent vehicle collisions and traffic fatalities involving cannabinoids poses a significant risk to society. Since some states had already legalized medical marijuana, the National Safety Council (NSC, 2013) sought to provide guidance on the issue of marijuana and driving for state and local government agencies and organizations as well as society in general. The NSC (2013) determined that smoking marijuana caused impairment and operating a motor vehicle or heavy equipment while impaired by marijuana was unsafe to the extent that it posed a significant risk of injury or death to themselves or others. The importance of this stance was that it recognized smoking marijuana caused impairment and significant risk to society that marijuana proponents have not adequately acknowledged.

The National Highway Traffic Safety Administration (NHTSA) conducted a research study during weekend nighttime hours to see which type of impairment was more prevalent within drivers. 9,000 voluntary participants in over 300 different geographic locations within the United States were compensated $60 for their time, providing breath samples, oral swabs, and some offered blood (NHTSA, 2015). The results showed an 80% decrease in alcohol-impaired drivers from 1973 to 2014 (NHTSA, 2015). In contrast, marijuana impaired-driving showed a 47% increase amongst drivers between 2007 and 2014 (NHTSA, 2015). Additionally, further research studies showed

marijuana-impaired driving to be increasing while alcohol-impaired driving remained steady (Bogstrand, & Gjerde, 2014; NHTSA, 2015; Wilson, 2012).

Furthermore, research studies showed marijuana was the most preferred drug of choice among drivers compared to other types of drugs (Bogstrand, & Gjerde, 2014; NHTSA, 2015; Wilson, 2012). This increase in marijuana-impaired driving may be related to those states that have legalized medical marijuana, decriminalized marijuana possession making it an infraction, or legalized recreational marijuana altogether. In doing so, state and local governments have inadvertently led society to possibly perceive marijuana-impaired driving is less dangerous and less impactful than alcohol-impaired driving. The majority of states have taken preventative, deterrent and educational measures to address the problems of driving under the influence of alcohol. As society becomes increasingly tolerant of marijuana use, the risks associated with increased use within society have not been fully explored. Preventative measures such as educational campaigns similar to that of alcohol are not prevalent to those associated with Mothers Against Drunk Driving.

Recent studies have shown an increase in marijuana related crashes that exacerbates the legalization of marijuana (Salomonsen-Sautel et al. 2014). Failure to understand the risks that marijuana-impaired driving pose may inadvertently lead to increased motor vehicle accidents and DUI arrests and subsequently traffic fatalities involving cannabinoids (Pollini et al., 2015; NHTSA, 2015; Salomonsen-Sautel et al. 2014). After legalizing recreational marijuana in the State of Colorado, not only was there an increase in motor vehicle accidents but researchers found a significant increase

in the number of marijuana fatality drivers compared to alcohol related fatalities that remained at similar levels (Salomonsen-Sautel et al. 2014). Opponents have argued legislators not only indirectly increased marijuana traffic related fatalities and crashes but also increased the number of marijuana-impaired drivers on the roadway at any given time, thereby raising the risks of serious injuries and fatalities within the community.

Several organizations may be given credit for bringing awareness to alcohol-impaired driving such as Mothers Against Drunk Driving (MADD). MADD worked with legislators to stiffen penalties for repeat offenders and educating the public through educational outreach with the help of the media. Additionally, these organizations partnered with substance abuse counselors creating driving under the influence (DUI) courts specifically dedicated to impaired driving and reducing recidivism (Washington State's Target Zero Campaign, 2014). Furthermore, law enforcement agencies through grant funded programs partnered with media and other outreach programs in high visibility deterrent programs such as Washington State's Target Zero Campaign (2014).

However, since the legalization of marijuana, these educational and preventative campaigns have primarily focused on alcohol outreach programs. The dangers of marijuana-impaired driving have not yet reached society to the same extent that alcohol-impaired driving has (NSC, 2013). In contrast, the labeling of legalized marijuana use as recreational marijuana potentially creates a mindset within society that the risks associated with smoking marijuana and driving are relatively minimal (Acheampong, Okafor, Scheidell, & Johnston, 2014; Kohn, Saleheen, Borrup, Rogers, & Lapidus, 2014). With several states recently legalizing marijuana, the failure to examine whether a

relationship exists between legalized marijuana and traffic fatalities involving cannabinoids based on these previous studies, suggests a significant threat to society.

Research studies have shown the attitudinal understanding toward marijuana by particular groups within society such as high school and college students have substantially minimized the risks associated with the drug (Acheampong et al., 2014; Kohn, et al., 2014). The combination of limited educational outreach and society's dangerous misconception with regard to marijuana-impaired driving provides for a deadly combination. Qualitative research studies showed that a majority of both high school and college students would drive a motor vehicle after smoking marijuana (Acheampong et al., 2014; Kohn, et al., 2014). Furthermore, a majority of participants indicated their belief that alcohol was more dangerous than smoking marijuana and driving a motor vehicle (Acheampong et al., 2014; Kohn, et al., 2014).

Additionally, both high school and college students were more likely to ride with an individual who just smoked marijuana as a passenger than an individual who had been consuming alcohol (Acheampong et al., 2014; Kohn et al., 2014). Despite research studies finding increased risks of marijuana-impaired driving, some segments of society consider them to be far lower than those risks associated with alcohol and driving. This is contrary to the research studies conducted by NHTSA, 2015, NSC, 2013, Pollini et al., 2015, and Salomonsen-Sautel, et al. 2014, that showed marijuana-impaired driving increased a driver's risk of being involved in a traffic accident or marijuana related traffic fatality. These research studies laid the groundwork to build upon and explore whether a relationship existed between legalized marijuana and traffic fatalities involving

cannabinoids, and whether rational choice and perceptual deterrence theory may explain this problem.

According to Davis et al. (2016), the U.S. National Roadside Survey indicated a relative 47% increase in positive testing for THC in drivers between 2007 and 2014. This report showed marijuana was the greatest increase of all drugs tested (Davis et al., 2016). Davis et al. (2016) conducted a quantitative survey study, which examined the relationship between marijuana DUI and two types of behavioral precursors. The first precursor was knowledge of the legal consequences of marijuana DUI and the second was the understanding of the dangers of marijuana DUI (Davis et al., 2016). This research study helps understand contributing factors toward traffic fatalities involving cannabinoids. The Washington Traffic Safety Commission's Target Zero Campaign established a multi-agency coordinated approach to achieving zero traffic fatalities and serious injuries on Washington State's roadways by 2030 (WTSC, 2016). The Washington State Traffic Safety Commission in coordination with multiple agencies developed a plan that included addressing marijuana-impaired, which focused on the creation of five key objectives to include education and high visibility enforcement within certain high-risk corridors (WTSC, 2016). While there has been a downward trend since 1966 with regard to the nation's traffic fatality rates, factors such as lowering speed limits, mandatory helmet and seatbelt laws, motor vehicle safety improvements, and the lowering of an individual's breath alcohol concentration (BAC) from 0.10 to 0.08 BAC have all played a significant factor in reducing traffic fatalities (WTSC, 2016). Since the legalization of marijuana within Washington State a new variable has been introduced

into the traffic fatality equation, that of legalized marijuana and its possible relationship in traffic fatalities involving cannabinoids.

The Washington State's Target Zero campaign aggressively pursues impaired driving through public awareness, education and high visibility enforcement programs for DUI (WTSC, 2016). The WTSC (2016) Target Zero campaign approached reducing impaired driving fatalities and serious injuries through five key objectives, one of which is to enforce and publicize DUI laws. Strategies included high visibility enforcement (HVE) and media campaigns as well as educating law enforcement officers in detecting impaired driving (WTSC, 2016). WTSC's media campaigns have utilized phrases such as "Drive high – Get a DUI." (WTSC, 2016). This type of outreach is similar to MADD's educational outreach to lower driving under the influence of alcohol.

Legislators in Washington State attempted to address the issue of driving under the influence of marijuana through RCW 46.61.502, which defined driving under the influence of marijuana as:

> (1) A person is guilty of driving while under the influence of intoxicating liquor, marijuana, or any drug if the person drives a vehicle within this state:
>
> (a) And the person has, within two hours after driving, an alcohol concentration of 0.08 or higher as shown by analysis of the person's breath or blood made under RCW 46.61.506; or
>
> (b) The person has, within two hours after driving, a THC concentration of 5.00 or higher as shown by analysis of the person's blood made under RCW 46.61.506; or

(c) While the person is under the influence of or affected by intoxicating liquor, marijuana, or any drug; or

(d) While the person is under the combined influence of or affected by intoxicating liquor, marijuana, and any drug. (RCW 46.61.502)

The *per se* DUI limit of delta-9 THC levels, the psychoactive compound in marijuana, was set at 5.00 Nano grams per milliliter of blood and higher, which came about as a compromise between marijuana proponents trying to legalize the drug and legislators seeking to address traffic safety concerns. Karschner, Schwilke, Lowe, Darwin, Herning, Cadet, & Huestis (2009) conducted research that suggested THC concentrations remain prevalent in chronic marijuana smokers. Karschner et al., (2009) stated, "The likelihood of culpability increased 6.6-fold (95% CI 1.5–28.0) when drivers had blood THC concentrations at or above 5.0 ng/mL (approximately 10 ng/mL plasma)" (p. 475). I-502 proponents and legislators relied on this research study as a means to draft per se laws.

Little research to validate the per se limit had been completed at the time compared to the National Highway Traffic Safety Administration (NHTSA) sponsored research in 1975 (NHTSA, n.d.). The NHTSA (n.d.) research study led to the development of nationally accepted standards in voluntary standardized field sobriety testing (SFST). These SFSTs were adopted in 1981 by law enforcement agencies across the United States along with the mandated breath alcohol limit of 0.08 (NHTSA, n.d.). Research showed failing these sobriety tests demonstrated an alcohol impairment for driving that was typically above the alcohol concentration of 0.08 as demonstrated by analysis of breath or blood.

To address a gap in training between SFST certified officers and Drug Recognition Experts, the NHTSA with input from the International Association of Chiefs of Police and the Technical Advisory Panel, developed an Advanced Roadside Impaired Drug Enforcement (ARIDE) program to assist officers in identifying the signs and symptoms of seven drug categories (NHTSA, n.d.). The development of ARIDE testing procedures helped patrol officers in the field identify signs and symptoms of seven drug categories to include marijuana. However, ARIDE testing provides no guidance to officers for per se limits for drugs like marijuana. Officers must instead focus on the identification of the overall signs of impairment and rely on the testing of a driver's blood to identify the amount of THC in the blood (NHTSA, 2007). Legislators sought to add a per se limit for marijuana similar as had been done with the 0.08 breath alcohol limit.

Proponents of I-502 argued against setting a per se limit for marijuana and noted THC concentrations remain within an individual's blood for a protracted period and did not necessarily signify impairment. O'Kane, Tutt, and Bauer (2002) noted the importance of differentiating between delta-9 THC and THC-COOH, as the latter only represented recent use, while delta-9 THC levels affected a driver's ability to safely operate a motor vehicle. O'Kane et al., (2002) stated that setting a lower per se limit allowed police officers to overcome difficulties in proving a driver was marijuana-impaired. They noted Huestis et al., (1992) had proposed a consumption formula to measure THC levels (O'Kane et al., 2002). Proponents used this research to propose designating a level of delta-9 THC of 5.00 or higher as shown by analysis of a person's blood.

O'Kane et al., (2002) noted the consumption formula was based on serum plasma THC levels and when compared to whole blood levels, whole blood THC levels were approximately half of serum plasma. I-502 proponents suggested a delta-9 THC of 5ng/ml whole blood be applied. However, Karschner, Schwilke, Lowe, Darwin, Herning, Cadet, and Huestis (2009) noted in their research study, "Drivers with detectable blood THC concentrations were 2.7 times (95% CI 1.0–7.0) more likely to be culpable in an accident compared to drug-free drivers (37). The likelihood of culpability increased 6.6-fold (95% CI 1.5–28.0) when drivers had blood THC concentrations at or above 5.0 ng/mL (approximately 10 ng/mL plasma)" (p. 475). I-502 opponents countered lowering the THC level to 2.0 and argued it was necessary due to research studies suggesting increased traffic related accidents and fatalities involving drivers with marijuana in their blood. According to the Substance Abuse and Mental Health Services Administration (2014), marijuana use increased from 6.2% in 2002 to 8.4% in 2014, with approximately 22.2 million people aged 12 and older.

Furthermore, research showed smoking marijuana was most prevalent among individuals aged 18 to 25 where drivers were the least experienced (SAMHSA, 2014). This combined with research that showed a majority of high school and college students believed that driving under the influence of marijuana was less dangerous than driving under the influence of alcohol potentially leads to a dangerous combination (Bogstrand & Gjerde, 2014; Glascoff et al., 2013; Kohn et al., 2014). Despite the growing trends in marijuana use, the indifference to associated dangers while driving impaired by marijuana, increased traffic accidents involving marijuana-impaired drivers, legislators in

Washington State opted to settle with a THC limit of 5 ng/mL whole blood as the per se DUI limit without proven scientific research identifying this as a per se limit of impairment. According to the Centers for Disease Control (CDC), 13% of nighttime weekend drivers have marijuana in their system and were 25% more likely to be involved in a traffic accident compared to those with no marijuana use (CDC, 2016). With research studies showing marijuana use within society growing, society's attitude toward marijuana impaired driving as being considered by many to be less dangerous than alcohol impaired driving, and a growing trend in marijuana related traffic fatalities and accidents, the legalization of marijuana has posed some grave consequences for legislators to consider.

Since the legalization of marijuana in several states, researchers are seeking ways to detect marijuana impaired drivers and determine their THC concentration (Owusu-Bempah, 2014). While oral swabs have grown in popularity as a means to detect marijuana use, they do not provide police officers with the per se delta-9 THC limit required by legislation (Owusu-Bempah, 2014). Additionally, opponents argue that since marijuana can be identified days after smoking marijuana, the test is not of sound scientific practice to detect marijuana impairment (Owusu-Bempah, 2014). While blood tests provide a definitive answer, the Fourth Amendment protects against such intrusions without a search warrant, which relies on probable cause developed through observations of driving, statements made and SFST and ARIDE testing. Within Washington State a search warrant for an individual's blood must first be obtained, the same would be for obtaining oral swabs, which are less invasive.

Some case studies have suggested the best method to determine marijuana-impaired drivers are by a Drug Recognition Expert (DRE) trained to detect different types of drugs through a 12-step process based upon three scientifically accepted studies approved by the courts (Owusu-Bempah, 2014). However, a search warrant would still be necessary for a blood draw after the DRE made a determination for testing. The DRE would then be able to speak with specificity as to the individual's impairment. With the legalization of marijuana and its use becoming more prevalent, legislators and law enforcement administrators must provide necessary tools and training for officers to detect and apprehend marijuana-impaired drivers. Additionally, this should be combined with educating society that choosing to drive a motor vehicle while impaired by marijuana is not only inherently dangerous but may lead to death (NSC, 2013). Along with educating society as to the dangers of marijuana-impaired driving, law enforcement should combine these vital pieces with high visibility deterrence patrols. The disregarded bounded rationality and perceptual deterrence decisions made by the offender at the time of marijuana-impaired driving potentially lead to traffic fatalities involving cannabinoids if not countered correctly. Legislators may use these insights to develop policies and best practices to reduce these fatalities.

This aspect was identified by Archambault et al. (2013) in their cost-benefit analysis of I-502, which projected an approximate cost of over $2 million to train WSP troopers to identify marijuana related impairment through ARIDE certification. (Archambault et al., 2013). The analysis failed to apply the theories of rational choice and perceptual deterrence. To detect marijuana-impaired drivers, it is necessary to train

officers at a minimum in ARIDE testing procedures during their basic academy. This still falls considerably short of the drug recognition expert certification. As a result of legalizing marijuana, law enforcement agencies must now budget for additional training to address marijuana-impaired driving in order to prevent marijuana-impaired traffic fatalities. Detecting marijuana-impaired drivers on the roadway requires specialized training, staffing, and funding, to reduce traffic fatalities involving cannabinoids. In contrast to the State of Washington's per se limit for marijuana of 5 ng/ml whole blood of delta-9 THC, Oregon took a zero tolerance stance and stated any amount of marijuana within the driver's blood or urine would establish the driver was under the influence (Oregon Revised Statute § 813.010, 2016). This approach takes into consideration research that noted the decreased time frame that delta-9 THC affects a person's brain and its presence within the blood (Karschner et al., (2009). A critical piece of this research study was its reliance on serum plasma compared to whole blood, with plasma representing a 2:1 ratio to whole blood.

Despite conducting cost-benefit analyses of legalized marijuana, legislators failed to examine the potential outcome of marijuana-impaired driving and associated traffic accidents and related traffic fatalities when it came to driving under the influence of marijuana (Washington State Legislation, 2012; Archambault et al., 2013). Several studies have focused on the effects of drugged driving, traffic accidents, and fatalities and have shown an increase in marijuana use among drivers and those involved in accidents and deaths (Bogstrand, & Gjerde, 2014; NHTSA, 2015; Wilson, 2012). Furthermore, studies have shown while alcohol fatalities have remained at similar levels, there has

been an increase in marijuana-related deaths (NHTSA, 2015; Pollini et al., 2015; Salomonsen-Sautel, et al. 2014).

Additionally, studies show that attitudes toward smoking marijuana and driving are perceived as less dangerous than drinking and driving (Kohn et al., 2014; O'Malley & Johnston, 2013). These research studies show a growing trend in marijuana use and the attitudinal relationship between marijuana use and marijuana-impaired driving as posing little to no threat to self or society when compared to driving under the influence of alcohol. Little attention was given toward the relationship between legalized marijuana and traffic fatalities involving cannabinoids, which poses a significant risk to society (Kohn et al., 2014; NHTSA, 2015; O'Malley & Johnston, 2013; Pollini et al., 2015; Salomonsen-Sautel, et al. 2014). Until accepted scientific research studies establish a per se limit of 5 ng/ml as an impairment, prospective states seeking to legalize recreational marijuana must examine whether the current risks of marijuana-impaired driving and traffic fatalities involving cannabinoids outweigh the revenue that taxation brings with legalized marijuana. Furthermore, legislators must question whether any traffic fatality involving cannabinoids at this time is acceptable and whether a zero tolerance per se limit should be implemented.

Summary

With several states legalizing marijuana for personal use, the State of Washington selected a 5 ng/ml as a per se DUI limit to establish driving under the influence. The NSC (2013) took the position that after smoking marijuana an individual posed a significant threat of safety to self and others after smoking marijuana and then driving or operating

heavy equipment. Despite their recommendation, legislators did not change the per se limit for marijuana DUIs despite studies suggesting an increase in marijuana related traffic fatalities and indifference to the dangers of marijuana use and operating a motor vehicle Kohn et al., 2014; NHTSA, 2015; O'Malley & Johnston, 2013; Pollini et al., 2015; Salomonsen-Sautel, et al. 2014). Researchers found high school and college students were more likely to drive after smoking marijuana than if they had consumed alcohol. Furthermore, the majority of students considered marijuana to be less dangerous than alcohol when it came to driving under the influence (Salomonsen-Sautel, et al. 2014, Pollini et al., 2015, and the NHTSA, 2015). With the State of Colorado demonstrating an increase in marijuana related traffic accidents and traffic fatalities after its medical marijuana commercialization, the combination of marijuana impairment and and laisse-faire attitude poses an increased risk to society.

The WTSC's Target Zero campaign was developed to reduce traffic fatalities to zero by 2030 through among other things media blitz campaigns and periodic high visibility enforcement teams (WTSC, 2016). This aggressive approach in part draws upon two developed theories, rational choice and perceptual deterrence theory in reducing traffic fatalities. The purpose of this research study examined whether a relationship existed between legalized marijuana and traffic fatalities involving cannabinoids. The two theories helped explain possible factors that lead to marijuana involved traffic fatalities. Furthermore, the findings of this research study will aid legislators and policy administrators to develop laws and strategies to address marijuana impaired driving and

its associated risks, which lead to traffic fatalities. This research study has contributed to the existing body of knowledge and will allow other scholars to build upon.

Chapter 3: Research Method

Driving under the influence remains prevalent in the United States and is considered to be a leading cause in traffic fatalities. Numerous studies have addressed alcohol-impaired driving, but little is known about the relationship between legalized marijuana and traffic fatalities involving cannabinoids. With Washington State voters narrowly passing Initiative-502 to legalize marijuana for personal use on December 9th, 2012, the State of Washington followed Colorado in legalizing marijuana despite the federal government's classification of marijuana as a Schedule I drug. During an economic period when numerous states face revenue shortfalls, marijuana advocates have capitalized on the situation to legalize marijuana pointing to the state's ability to generate revenue through taxation. Since the enactment of Initiative-502, Alaska, Oregon, California, Nevada, Maine, and Massachusetts have followed suit in legalizing marijuana.

The purpose of this study was to examine the relationship between marijuana legalization and traffic fatalities involving cannabinoids in Washington. This chapter provides a comprehensive overview of the quantitative quasi-experimental time series design, also known as a regression point displacement design (RPDD) used to examine aggregated publicly available data collected from NHTSA's FARS system.

Research Questions and Hypothesis

This study included a quantitative quasi-experimental design called regression point displacement to examine the relationship between legalized marijuana in the State of Washington and DUI arrests. The following research questions were used to guide this study:

RQ1: Does a relationship exist between marijuana legalization and traffic fatalities involving cannabinoids in the State of Washington?

RQ2: Does rational choice theory explain any possible relationship between marijuana legalization and traffic fatalities involving cannabinoids in the State of Washington?

RQ3: Does perceptual deterrence theory explain any possible relationship between marijuana legalization and traffic fatalities involving cannabinoids within the State of Washington?

H_a: There is a significant relationship between marijuana legalization and traffic fatalities involving cannabinoids in the State of Washington.

H_o: There is no significant relationship between marijuana legalization and traffic fatalities involving cannabinoids in the State of Washington.

Research Design and Approach

I used a quantitative approach to examine the relationship between legalized marijuana and traffic fatalities involving cannabinoids in the State of Washington. Of the three research methods available, quantitative, qualitative, and mixed methods, a quantitative approach provided an appropriate means of addressing the relationship between variables. The treatment effect of legalized marijuana is a complex issue with regard to controlling for other variables that might influence the relationship between legalized marijuana and traffic fatalities involving cannabinoids. A quantitative design was appropriate to test the hypotheses.

The quantitative design involves standards of validity and reliability, including numerical measurements, and unbiased research findings. The epistemological foundation for quantitative research is postpositivism, which rejects absolute truth and the proving of hypotheses and instead seeks the failure to reject hypotheses (Creswell, 2009). When examining programs in which an intervention has been introduced and no random control groups are available, researchers typically use a pre and post quasi-experimental design.

Pre and post quasi-experimental time-series research designs work when there are multiple posttest time measurements. Multiple posttest time measurements were not available in the current study due to the delay in government reporting and reliance on secondary data collection. A quasi-experimental time-series design relies on multiple time-series measurements, as noted in Figure 2.

O_1 O_2 O_3 O_4 X O_5 O_6 O_7 O_8

Where X = the legalization of marijuana and O are pre/post data for DUI arrests.

Figure 2. Time-series design.

Although Initiative-502 was legalized in November 2012, the first marijuana retail store did not open until July 8th, 2014. This allowed the Marijuana and Liquor Control Board to develop regulatory practices. This also provided a delay in secondary data collected through NHTSA's FARS system for traffic fatalities involving cannabinoids. The delay in opening of retail marijuana stores slightly weakened the strength of this quasi-experimental time-series design but was reflective of an

individual's decision to drive impaired with the possibility of being involved in a traffic fatality.

The regression point displacement design (RPDD) was used to overcome the need for a multiple series design through the use of aggregate measures. The RPDD is used to compare a pretreatment group's regression line with an intervention group's posttreatment and multiple groups to determine whether a displacement exists from the regression line. The use of aggregate measures allows researchers to implement and analyze community-based interventions (Linden, Trochim, & Adams, 2006; Trochim & Campbell, 1966). The RPDD was used to compare a single treatment group, namely Washington State, through aggregation to multiple control groups and through aggregated data, namely the other 42 states that have not legalized recreational marijuana. Despite the overall simplicity of this design, it provides great statistical power.

The RPDD has become more common in population-based intervention and treatment programs such as managed health care facilities and clinics, and allows the state to analyze the effectiveness of various programs (Linden et al., 2006). The RPDD may be applied to examine public policy implementation, such as the legalization of marijuana in the State of Washington and whether a relationship exists between legalization and traffic fatalities involving cannabinoids.

The RPDD enables the researcher to address the issues involved in convenience sampling, which occurs during DUI arrests and traffic fatalities where the researcher cannot control for specific THC amounts. Convenience sampling consists of a naturally formed groups such as a church group, business organization, students in a class, or

individuals involved in a traffic fatality with the presence of cannabinoids. Convenience sampling is commonly used by researchers due to the accessibility of subjects and relatively lower expense. Unlike random sampling methods, convenience sampling does not allow the researcher to have any way of knowing whether the sample is representative of the population (Frankfort-Nachmias & Nachmias, 2008; Creswell, 2009). This study included aggregated nonidentifiable secondary data collected by law enforcement and coroners through NHTSA's FARS. I used the population of the State of Washington as the treatment group upon which an intervention had occurred. I compared pre- and postintervention results and compared those results to other states where marijuana was not legalized. The RPDD was appropriate for examining nonidentifiable, aggregated, publicly available data from a government agency. The control group included 42 non-recreational marijuana states and the intervention as the State of Washington, which allowed the design to yield strong internal validity (see Sundt, Salisbury, & Harmon, 2016).

The true experimental research design typically would afford full experimental control through random exposure of when a variable is introduced and to whom is exposed (Campbell & Stanley, 1966). The scientific approach reinforces the importance of random sampling, where the treatment and control groups are representative of the community and the researcher is able to generalize to the larger population. The current study addressed the relationship between legalized marijuana and traffic fatalities involving cannabinoids in the State of Washington since the enactment of Initiative-502. The RPDD was appropriate due to its pre- and posttest nature (Sundt et al., 2016;

Trochim & Campbell, 1996). Data from nonlegalized marijuana states as a control group were compared to a regression line, which was the strength of the RPDD.

As a quasi-experimental design, the RPDD is used to examine potential differences in preintervention and postintervention measures. The treatment group's posttest data are compared to a regression line of the control group to determine whether there is a significant change or displacement from the regression line (Sundt et al., 2016; Trochim & Campbell, 1996). If a significant change or displacement is evident, the researcher must consider other potential causes for the significant shift from the regression line. The use of other states as a control group lent credibility to this research design. The use of aggregated data from other states strengthened my ability to accept or reject the hypothesis. Sundt et al. (2016) stated that "a primary strength of RPDD is that it does not require us to make any assumptions about the comparability of US states, to match the treatment and comparison group, or to use changes in crime rates over time as a benchmark of comparison" (p. 13).

This research design afforded the ability to unbiasedly estimate a regression line to see if a significant change existed and whether a relationship existed between marijuana legalization and traffic fatalities involving cannabinoids in the State of Washington. A RPDD while considered a quasi-experimental design, leans more toward a true experimental design than other quasi-experimental designs, primarily from its use of control groups to control for other extraneous variables, lending further credibility of its application within this research problem (Trochim & Campbell, 1996). The basic notation of the RPDD is described in Figure 3.

$N_{(□ = 1)}$ O X O

$N_{(□ = 42)}$ O O

Where X = the legalization of marijuana and O are pre/post aggregated annual data for DUI arrests.

Figure 3. RPD notation.

The treatment group in RPDDs consist of one sample (n=1). In this design, aggregated data from the State of Washington consisting of pre and post traffic fatalities involving cannabinoids data was collected. This aggregated data is therefore representative of the population. The control group consisted of those states where marijuana was not legalized and is also representative of the population. At the time of this research study, Alaska, Washington, Oregon, California, Nevada, Colorado, Maine, Massachusetts, and Washington D.C. had legalized recreational marijuana. The remaining n=42 states had not legalized recreational marijuana and were used as the control group. Thus convenience sampling is minimized and not a threat to validity.

An important feature of the RPDD is the fact it does not require the same measurement instrument, particularly when historic changes have occurred (Wyman, Henry, Knoblauch, Brown & Brown, 2015). With the legalization of marijuana (X) in 2012, Washington State legislators amended RCW 46.61.502 – Driving Under the Influence as part of Initiative-502. Washington State legislators included a new per se limit for DUI, "The person has, within two hours after driving, a THC concentration of 5.00 or higher as shown by analysis of the person's blood made under RCW 46.61.506" (Washington State Legislature, 2016).

Prior to 2012 and the passage of I-502, law enforcement demonstrated impairment through SFSTs and marijuana consumption without a per se requirement. This is the same for the current control group. The other prong to this piece of legislation was it retained the, "under the influence of" requirement about marijuana and poly-drug combinations. Therefore, traffic fatalities involving cannabinoids may include both per se, poly-drug combinations, and marijuana impairment within the aggregated totals.

According to Trochim & Campbell (1996), a RPDD is characterized by four key features that provide a significant strength in analyzing this research problem. Firstly, the treated group is considered to have a size of n=1. Some may think n=1 is a small sampling size, but the sampling group is comprised of the entire population of the State of Washington. Secondly, collected data is aggregated instead of used at the individual level. Thirdly, no adjustments are necessary as the pre-treatment group and control group are assumed to be equal. Lastly, a regression line is used to observe if a post-test displacement has occurred since the treatment intervention (Trochim & Campbell, 1996). On the surface, the use of aggregated data appears to impact the effect size, the RPDD's aggregation provides a closer representation of the mean.

This research provides a foundation for others to build upon, further research studies with greater time, funding, and accessibility to data will be able to expand upon this study. Researchers can explore additional variables such as geographic demographics and socioeconomic factors that impact legalized marijuana and traffic fatalities involving cannabinoids. Biglan, Ary & Wagenaar (2000) noted quasi-experimental time series designs are best used when convenience sampling is necessary, and a limited number of

variables are involved. Other quasi-experimental designs do not control for extraneous variables. The use of a t test would only indicate whether a change has occurred, not accounting for if it is due to the independent variable, namely the legalization of marijuana. This research design is the best approach to correctly examine whether a relationship exists between legalized marijuana and traffic fatalities involving cannabinoids with the data available to the researcher.

Independent and Dependent Variables

This research study tested to see if a relationship existed between the independent variable and the dependent variable. The following definitions are utilized and guided this quasi-experimental time-series design:

The Dependent Variable (DV) is termed as a "traffic fatality involving cannabinoids", which includes per Washington State RCW:

> (1) A person is guilty of driving while under the influence of intoxicating liquor, marijuana, or any drug if the person drives a vehicle within this state:
>
> (a) And the person has, within two hours after driving, an alcohol concentration of 0.08 or higher as shown by analysis of the person's breath or blood made under RCW 46.61.506; or
>
> (b) The person has, within two hours after driving, a THC concentration of 5.00 or higher as shown by analysis of the person's blood made under RCW 46.61.506; or
>
> (c) While the person is under the influence of or affected by intoxicating liquor, marijuana, or any drug; or

(d) While the person is under the combined influence of or affected by intoxicating liquor, marijuana, and any drug. (RCW 46.61.502)

The DV was measured as an aggregated variable considered to be more precise and representative than individual values.

The Independent Variable (IV) is termed as "legalized marijuana" to include all marijuana to include all parts of the plant Cannabis, whether growing or not, with a THC concentration greater than 0.3 percent on a dry weight basis. The IV was measured as 1 = Washington State's I-502 legalized marijuana and 0 = Other States where marijuana is illegal.

Poly-drug is defined as more than one drug to include controlled substances and over the counter substances as detected in the toxicology screening by the Washington State Patrol Toxicology Laboratory. In the event toxicology results yield a poly-drug, any amount of marijuana was used to meet the criteria of the dependent variable.

Resource Constraints

This research study relied on aggregated data collected by NHTSA's FARS system. The use of available secondary data helped to explain why a RPDD is utilized in this research study. This data relied heavily on law enforcement officers and coroners to correctly identify the presence of cannabinoids within a driver's system. A marijuana-alcohol poly combination may not be readily apparent to the officer or coroner without proper testing.

Not all law enforcement officers are ARIDE certified, which helps officers to identify the signs of marijuana use and other drugs. Poly-drug use such as marijuana and

alcohol potentially impact the officer's ability to correctly identify marijuana-impaired driving. With an officer's time constraints, if alcohol is the only indicator on scene during a traffic fatality a toxicology screening may not look for other drugs in an individual's blood or urine.

Methodology

Population and Geographical Location of the Study

According to a population survey conducted by the State of Washington (2016), the following annual population totals were as follows. In 2011 there were 6,767,900, in 2012 there were 6,817,770, in 2013 there were 6,882,400, in 2015 there were 7,061,410, and in 2016 there were 7,183,700. Washington State is bordered by the states of Idaho and Oregon, the latter having legalized marijuana use in 2014. This research study acknowledges the possibility of non-residents traveling through or visiting the State of Washington, who may have purchased and used marijuana legally within the state being involved in a traffic fatality involving cannabinoids. Since marijuana legalization there has been an increase in population by about 365,930.

The Washington Traffic Safety Commission's (2016) strategic plan implemented a high visibility DUI prong that focused on geographical areas of population density and high numbers of DUI crashes. The focus of emphasis patrols on specific geographical regions potentially skews the ability to generalize back to the entire population. Furthermore, the number of marijuana retailers within a particular county may also unduly influence the number of marijuana impaired drivers through its ease of availability.

Sampling and Sample Size

Traffic fatalities involving cannabinoids are a form of convenience sampling within the general population. In the case of this research study, aggregated state data collected during these events and submitted to NHTSA's FARS were selected for traffic fatalities involving cannabinoids. Research studies have examined relationships between socio-economic variables such as education, income, unemployment, and other variables with regard to driving under the influence of marijuana and noted the complex nature of the problem (Creswell, 2009; Frankfort-Nachmias & Nachmias, 2008). In this research study, the RPDD utilized an aggregated method of sampling and the population of n=1, which will be compared to a regression line to the control groups of other states n=42 where marijuana is not legal. There is a gap in the literature regarding marijuana legalization and its impact upon traffic fatalities involving cannabinoids.

Threats to Validity

Threats to internal validity exist when a researcher draws conclusions from an experimental research design that does not reflect the results of the experiment itself (Creswell, 2009). The following threats to internal validity may affect the outcome of a researcher's study, history, maturation, testing, instrumentation, regression, selection, mortality, and interaction of selection and maturation (Creswell, 2009; Frankfort-Nachmias & Nachmias, 2008). Selection bias is a threat to validity where some sociologists have argued that minority groups are more susceptible toward marijuana use due to possible socioeconomic variables within a particular community and may be involved in a traffic fatality as a result (Creswell, 2009; Frankfort-Nachmias &

Nachmias, 2008). Targeted DUI enforcement in minority communities may skew results with regard to rational choice and perceptual deterrence theories. The RPDD utilized aggregated data, which in turn creates variability and instead a high degree of internal validity (Linden, Trochim & Adams, 2006). The design's strength of n=1 as the aggregated treatment group limits the threat to internal validity. Extraneous variables potentially exist and may compete with the independent variable. The RPDD controlled for these extraneous variables through the control groups (Other States) where marijuana is not legal. Utilizing aggregated data means the population is fairly representative of the treatment group as a whole. Since marijuana legalization in Washington no other significant changes in policing have been made. Therefore, the interaction between independent and dependent variables are not likely a threat to internal validity.

RPDD also controls for historical threats to validity as the design is essentially a comparison between the treatment group and the control group. Maturation also is not a threat to this model as it assumes any changes to the dependent variable, namely a traffic fatality involving cannabinoids occurs within both groups at the same rate. Since the RPDD controls for extraneous variables and its use of aggregated secondary data it has a strong internal validity. The threat to validity occurs when the pre-test affects the outcome of the post-test. RPDD is not impacted by this as the treatment and control group are exposed to the same pre-test conditions, where it is illegal to drive under the influence of marijuana. Therefore, any post-test difference is not a direct result of testing.

The legalization of marijuana through Initiative-502, added a per se of THC within an individual's blood, but also kept the impairment prong within the revised code

of Washington (RCW). The per se nature is a moot point as the study narrows its scope to traffic fatalities involving cannabinoids and not per se limits. Future studies may wish to expand upon this research. While the RPDD is not a true experimental study, it is the best design to measure implemented social policies such as marijuana legalization and its possible impact on traffic fatalities involving cannabinoids.

Cronbach's alpha is the most commonly used measurement to test reliability and internal consistency when it comes to the social sciences such as the research of public policy implementation and its effects where aggregated data exists (Bonett & Wright, 2015; Vaske, Beaman & Sponarski, 2017). Washington State will be excluded from the Cronbach's alpha and test-retest reliability due to it being the treatment group. The test-retest would be administered to the "Other States" or the control group to measure the degree to which the results are consistent over time. This testing method is the most commonly accepted principle of reliability. The test-retest would be that data collected from the control group pre and post-test using Pearson's r for test-retest reliability. The scores are correlated and the closer they are to one another the higher degree of reliability and coefficient of test measure. The closer to the coefficient of stability to 1.0 means that the test-retest are closely aligned. A coefficient of stability of 0 would mean the test is unreliable.

Data Collection and Analysis

This research study utilized aggregated data collected through NHTSA's FARS regarding traffic fatalities involving cannabinoids. The aggregated data had no identifiers and was submitted by law enforcement officers and coroners through NHTSA's FARS

system. The data is existing, aggregated, publicly available data that do not have identifiable indicators. The data will be checked for data entry errors by the researcher. The use of secondary data is the best source of data for this research study as it is collected by law enforcement officers and coroners at or about the time of a traffic fatality and is available to the general public.

Since the data is aggregated, vulnerable groups may be embedded within the data but they do not have identifiable indicators and as such I have no idea of who they might be or how many might exist within the data. Police officers and coroners make a determination whether or not the traffic fatality involves cannabinoids. I have as a police officer stopped individuals and investigated them for driving under the influence. I have also investigated traffic fatalities some of which included cannabinoids. The data was provided by NHTSA's FARS system and coded by the researcher into an Excel file dataset. I then exported the coded data into a software analysis tool called Statistical Package for Social Sciences (SPSS) version 23.0.

The treatment group of n=1 consisted of an aggregated sum of traffic fatalities involving cannabinoids within Washington State where marijuana is legalized. The control group of n=42 consisted of an aggregated sum of traffic fatalities involving cannabinoids in all states where recreational marijuana is not legalized, with total N=43. The RPDD consisted of four post-tests comprised of aggregated traffic fatalities involving cannabinoids between 2013-2016. The statistical notation of the pre and post research design of multiple points is described in Figure 4.

Pre-Test	Treatment	Posttest1	Posttest2	Posttest3	Posttest4
N□□□□□	O□□□□□□	X	O□□□□□□		
N□□□□□□	O□□□□□□	X	O□□□□□□		
N□□ □ □□	O□□□□□□	X		O□□□□□□	
N□□ □ □□□	O□□□□□□			O□□□□□□	
N□□ □ □□	O□□□□□□	X			
	O□□□□□□				
N□□ □ □□□	O□□□□□□				
	O□□□□□□				
N□□ □ □□	O□□□□□□	X			
	O□□□□□□				
N□□ □ □□□	O□□□□□□				
	O□□□□□□				

Figure 4. RPD pre and posttest notation.

Statistical Power

The key strength of the RPDD lies within the concept of aggregated data. On the surface small sample sizes may appear to reduce statistical power but the design incorporates multiple data points and does not represent individual values (Linden et al., 2006; Sundt et al., 2016). When large aggregated values are utilized, the statistical assumption about the normal distribution of variables is more than likely met (Linden et al., 2006; Sundt et al., 2016). The statistical power may be thought of as the probability of rejecting the null hypothesis (Ha) when the hypothesis (H_1) is true.

At a glance, the RPDD appears to be low in statistical power based upon the low number of pre and post-test points. It is important to note each point is a representation of an aggregated group of data and not individual points. Linden et al., (2006) stated:

> Such group means, totals or rates, are typically more stable and precise than within-group data (Trochim & Campbell, 1996, 1999) and they correspondingly increase the strength of the prepost measure correlation coefficient (which is also a factor in the available power). Given that only one group is assigned to the intervention, power can be increased as a result of either a rise in the number of controls or demonstrating a large program effect. (p. 420)

The number of control groups within this study consists of all the other states where marijuana is illegal (n=42). The treatment group consists of an aggregated total of traffic fatalities involving cannabinoids within Washington State n=1.

The size and statistical significance of the treatment effect are measured by utilizing an Analysis of Covariance (ANCOVA). Sundt, Salisbury & Harmon (2016) aptly noted ANCOVA's difference:

> ANCOVA differs from gain scores or difference-in-difference scores, which estimate the effect of the treatment by comparing the average gain for the treatment group to the average gain for the control group. In contrast, the ANCOVA model here tests whether the posttest for the treatment group differs from its predicted location in the population, controlling for the pretest measure. (p. 17)

ANCOVA is considered best suited when controlling for extraneous variables such as traffic fatalities involving cannabinoids where pretest data has a somewhat linear relationship to post-test data (Sundt, Salisbury & Harmon, 2016). The RPDD is superior to other designs with what data I had available. Furthermore, this research design will lay a foundation upon which future researchers can further the existing body of knowledge.

Role of Researcher and Bias

I am employed as a law enforcement officer within the State of Washington, with a 15-year background in law enforcement. One of my primary duties includes traffic enforcement and the deterrence and detection of impaired drivers. I have participated within the Washington Traffic Safety Commission's Target Zero Campaign as a DUI emphasis patrol officer and Law Enforcement Liaison Officer. I have through my duties in part collected both pre and post data upon the arrest of an impaired driver involved in an accident as well as a traffic fatality involving cannabinoids. I have collected in part the secondary data through the Washington State Patrol's reporting process.

Summary

Examining whether a treatment effect such as a public policy decision has had a particular outcome within a population or group can be difficult to ascertain due to the number of outside variables that potentially impact the treatment effect. RPDD is aptly suited for analyzing public policy decisions and their implications, utilizing a pre-posttest design that follows a quasi-experimental approach. The post-test results of the treatment group are compared to the pre and post-test of a regression line from the control group. Sundt et al., (2015) stated, "[…] RPDD allows us to test the effect of treatment on the

posttest that is not predicted from the pretest" (p. 12). Another strength of the RPDD is that it does not require the researcher to make any assumptions as to the comparison between US states and therefore overcomes the issue of convenience sampling.

Due to the nature of traffic fatalities involving cannabinoids, it is not possible to utilize a research design with true randomization and control. It can be said with confidence that both the treatment and control groups are representative of the population. Sundt et al., (2015) noted an additional strength of the RPDD was its capacity to approximate, "[…] A true experimental design in its ability to yield internally valid results" (p. 13). For this reason, the RPDD is an excellent design for analyzing whether a relationship exists between marijuana legalization and traffic fatalities involving cannabinoids.

Chapter 4: Results

The federal government during the early and mid 1900s shifted toward greater regulation and penalties for marijuana. Marijuana was classified as a Schedule I drug with no currently accepted medical use, the potential for psychological and physical dependence on it, as well as potential for abuse. Some states have opted to decriminalize marijuana while others have legalized its medical use, and eight states have chosen to legalize its recreational use. Research studies have shown an increase in drivers who tested positive for the presence of marijuana in traffic fatalities since its legalization in Colorado, and drivers testing positive for the presence of marijuana (Bogstrand & Gjerde, 2014; Pollini et al., 2015; Salomonsen-Sautel et al., 2014; WTSC, 2016). Washington State implemented Target Zero, a strategic traffic safety plan that addressed high-risk behaviors and methods for improving traffic safety. Marijuana-impaired driving is a high-risk behavior that has led to traffic fatalities. The overall goal of this plan is to reduce the number of traffic fatalities in Washington State to zero. This research study addressed the relationship between marijuana legalization and traffic fatalities involving cannabinoids.

Studies have shown that marijuana use and operating a motor vehicle or riding in one where the driver has recently smoked marijuana is considered by some high school and college students to be less dangerous than if the driver had consumed alcohol (Bogstrand & Gjerde, 2014; Glascoff et al., 2013; Kohn et al., 2014). Society's shift in attitude toward marijuana use and driving after smoking marijuana may be in part reflected through legislators drafting laws about marijuana-impaired driving under the

influence, and the results of this attitude shift may be indicated through those arrested for marijuana-impaired driving.

The purpose of this research study was to examine whether a relationship exists between marijuana legalization and traffic fatalities involving cannabinoids in Washington State. Two subquestions addressed whether the theories of rational choice and perceptual deterrence helped explain any possible relationship between marijuana legalization and traffic fatalities involving cannabinoids in the State of Washington. The following hypotheses stated Ha there is a significant relationship between marijuana legalization and traffic fatalities involving cannabinoids in the State of Washington. Whereas, the Ho stated there is no significant relationship between marijuana legalization and traffic fatalities involving cannabinoids in the State of Washington.

This study included annually aggregated totals of traffic fatalities where cannabinoids were present. The study also included a regression point displacement design to analyze the results through SPSS Version 23. In this chapter, I describe the use of the regression point displacement design, detail the demographics and collected data, provide a descriptive analysis of the data and results, and conclude with a summary.

Data Collection

The National Traffic Safety Administration (NHTSA) through its National Center for Statistics and Analysis has collected data on all police-reported traffic fatalities on all public roadways in the 50 states, the District of Columbia, and Puerto Rico since 1975. The Fatality Analysis Reporting System (FARS) contains the census data collected from these reported traffic fatalities. The purpose of FARS is “to provide an overall measure of

highway safety, to help identify traffic safety problems, to suggest solutions, and to help provide an objective basis to evaluate the effectiveness of motor vehicle safety standards and highway safety programs" (NHTSA, 2014, para. 6). The FARS data set for fatal motor vehicle traffic crashes and fatalities in accidents and those involving a driver who tested positive for drugs by state also includes fatal crashes involving cannabinoids.

The FARS has included a standardized reporting system to collect data used by most states. Federal, state, and local governments use FARS to develop policy and legislation to improve vehicle safety and traffic laws including driving under the influence. Additionally, FARS is used by researchers, advocacy organizations, insurance companies, and private citizens for the collection of data to be analyzed. FARS is not used to collect individually identifiable data, and vehicle identification numbers collected during the investigation are truncated to protect personal information (NHTSA, 2014). Although other sources of data were available from state toxicology laboratories, not every state maintains records or has a sufficient time frame of records to conduct an analysis. The lack of consistent data, the inconsistency in sampling, and the threshold between states made other sources of data unsuitable for this study. The data collected for this study included fatal crashes involving cannabinoids between 2012 and 2016.

Due to insufficient and inconsistent data from state toxicology laboratories, the purpose of this study shifted from examining whether a relationship existed between marijuana legalization and DUI arrests to the relationship between marijuana legalization and traffic fatalities involving cannabinoids. A revised request was made to the institutional review board (IRB approval number 02-28-18-0469545) to obtain data from

NHTSA's FARS website reporting system and was approved. An e-mailed request to NHTSA's National Center for Statistics and Analysis was made for annually aggregated data by state and territory for traffic fatalities involving cannabinoids, which was provided in tabulated form and transferred in SPSS.

The regression point displacement design was used to compare the treatment group aggregate value against a set of control groups. The treatment group was the state of Washington, with the intervention being marijuana legalization for recreational use, while the control consisted of 42 states and the territory of Puerto Rico where marijuana is not legal for recreational use. The study relied on the response of a law enforcement officers to a traffic fatality and the collection and analysis of blood or urine toxicology. Both the treatment group and control groups involved a randomized draw demographically from the state and were therefore considered representative of the larger population (see Sundt et al., 2016). Trochim and Campbell (as cited in Linden et al., 2006) stated "the primary concern is whether the control groups yield an unbiased estimate of the true population regression line and/or whether the treatment group is a member of the control group population" (p. 410). In this study, both concerns were minimized as the treatment and control group yielded an unbiased representation of the larger population.

Data Limitations

This study involved different DUI laws involving driving under the influence of marijuana. Under Washington State's RCW 46.61.502 – Driving Under the Influence of marijuana is stated as

> (b) The person has, within two hours after driving, a THC concentration of 5.00 or higher as shown by analysis of the person's blood made under RCW 46.61.506; or (c) While the person is under the influence of or affected by intoxicating liquor, marijuana, or any drug; or (d) While the person is under the combined influence of or affected by intoxicating liquor, marijuana, and any drug. (RCW 46.61.502)

A fundamental limitation of this research study was FARS data did not differentiate between the presence of marijuana in a decedent and the decedent meeting the Washington State requirement of within 2 hours after driving, the driver must have a THC concentration of 5.00 or higher. It was not possible to determine whether the decedent was under the influence or affected by marijuana without conducting specific roadside tests or determining the actual THC concentration, which some states do not do.

Initially, this study was designed to examine whether there was a relationship between marijuana legalization and DUI arrests. The IRB had approved the research and data collection process. When I contacted state toxicology laboratories, I found that there was no uniform data collection process by the laboratories. Although some states selected to draw blood, others opted for urine testing during the arrest. Additionally, depending on whether there was a poly-drug combination, blood or urine may or may not have been analyzed for delta-9 tetrahydrocannabinol levels and merely the presence of Carboxy THC.

The differences among state testing practices and the lack of uniform collection of data were detrimental to this study. Washington State used a measurement stating that

within 2 hours after driving, the subject must have a THC concentration of 5.00 or higher as shown by analysis of the person's blood. Due to these data collection limitations and inconsistencies, data collection and analysis were impossible as initially proposed. As a result, I used traffic fatality data as a proxy measure of marijuana use while driving to explore the relationship between legalized marijuana in Washington State and traffic fatalities involving cannabinoids. The IRB reviewed and approved the changes to the study with a change in the proposed research questions and hypotheses.

Impaired driving may appear somewhat simplified as a cause of traffic fatalities. The issue of poly-drug combinations makes it difficult to determine whether a particular drug, alcohol, or a combination thereof was the cause of the impairment and thereby the traffic accident and fatality. Additional factors complicate the research about traffic fatalities such as the type of vehicle, whether or not it was equipped with airbags, whether the driver was wearing a seatbelt, speed, and roadway engineering. The National Safety Council (2013) determined that smoking marijuana caused impairment, and operating a motor vehicle or heavy equipment while impaired by marijuana was unsafe to the extent that it posed a significant risk of injury or death. The nature of impairment may include poor judgment such as the driver not wearing a seatbelt, the driver traveling at an unsafe speed, or the driver not using greater caution. This study focused only on whether cannabinoids were present in the driver(s) at the scene of a traffic fatality.

The National Highway Traffic Safety Administration (2014) noted differences in drug testing procedures and lack of consistency among states for drug testing and threshold levels. Some states test all drivers involved in the fatality, other states only test

for drugs when evidence points to the suspicion of drug impairment, and other states do not test for other drugs if alcohol is present. Due to the cost of drug testing, some toxicology laboratories perform a cursory examination for the presence of drugs instead, and other laboratories have differing threshold levels for the presence of drugs. Furthermore, not all laboratories use the same method for testing drugs. Washington State uses a blood draw sample for testing while other states use urine or an oral fluid swab (NHTSA, 2014). The lack of uniformity in throughout the states posed a limitation to this study as well as to creating legislation and policies to address marijuana-impaired driving.

As states shift to legalize marijuana for recreational use, researchers seek to develop appropriate testing methods for law enforcement to utilize in the field to determine marijuana impaired driving. Washington State courts do not accept the use of a portable breath test in the field with regard to alcohol and is merely used as a tool to confirm an officer's decision based upon standardized field sobriety tests. Advanced roadside investigative drug evaluations may show indicative drug use, do not explicitly aid the officer in determining a the per se 5.00 ng/ml delta-9 THC has been met. A DRE would be able to determine the type of drug and speak to impairment, but only an analysis of toxicology would determine if the per se has been met. Those states with a zero tolerance for marijuana impaired driving, will find oral swabs are an easy method to determine the presence of THC, but it should be noted that in some cases the presence of Carboxy THC may be detected weeks after consumption unlike Delta-9 THC that is quickly absorbed into the blood and beings to leave the body making identifying levels of

THC for DUI difficult. Furthermore, search warrants are necessary to conduct an oral swab but are a less invasive method than drawing blood.

Lastly, while Initiative-502 was enacted in November of 2012, the first legalized retail store in Washington State did not open until July 8th, 2014. The delay in opening is attributed due to the time it took for the newly formed Washington Liquor and Cannabis Board to develop protocols for licensing of growers and retail stores, establishing vetting processes, and the number of licenses to be issued. Therefore, the data results for 2013 do not adequately reflect marijuana use from retail sales and likely includes statistical data from the black market, medical marijuana sales, and personal growth. The results are included in this research study merely as a post initiative benchmark for review.

Results

This research study utilized a regression point displacement design (RPDD), a quantitative quasi-experimental pre-test/post-test design that allowed for the study of implemented public policy legislation such as I-502 and its possible implications utilizing an ANCOVA analysis. The post-test results from the intervention group are compared to a pre/post-test regression line of control groups to see if there is a vertical displacement. A significant shift from the regression line would indicate a possible implication due to the intervention. This simple premise provides for a method to analyze the impact of policy interventions from a criminal justice perspective such as legalizing marijuana within the state (Trochim & Campbell, 1996, 1999; Linden, Trochim, & Adams, 2006; Sundt, Salisbury, & Harmon, 2016). The quasi-experimental time-series design of the

RPDD allowed this research study to utilize aggregated data by year instead of using individual points, upon which its statistical power is based.

Statistical power for the research study may initially appear to be small, but this would be an incorrect assumption of the RPDD. Linden, Trochim, and Adams (2006) aptly stated:

> To clarify this point further, assume a study in which 10 medical groups are compared where 1 group received the treatment and 9 did not. The unit of measure in this study is the medical group. Individual group measures may include the following: type of medical group (general practice or specialty care), reimbursement method (fee schedule or capitation), location (urban or rural), and so on. With a sample size of 10 units, these individual group level measures can be widely variable and thus limit the ability to draw conclusions from the outcomes. However, measures that are aggregated to the group level such as office visits per thousand patients, prescriptions per patient per year, and so on, have much less variability because the denominator for each measure is based on size of the group's population (which in most cases can be in the hundreds or thousands). (p.411)

This research study has one treatment group, Washington State (n=1) and 43 control groups where marijuana has not been legalized for recreational use (n=43). The measures are aggregated to the group level and drawn from the population of each state allowing for generalizing back to the population.

Sundt et al., (2016) analyzed the effect of California's realignment act in mandated Court ordered downsizing of the prison population and utilized a regression point displacement design. The authors noted the increased reliability in measurement due to the use of aggregation and stated:

> Spelman (2005) argues in favor of the use of smaller aggregation units for studying the prison/public safety question when using econometric models due to gains in measurement variability and sample size. In contrast, the pre-post test design used here means that the stronger measurement reliability associated with larger aggregation units and the use of ANCOVA improves our ability to detect treatment effects. (p.324)

With the challenges of obtaining uniform data to analyze the impact of legalized recreational marijuana within Washington State, the use of aggregated data made the regression point displacement design advantageous over other designs.

Statistical data from 2011 (Pre-Initiative 502) were collected along with 2013-2016 (Post-Initiative 502) from the National Highway Traffic Safety Administration's (NHTSA) Fatality Analysis Reporting System and entered into an SPSS data table for analysis, see Table 3. States where marijuana was not legalized for recreational use were coded with a Group code of 0 in SPSS. Washington State was coded as a Group code of 1 in SPSS. The following seven states where recreational marijuana is legalized were not included, namely Alaska, California, Colorado, Massachusetts, Maine, Nevada, and Oregon, as well as the District of Columbia.

Table 3
Marijuana Fatalities Involving Cannabinoids

State	Pre2011	Post2013	Post2014	Post2015	Post2016
Alabama	54	55	75	82	3
Arizona	36	54	34	54	42
Arkansas	51	60	86	101	100
Connecticut	1	12	20	34	37
Delaware	9	8	17	16	21
Florida	124	133	126	155	93
Georgia	42	61	110	96	120
Hawaii	18	17	12	15	13
Idaho	11	11	11	14	17
Illinois	70	95	101	109	125
Indiana	64	57	51	48	44
Iowa	7	23	19	25	34
Kansas	15	30	28	20	18
Kentucky	59	69	84	95	108
Louisiana	21	27	35	46	82
Maryland	1	1	3	1	0
Michigan	77	93	90	93	133
Minnesota	19	21	13	35	28
Mississippi	19	31	12	32	20
Missouri	67	75	85	102	118
Montana	25	38	28	32	35
Nebraska	6	8	6	21	20
New Hampshire	14	29	20	24	30
New Jersey	49	50	47	51	69
New Mexico	15	26	26	17	36
New York	71	100	79	123	93
North Carolina	0	1	0	2	2
North Dakota	5	7	3	5	3
Ohio	114	116	119	158	167
Oklahoma	11	5	23	33	18
Pennsylvania	71	100	61	84	46
Rhode Island	8	8	6	10	12
South Carolina	79	96	91	128	125
South Dakota	3	8	3	3	2
Tennessee	64	65	84	97	101
Texas	148	156	189	213	210
Utah	15	10	19	38	26
Vermont	7	11	8	11	16
Virginia	45	25	43	66	51
Washington	55	56	86	91	105
West Virginia	32	22	19	28	34
Wisconsin	53	48	58	84	75
Wyoming	13	10	14	21	14
Puerto Rico	0	0	5	16	3

Marijuana Fatalities Involving Cannabinoids
From “Fatal Motor Vehicle Traffic Crashes and Fatalities in Crashes Involving a Driver Who Tested Positive for Drugs” by NHTSA’s FARS, 2018).

The samples are representative of the population and drawn from the state population itself. Table 4 shows the population by state according to the U.S. Census Bureau with estimates based on the 2010 census (US Census Bureau, 2018).

Table 4

U.S. Population Estimates by State

	April 1, 2010		Population Estimate (as of July 1)							
Geography	Census	Estimates Base	2010	2011	2012	2013	2014	2015	2016	2017
United States	308,745,538	308,758,105	309,338,421	311,644,280	313,993,272	316,234,505	318,622,525	321,039,839	323,405,935	325,719,178
Alabama	4,779,736	4,780,135	4,785,579	4,798,649	4,813,946	4,827,660	4,840,037	4,850,858	4,860,545	4,874,747
Alaska	710,231	710,249	714,015	722,259	730,825	736,760	736,759	737,979	741,522	739,795
Arizona	6,392,017	6,392,309	6,407,002	6,465,488	6,544,211	6,616,124	6,706,435	6,802,262	6,908,642	7,016,270
Arkansas	2,915,918	2,916,031	2,921,737	2,938,640	2,949,208	2,956,780	2,964,800	2,975,626	2,988,231	3,004,279
California	37,253,956	37,254,518	37,327,690	37,672,654	38,019,006	38,347,383	38,701,278	39,032,444	39,296,476	39,536,653
Colorado	5,029,196	5,029,325	5,048,029	5,116,411	5,186,330	5,262,556	5,342,311	5,440,445	5,530,105	5,607,154
Connecticut	3,574,097	3,574,114	3,580,171	3,591,927	3,597,705	3,602,470	3,600,188	3,593,862	3,587,685	3,588,184
Delaware	897,934	897,936	899,712	907,884	916,868	925,114	934,805	944,107	952,698	961,939
District of Columbia	601,723	601,766	605,040	620,336	635,630	650,114	660,797	672,736	684,336	693,972
Florida	18,801,310	18,804,594	18,846,461	19,097,369	19,341,327	19,584,927	19,897,747	20,268,567	20,656,589	20,984,400
Georgia	9,687,653	9,688,690	9,712,696	9,810,595	9,911,171	9,981,773	10,083,850	10,199,533	10,313,620	10,429,379
Hawaii	1,360,301	1,360,301	1,363,817	1,378,323	1,392,772	1,408,038	1,417,710	1,426,320	1,428,683	1,427,538
Idaho	1,567,582	1,567,650	1,570,912	1,583,180	1,594,673	1,610,187	1,630,391	1,649,324	1,680,026	1,716,943
Illinois	12,830,632	12,831,565	12,841,196	12,862,298	12,878,494	12,890,403	12,882,438	12,862,051	12,835,726	12,802,023
Indiana	6,483,802	6,484,125	6,490,029	6,515,358	6,535,665	6,567,484	6,593,182	6,610,596	6,634,007	6,666,818
Iowa	3,046,355	3,046,869	3,050,223	3,063,690	3,074,386	3,089,876	3,105,563	3,118,473	3,130,869	3,145,711
Kansas	2,853,118	2,853,130	2,858,403	2,868,756	2,885,316	2,892,900	2,899,553	2,905,789	2,907,731	2,913,123
Kentucky	4,339,367	4,339,340	4,347,948	4,368,505	4,383,673	4,399,121	4,410,415	4,422,057	4,436,113	4,454,189
Louisiana	4,533,372	4,533,478	4,544,871	4,574,388	4,602,681	4,626,795	4,648,797	4,671,211	4,686,157	4,684,333
Maine	1,328,361	1,328,362	1,327,568	1,327,968	1,328,101	1,327,975	1,328,903	1,327,787	1,330,232	1,335,907
Maryland	5,773,552	5,773,807	5,788,099	5,843,115	5,891,680	5,932,654	5,970,245	6,000,561	6,024,752	6,052,177
Massachusetts	6,547,629	6,547,808	6,564,943	6,612,178	6,659,627	6,711,138	6,757,925	6,794,002	6,823,721	6,859,819
Michigan	9,883,640	9,884,129	9,876,731	9,876,199	9,886,610	9,899,219	9,914,675	9,918,170	9,933,445	9,962,311
Minnesota	5,303,925	5,303,924	5,310,711	5,345,967	5,377,695	5,416,074	5,452,649	5,483,238	5,525,050	5,576,606
Mississippi	2,967,297	2,968,103	2,970,437	2,977,452	2,982,963	2,987,721	2,988,578	2,985,297	2,985,415	2,984,100
Missouri	5,988,927	5,988,925	5,995,681	6,010,280	6,023,267	6,041,142	6,058,014	6,072,640	6,091,176	6,113,532
Montana	989,415	989,414	990,507	996,866	1,003,522	1,011,921	1,019,931	1,028,317	1,038,656	1,050,493
Nebraska	1,826,341	1,826,327	1,829,956	1,841,641	1,854,862	1,867,414	1,880,920	1,893,564	1,907,603	1,920,076

	April 1, 2010		Population Estimate (as of July 1)							
Geography	Census	Estimates Base	2010	2011	2012	2013	2014	2015	2016	2017
Nevada	2,700,551	2,700,691	2,702,797	2,718,170	2,752,410	2,786,547	2,831,730	2,883,057	2,939,254	2,998,039
New Hampshire	1,316,470	1,316,460	1,316,700	1,318,345	1,320,923	1,322,622	1,328,684	1,330,134	1,335,015	1,342,795
New Jersey	8,791,894	8,791,953	8,803,708	8,844,694	8,882,095	8,913,735	8,943,010	8,960,001	8,978,416	9,005,644
New Mexico	2,059,179	2,059,207	2,064,607	2,077,744	2,083,590	2,085,161	2,083,207	2,082,264	2,085,432	2,088,070
New York	19,378,102	19,378,110	19,405,185	19,526,372	19,625,409	19,712,514	19,773,580	19,819,347	19,836,286	19,849,399
North Carolina	9,535,483	9,535,721	9,574,247	9,662,940	9,755,299	9,849,812	9,941,160	10,041,769	10,156,689	10,273,419
North Dakota	672,591	672,585	674,518	684,830	701,380	722,908	738,658	754,859	755,548	755,393
Ohio	11,536,504	11,536,730	11,539,282	11,543,332	11,546,969	11,567,845	11,593,741	11,606,027	11,622,554	11,658,609
Oklahoma	3,751,351	3,751,598	3,759,529	3,785,232	3,815,298	3,849,840	3,875,008	3,904,353	3,921,207	3,930,864
Oregon	3,831,074	3,831,072	3,837,073	3,865,845	3,893,920	3,919,664	3,960,673	4,016,537	4,085,989	4,142,776
Pennsylvania	12,702,379	12,702,857	12,711,063	12,742,811	12,768,034	12,778,450	12,790,341	12,791,124	12,787,085	12,805,537
Rhode Island	1,052,567	1,052,945	1,053,169	1,052,154	1,052,761	1,052,784	1,054,782	1,055,916	1,057,566	1,059,639
South Carolina	4,625,364	4,625,381	4,635,834	4,672,744	4,719,009	4,765,862	4,824,758	4,892,423	4,959,822	5,024,369
South Dakota	814,180	814,197	816,227	823,338	832,576	842,513	849,455	854,036	861,542	869,666
Tennessee	6,346,105	6,346,295	6,355,882	6,396,281	6,450,632	6,490,795	6,540,007	6,590,726	6,649,404	6,715,984
Texas	25,145,561	25,146,100	25,241,648	25,644,424	26,078,327	26,479,279	26,954,436	27,454,880	27,904,862	28,304,596
Utah	2,763,885	2,763,889	2,775,260	2,815,430	2,854,222	2,899,961	2,938,671	2,984,917	3,044,321	3,101,833
Vermont	625,741	625,741	625,842	626,210	625,606	626,044	625,665	624,455	623,354	623,657
Virginia	8,001,024	8,001,043	8,025,206	8,107,548	8,188,656	8,261,689	8,316,902	8,366,767	8,414,380	8,470,020
Washington	6,724,540	6,724,545	6,741,386	6,819,155	6,890,899	6,963,410	7,046,931	7,152,818	7,280,934	7,405,743
West Virginia	1,852,994	1,853,006	1,854,315	1,854,891	1,855,360	1,852,333	1,847,624	1,839,767	1,828,637	1,815,857
Wisconsin	5,686,986	5,687,288	5,690,403	5,705,812	5,721,075	5,736,673	5,751,272	5,759,744	5,772,917	5,795,483
Wyoming	563,626	563,767	564,376	567,602	576,608	582,341	583,334	586,102	584,910	579,315
Puerto Rico	3,725,789	3,726,157	3,721,525	3,678,732	3,634,488	3,593,077	3,534,874	3,473,177	3,406,520	3,337,177

From US Census Bureau, 2018 (Retrieved from https://www.census.gov/topics/population.html).

The purpose of this research study was to examine whether or not a relationship exists between legalizing recreational marijuana and cannabinoid involved motor vehicle fatalities within Washington State. The results are presented below using a scatter plot, which visually showed the Pre-2011 and Post-2013 measures were strongly linear and for the most part evenly distributed along the regression line. Figure 5 shows the scatter plot of these measures with the regression line placed on to the scatter plot.

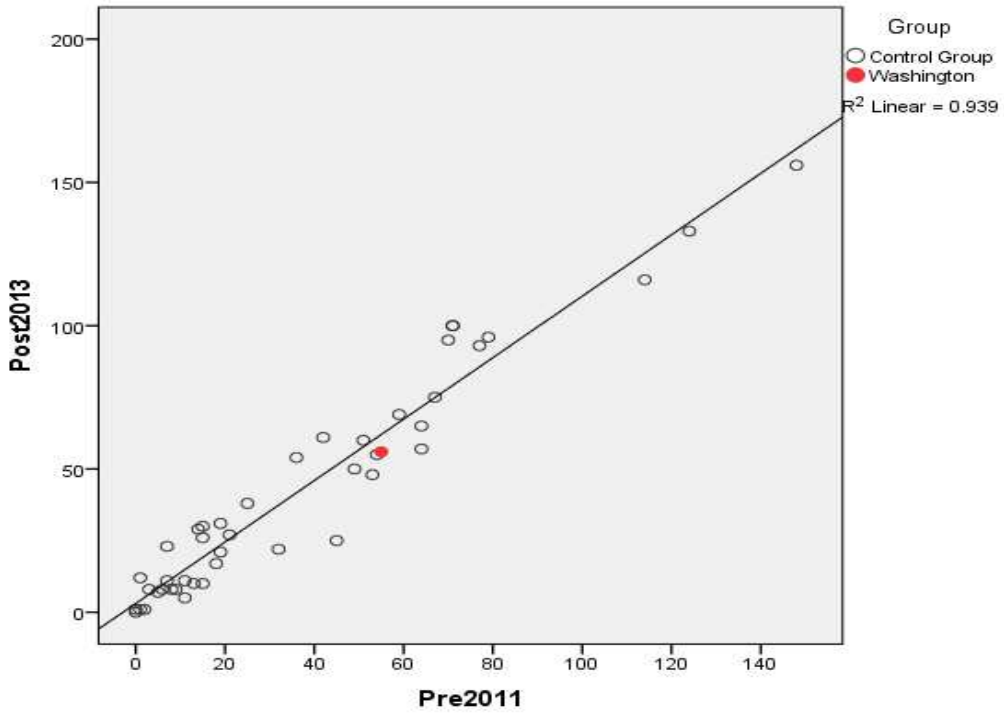

Figure 5. Pre-2011 and post-2013 RPDD of traffic fatalities involving cannabinoids.

The scatter plot shows Washington State denoted by the red dot below the regression line, with others evenly distributed around it. States such as Texas with a larger population base have a higher number of fatalities but are still within the norm of the regression line. The level of significance between the Pre-2011 and Post-2013 is .540 with an R squared of .938 and adjusted R squared of .935. The larger the R square, a greater likelihood the regression model fits the observations. Table 5 shows the pre-2011-post-2013 tests between subjects results.

Table 5

Pre-2011 and Post-2013 Tests of Between Subjects Effects

Source	Type I Sum of Squares	df	Mean Square	F	Sig.	Noncent. Parameter
Corrected Model	61689.454[a]	2	30844.727	308.516	.000	617.031
Intercept	84481.455	1	84481.455	845.002	.000	845.002
Pre2011	61651.266	1	61651.266	616.649	.000	616.649
Group	38.188	1	38.188	.382	.540	.382
Error	4099.092	41	99.978			
Total	150270.000	44				
Corrected Total	65788.545	43				

The analysis showed a B = -6.268 below the regression line, t = -.618, with a level of significance of .540 and a 95% confidence level with a range between Washington State and the control group falling between -26.752 in the lower bound and 14.215 in the upper bound and an observed power of .093. This shows there was no statistical difference between Washington State and other states between 2011 and 2013. Table 6 shows the pre-2011 and post-2013 parameter estimates.

Table 6

Pre-2011 and Post-2013 Parameter Estimates

					95% Confidence Interval		
Parameter	B	Std. Error	t	Sig.	Lower Bound	Upper Bound	Noncent. Parameter
Intercept	3.352	2.224	1.507	.139	-1.140	7.845	1.507
Pre2011	1.071	.043	24.810	.000	.984	1.158	24.810
Group	-6.268	10.143	-.618	.540	-26.752	14.215	.618

The same ANCOVA analysis was conducted with Pre-2011 and Post-2014 data. Figure 6 below shows the results in a scatterplot for visualization.

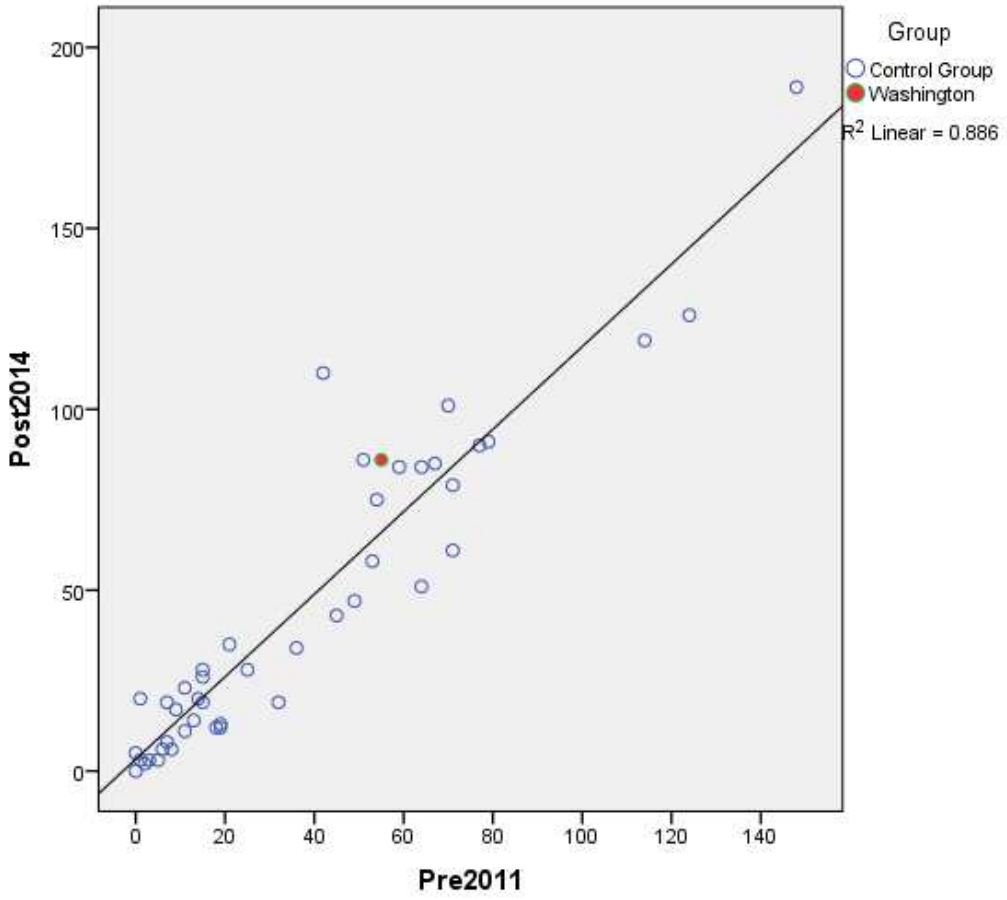

Figure 6. Pre-2011 and post-2014 RPDD of traffic fatalities involving cannabinoids.

The scatterplot of the Pre-2011 and Post-2014 RPDD of traffic fatalities involving cannabinoids are visually scattered evenly around the regression line, with Washington State falling slightly above the regression line. This higher level is not representative of any treatment effect and does not appear to be significant. Table 7 shows the pre-2011 and post-2014 tests of between subjects effects.

Table 7

Pre-2011 and Post-2014 Tests of Between Subjects Effects

Source	Type I Sum of Squares	df	Mean Square	F	Sig.	Noncent. Parameter
Corrected Model	70241.877[a]	2	35120.939	163.503	.000	327.006
Intercept	95418.205	1	95418.205	444.213	.000	444.213
Pre2011	69830.975	1	69830.975	325.093	.000	325.093
Group	410.902	1	410.902	1.913	.174	1.913
Error	8806.918	41	214.803			
Total	174467.000	44				
Corrected Total	79048.795	43				

Table 8 showed the level of significance between the Pre-2011 and Post-2014 is .174 with an R squared of .889 and adjusted R squared of .883. Additionally, B = 20.562, with a 95% confidence level between -9.462 and 50.586, and an observed power of .272. This shows there was no statistical difference between Washington State and other states between 2011 and 2014.

Table 8

Pre-2011 and Post-2014 Parameter Estimates

					95% Confidence Interval		
Parameter	B	Std. Error	t	Sig.	Lower Bound	Upper Bound	Noncent. Parameter
Intercept	3.210	3.261	.984	.331	-3.375	9.795	.984
Pre2011	1.131	.063	17.877	.000	1.004	1.259	17.877
Group	20.562	14.867	1.383	.174	-9.462	50.586	1.383

Figure 7 below shows the results in a scatterplot for visualization for pre-2011 and post-2015 traffic fatalities involving cannabinoids.

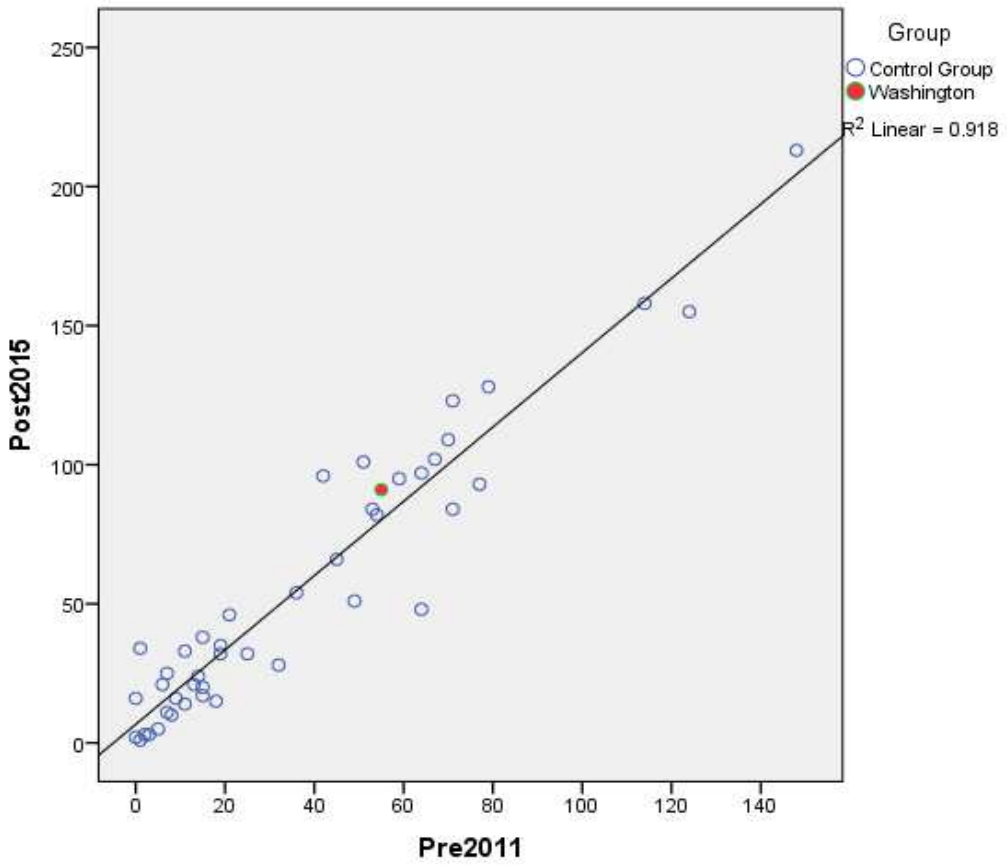

Figure 7. Pre-2011 and post-2015 RPDD of traffic fatalities involving cannabinoids.

The third RPDD data points were plotted on a scatterplot for the Pre-2011 and Post-2015 analysis. Once again, the data points were visually evenly distributed around the regression line. After controlling for Pre-2011, post-test observations did not appear to differ or shift significantly from the regression line. The test of between subjects effects in Table 8 showed a level of significance of .457 with an observed power of .114. Parameter estimates in Table 10 showed the Group had a B = 11.076 with a 95% confidence level between -18.719 and 40.871.

Table 9

Pre-2011 and Post-2015 Tests of Between Subjects Effects

Source	Type I Sum of Squares	df	Mean Square	F	Sig.	Noncent. Parameter
Corrected Model	95743.786[a]	2	47871.893	226.301	.000	452.601
Intercept	145360.023	1	145360.023	687.147	.000	687.147
Pre2011	95624.563	1	95624.563	452.037	.000	452.037
Group	119.223	1	119.223	.564	.457	.564
Error	8673.191	41	211.541			
Total	249777.000	44				
Corrected Total	104416.977	43				

This shows there was no statistical difference between Washington State and other states between 2011 and 2015. Table 10 below shows the pre-2011 and post-2015 parameter estimates.

Table 10

Pre-2011 and Post-2015 Parameter Estimates

					95% Confidence Interval		
Parameter	B	Std. Error	t	Sig.	Lower Bound	Upper Bound	Noncent. Parameter
Intercept	6.878	3.236	2.126	.040	.344	13.413	2.126
Pre2011	1.328	.063	21.146	.000	1.201	1.455	21.146
Group	11.076	14.754	.751	.457	-18.719	40.871	.751

Figure 8 below shows the results in a scatterplot for visualization for pre-2011 and post-2016 traffic fatalities involving cannabinoids.

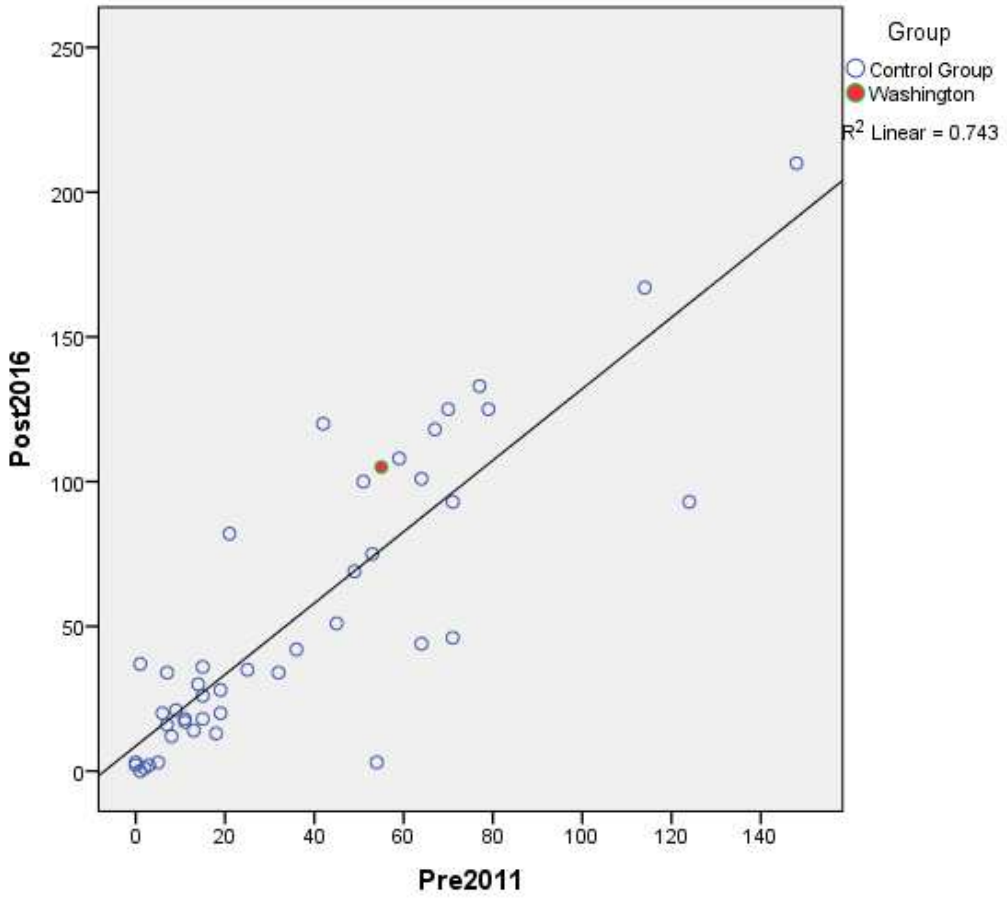

Figure 8. Pre-2011 and post-2016 RPDD of traffic fatalities involving cannabinoids.

The RPDD analysis was conducted a fourth time with Pre-2011 and Post 2016 data. For the most part, visually there was an evenly distributed number of data points around the regression line. The level of significance was .279. Parameter estimates showed a B = 29.190 with a confidence level of 95% with a lower bound of -24.504 and an upper bound of 82.885. Table 11 shows the pre-2011 and post 2016 tests of between subjects effects.

Table 11

Pre-2011 and Post-2016 Tests of Between Subjects Effects

Source	Type I Sum of Squares	df	Mean Square	F	Sig.	Noncent. Parameter
Corrected Model	82031.023[a]	2	41015.512	59.703	.000	119.405
Intercept	136309.114	1	136309.114	198.413	.000	198.413
Pre2011	81202.938	1	81202.938	118.200	.000	118.200
Group	828.085	1	828.085	1.205	.279	1.205
Error	28166.863	41	686.997			
Total	246507.000	44				
Corrected Total	110197.886	43				

This shows there was no statistical difference between Washington State and other states between 2011 and 2016. Table 12 shows the pre-2011 and post-2016 parameter estimates.

Table 12

Pre-2011 and Post-2016 Parameter Estimates

					95% Confidence Interval		
Parameter	B	Std. Error	t	Sig.	Lower Bound	Upper Bound	Noncent. Parameter
Intercept	8.828	5.831	1.514	.138	-2.948	20.604	1.514
Pre2011	1.218	.113	10.760	.000	.989	1.446	10.760
Group	29.190	26.587	1.098	.279	-24.504	82.885	1.098

Summary

The regression point displacement design (RPDD) is a versatile and robust design to analyze community interventions such as the statewide legalization of recreational marijuana. This research study's central question examined whether a relationship existed between recreational marijuana legalization and traffic fatalities involving cannabinoids within Washington State. It is hoped that this analysis may add to the existing body of

knowledge as legislators in those states where marijuana has not been legalized contemplate the pros and cons of legalizing recreational marijuana.

The RPDD utilizing a quasi-experimental Pre-Post design took advantage of aggregated data drawn from the population base of Washington State and those states where recreational marijuana has not been legalized, using an ANCOVA. The Pre-Post design was calculated for 2013-2016, and the results showed there had been no significant effect on traffic fatalities involving cannabinoids. The null hypothesis was accepted that since the passage of Initiative-502 in 2012, there was no significant difference between marijuana involved traffic fatalities. While recreational marijuana legalization is still relatively new with additional states shifting legislation to legalize marijuana, a number of future research possibilities exist that will be discussed along with findings related to the research questions in Chapter 5.

Chapter 5: Summary, Conclusions, and Further Research

This study was initially designed with the intent of examining the relationship between legalized marijuana and DUI arrests. With IRB approval, I sent requests for data from the state toxicology laboratories for annually aggregated data of blood draw requests sent in for toxicology screening that met for the presence of delta-9 tetrahydrocannabinol (THC). In speaking with directors from these state laboratories, I learned about the different policies and protocols between state toxicology laboratories. Although some states conducted blood toxicology, others used urine, and some used oral swabs for their analysis. Given the nonuniform data sets from state toxicology laboratories where marijuana was not legalized, I chose to modify my research question. I examined whether a relationship exists between legalized recreational marijuana and traffic fatalities involving cannabinoids in Washington State. Opponents to recreational marijuana legalization pointed to the possibility that marijuana-impaired drivers might increase the number of traffic fatalities. The change in my central research question and my hypotheses were approved by the IRB to continue my study.

I used a regression point displacement design, a quasi-experimental design, to conduct four separate ANCOVA analyses from 2013 to 2016 while controlling for 2011. A regression line was used to determine whether a shift had occurred as a result of a particular treatment effect, namely legalized recreational marijuana in Washington State. The results were plotted on a scatterplot, and the results revealed a strongly linear alignment around the regression line. Washington State was represented by a solid red dot compared to the control group. The pre- and postdata regarding traffic fatalities

involving cannabinoids were closely and evenly distributed around the regression line that was fit to the data. The scatterplot made it easy to visually determine whether there was a shift in the regression line that might indicate a significant treatment effect. Due to the closely and evenly distributed data around the regression line, a visual inspection suggested there had been no significant treatment effect between 2013 and 2016 since Washington State had legalized recreational marijuana.

Interpretation of the Findings

The Washington Traffic Safety Commission (WTSC), with over 180 traffic safety experts, created a traffic safety plan to reduce the number of traffic fatalities and serious injuries to zero by the year 2030. The WTSC (2016) identified critical factors that contributed to traffic fatalities in Washington State during 2012-2014, including three leading causes of traffic fatalities. Impairment contributed to 57% of traffic fatalities, lane departure contributed to 56% of traffic fatalities, and speeding contributed to 38% of traffic fatalities in Washington State; 81% of traffic fatalities had at least one of these factors, and 20% had all three. Given that impairment was a leading cause of traffic fatalities in Washington State, the purpose of this study was to examine the relationship between legalizing recreational marijuana and traffic fatalities involving cannabinoids.

Over the course of several decades, society has changed its attitude toward marijuana regulation, decriminalization, and legalization. During the early 1900s, greater regulation of the pharmaceutical industry by the Harrison Narcotics Act of 1917 created a black market for narcotics. The heavily regulated pharmaceutical market caused some users to turn to the unregulated marijuana market as an alternate source of narcotics. As

recreational marijuana use grew in popularity, the federal government sought to enhance regulation through greater taxation as a means to address growing concerns about marijuana use. The Commissioner of the Federal Bureau of Narcotics testified to Congress that the drug addict was the cause of many criminal offenses, triggering a push for greater regulation of the marijuana industry (Carnevale & Murphy, 1999; Chemerinsky et al., 2015; Sacco, 2014). The push for greater regulation continued with the creation of the Marijuana Tax Act of 1937, the dropping of marijuana from the U.S. Federal Pharmacopoeia list, and the Controlled Substance Act of 1970 (CSA). The commissioner's statement to Congress was shortsighted in linking drug use with social deviancy (Carnevale & Murphy, 1999; Chemerinsky et al., 2015; Sacco, 2014).

Despite the regulation of marijuana by the federal government as a Schedule I drug and the American Medical Association's acceptance of the classification, some states have chosen to legalize marijuana (Cornell University Law School, n.d.). Proponents of marijuana legalization noted that despite rigorous enforcement to curtail marijuana use, it is still one of the most highly used illicit drugs in the United States (Ducatti Flister, SAMHSA, 2014; 2012; Scherf, 2015). Marijuana proponents argued that legalization would free up limited law enforcement and judicial resources that were strained as a result of strict enforcement of marijuana laws.

A cost-benefit analysis in support of Washington State's Initiative-502 indicated that marijuana legalization would generate substantial tax revenue (Archambault et al., 2013). The study suggested Washington State might add $2 billion in marijuana revenue from taxation during the first 6 years of legalization (Archambault et al., 2013).

Furthermore, it was estimated that marijuana-involved traffic collisions would cost $9.1 million (Archambault et al., 2013). The study did not address a monetary loss due to traffic fatalities involving cannabinoids. Impaired driving and fatality rates were not examined in detail during the crafting of the legislation.

The WTSC (2015) noted that from 2010 to 2014, 60% of drivers involved in motor vehicle fatalities were tested for drug-impaired driving, and 20% (349 drivers) had tested positive for the presence of marijuana. The mere presence of marijuana did not indicate per se driving under the influence according to the revised code of Washington for driving under the influence. The WTSC noted that half of the drivers who tested positive for the presence of THC were also positive for the presence of alcohol and most exceeded the per se limit of .08 BAC per the revised code of Washington. The WTSC data shed light on the difficulties of analyzing recreational marijuana legislation and whether a relationship exists between legalized marijuana and traffic fatalities involving cannabinoids. Furthermore, poly-drug combinations make it difficult to determine whether marijuana or the combination of drugs was the cause of impairment and thereby the fatality.

The National Safety Council (2013) stated that there was an increased risk of death or serious injury to self or others when operating a motor vehicle or heavy equipment while impaired by marijuana. This study addressed the need to examine the relationship between marijuana legalization and traffic fatalities involving cannabinoids. The findings contributed to the existing body of knowledge and may help legislators in crafting legislation to address traffic fatalities involving cannabinoids. The WTSC and its

data-driven Target Zero plan have sought to reduce traffic fatalities and serious injuries in Washington State to zero by 2030. The program is updated through continuous review with input from a wide variety of stakeholders (WTSC, 2016). Advocates of marijuana legalization have argued that recreational use of marijuana and impairment are no different than alcohol and impairment should have an identifiable threshold like alcohol.

Figure 9 visually shows traffic fatalities within Washington State (WTSC, 2016). According to Figure 9 provided by the WTSC (2016), there appeared to be an increase in traffic fatalities during 2014, but a single increase in a data point is not necessarily an indicator of future trends.

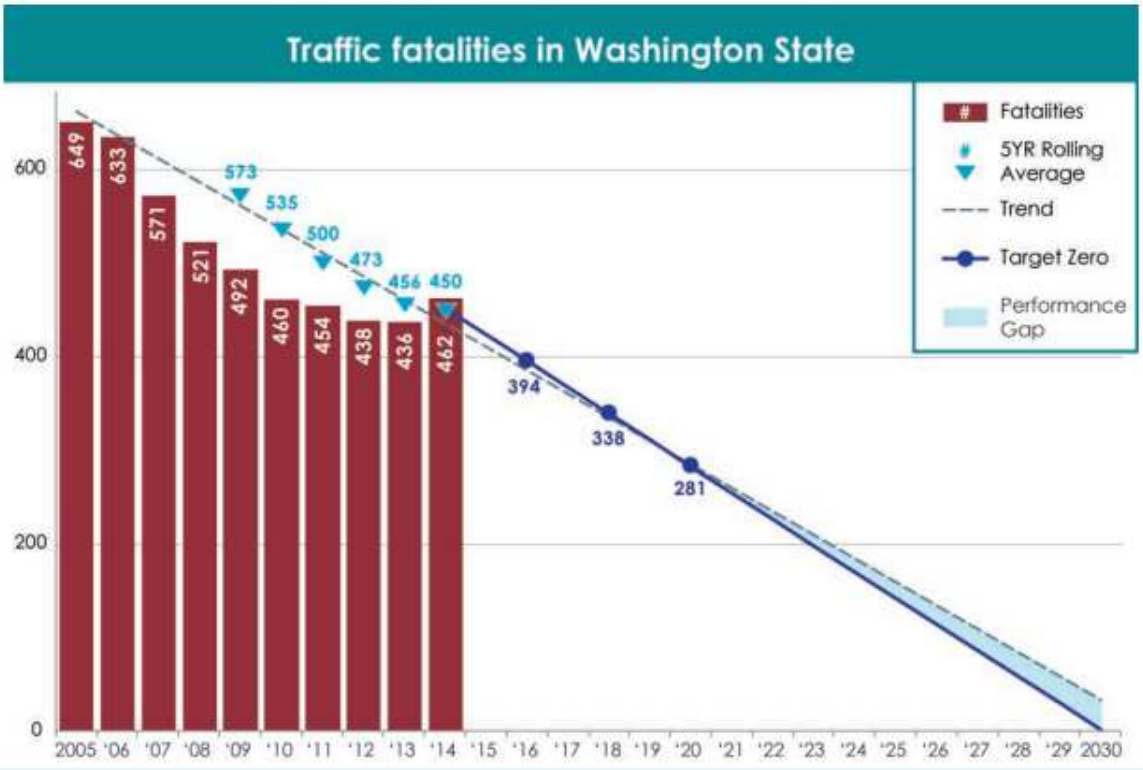

Figure 9. Traffic fatalities in Washington State from WTSC, 2016.

According to the WTSC's Data and Research Center, Dr. Staci Hoff noted, "[…] Marijuana involvement in fatal crashes remain steady over the years, and then it just spiked in 2014…The answer in 2014 is most of them were high" (WTSC, 2015). Figure 9 below, from the Washington State Strategic Highway Safety Plan (2016), indicated a steady decline of traffic fatalities in Washington State except for 2014, when there were 462 traffic fatalities compared to 436 traffic fatalities in 2013. NHTSA's FARS data for Washington State also showed an increase in traffic fatalities involving cannabinoids between 2011 and 2016. Although recreational marijuana was legalized through Initiative-502 in 2012, the first regulated marijuana retail store did not open until 2014.

The increase in traffic fatalities involving cannabinoids may be attributed to marijuana legalization and may reflect the opening of retail marijuana stores in Washington State during that period. The regression point displacement design was used to check for evidence of an effect of marijuana legalization within a group, which may be seen as a shift from the predicted regression line. Although marijuana related traffic fatalities increased in the State of Washington, this study's findings showed no statistical difference between Washington State and other states between 2011 and 2016; therefore, findings indicated that no relationship exists between marijuana legalization and traffic fatalities involving cannabinoids.

Society's attitude toward marijuana has changed significantly over the decades and moved away from an unregulated market to strict regulation. It later changed from strict criminal enforcement to decriminalization with permissible medicinal use. Finally, some states opted to legalize recreational marijuana use. This research study addressed

the shifting attitudes toward marijuana and its impact on the social choices individuals make when using marijuana. Theorists have posited that individuals conduct a cost-benefit analysis during the decision-making process whether to operate a motor vehicle while under the influence of marijuana.

Recent studies showed an increase in marijuana-related crashes but failed to acknowledge the inherent difficulties in researching poly-drug combinations (Salomonsen-Sautel et al. 2014; Pollini et al., 2015; NHTSA, 2015. The failure of understanding these risks that marijuana impaired and marijuana poly-drug driving pose potentially increases the dangers of motor vehicle accidents, DUI arrests, and traffic fatalities within those states that decide to choose legalizing recreational marijuana and thereby making it more accessible to the general public (Salomonsen-Sautel et al. 2014; Pollini et al., 2015; NHTSA, 2015). Additionally, the shift in attitude towards the dangers of marijuana-impaired driving as being an acceptable norm may contribute to traffic fatalities involving cannabinoids without considering specific deterrence.

Researchers found after legalizing recreational marijuana in Colorado, not only was there an increase in motor vehicle accidents but a significant increase in the number of marijuana fatality drivers when compared to alcohol-related fatalities that remained at similar levels (Salomonsen-Sautel et al. 2014). For decades, various government and private organizations have advocated and educated against the dangers of driving while intoxicated. However, the relatively new legislation of Initiative-502 has not had the decades of educational outreach the “Don’t Drink and Drive” campaigns have had.

Additionally, some research studies have shown that both high school and college students consider marijuana-impaired driving to be less dangerous than if driving while alcohol-impaired (Kohn et al., 2014; O'Malley & Johnston, 2013). While decades of education and research studies have shown alcohol to be a factor in some traffic fatalities, this type of education has not been in effect for marijuana-impaired driving (WTSC, 2016). School district programs have worked diligently in educating students as to the dangers of drugs and alcohol through various prevention and youth services, but research studies would suggest high school and college students still consider marijuana impairment to be less dangerous than alcohol impairment (Kohn et al., 2014; SAMHSA, 2014; O'Malley & Johnston, 2013;).

The lack of educational outreach may explain why some research studies show a tolerance or a laissez-faire attitude when it comes to marijuana-impaired driving or even riding with an individual under the influence of marijuana (Kohn et al., 2014; O'Malley & Johnston, 2013). Further research also showed in the WTSC's (2015) data that, "The largest increase in THC-positive [fatality] drivers were among males ages 21-25, from only 6 in 2013 up to 19 in 2014 – the most significant increase among any other age group" (p. 1). The increase in traffic fatalities among this age group is alarming, as it potentially supports previous research studies that indicate this age group's apathy toward marijuana-impaired driving. The societal impact is far greater considering most insurance companies find this age group to be already considered high risk.

The literature clearly shows a shift in societal attitude within the United States toward marijuana regulation and its overall use but implicates a dangerous attitude

toward marijuana-impaired driving and traffic fatalities involving cannabinoids. The central research question asked whether a relationship existed between legalized marijuana and traffic fatalities involving cannabinoids within Washington State. The RPDD utilized an ANCOVA analysis on FARS data, which showed there was no statistical difference between Washington State and other states between 2011 and 2016. Figure 9 showed that data presented in the Washington State Strategic Highway Safety Plan 2016, a steady decline in overall traffic fatalities from 2005 through 2012 when Initiative 502 to legalize recreational marijuana was enacted.

Figure 9 shows, during 2013, the decline in traffic fatalities begins to level off with a decrease of 2 fatalities for that year. However, 2014 shows an increase in 26 overall traffic fatalities for the following year. This data was inclusive of all deaths, to include all cannabinoid fatalities. As previously noted, opponents to marijuana legalization have suggested legalizing recreational marijuana would lead to an increase in marijuana-related traffic fatalities but the research into this topic is complex (Archambault et al., 2013). Only looking at an increase in cannabinoid traffic fatalities within Washington State does not necessarily mean it is directly due to legislation legalizing marijuana.

Table 13

Washington State FARS Data Involving Cannabinoid Traffic Fatalities

	2011	2012	2013	2014	2015	2016
Washington	55	58	56	86	91	105

From "Fatal Motor Vehicle Traffic Crashes and Fatalities in Crashes Involving a Driver Who Tested Positive for Drugs" by NHTSA's FARS, 2018).

Some opponents have pointed to fatalities in Washington State traffic involving cannabinoids as a means to highlight an increase in cannabinoid involved fatalities directly attributed to legislation legalizing recreational marijuana. The results of this RPDD analysis does not show a significant difference between legislation legalizing marijuana and cannabinoid fatalities. However, the complexity of traffic fatalities involving cannabinoids involves a significant number of different extraneous variables. Furthermore, differences in testing the level of Delta-9 THC (the psychoactive ingredient in marijuana) differs by statute from state to state when it comes to marijuana DUIs. To further the complexity of the relationship between public policy legalizing marijuana and its relationship if any between traffic fatalities, little is known as to the poly-marijuana combinations and contributing factors for impairment. Additionally, voluntary standardized field sobriety tests (SFSTs) commonly used for determining alcohol impairment have not been scientifically identified in determining if an individual is impaired by marijuana.

Unlike the SFSTs conducted out in the field by law enforcement, to determine alcohol impairment, there are no field tests like the SFSTs to determine whether an individual meets or exceeds, "(b) […] within two hours after driving, a THC concentration of 5.00 or higher as shown by analysis of the person's blood made under RCW 46.61.506" (Washington State Legislature, 2018). Determining impairment in the field and whether it meets the definition of the Revised Code of Washington is extremely difficult, it becomes even more convoluted in deciding whether or not it is the cause of a

traffic fatality if other indicators are present. Medical examiners may simply test for the presence of a particular drug and not the specific amount of delta-9 THC.

This research study compared the treatment group's aggregated fatality value against a set of control groups, namely the aggregated fatality values of those states where marijuana was not legalized. Both the treatment and control groups are comparable to a randomized draw from the state's entire general population each year and therefore also controls for a growing population across yearly statistics. Rising aggregated fatalities involving cannabinoids may then be controlled for with regard to population increases as a new group of individuals become legally permissible to purchase recreational marijuana as of 21-years of age. As noted previously, WTSC's (2015) research data indicated males between 21-25 were the most significant in any age group involving THC-positive fatalities, but once again this was merely for the presence of THC and was not indicative of per se impairment.

This research study repeated the ANCOVA analysis between Washington State and other states between 2011 and 2014, 2015, and 2016. The results showed there was no statistical difference or shift from the regression line. The original purpose of the research study was to examine whether or not there was a relationship between legalized marijuana in Washington State and DUI arrests. However, the researcher was unable to obtain sufficient aggregated data from the control groups to generalize back to the population. The data and results of this research study may potentially be used as a proxy measure of marijuana use while driving but there were limitations in this study that will be discussed shortly.

No significant difference existed between Washington State and the control group and the null hypothesis was accepted. The null hypothesis stated, there is no significant relationship between marijuana legalization and traffic fatalities involving cannabinoids in the State of Washington. This allowed for the discussion of the two theoretical research questions. The theory of rational choice and perceptual deterrence theory may help explain the underlying decision-making process when an individual chooses to drive impaired and help clarify whether or not a relationship exists between marijuana legalization and marijuana involved traffic fatalities within Washington State.

Both theories take a traditional conservative criminological approach and essentially state individuals make a conscientious decision when they decide to commit a crime. The theory of rational choice stated an individual deliberately weighs the options of committing a crime and considers the possible adverse outcomes compared to the potential individual benefits based upon bounded rationality (Lilly et al., 2011). Clarke and Cornish (2001) as cited in Lilly et al., (2011) stated social deviancy is a direct result of, "[…] Deliberate acts, committed with the intention of benefiting the offender" (p. 342). Criminologists broadly consider theories that take into account the social and socio-economic contexts of criminal deviancy but fail to acknowledge the direct details in the underlying decision-making process behind the choice to commit a crime such as driving under the influence and thereby possibly being involved in a traffic fatality.

This research study narrowed the theoretical application to rational choice theory and perceptual deterrence. Furthermore, additional theories were offered to understand marijuana-impaired driving and traffic fatalities involving cannabinoids, which could be

applied through additional research. The theory of rational choice helps explain whether a relationship exists between legalized marijuana and traffic fatalities involving cannabinoids and offers a possible means to address marijuana-impaired driving to reduce traffic fatalities.

Opponents to rational choice theory argue individuals do not make a deliberate and rational decision to become involved in a traffic fatality and the theory is flawed. However, those individuals that decide to use marijuana and then operate a motor vehicle are not to be considered perfectly rational. Lilly et al. (2011) concisely described this as, "[…] Rather, their rationality is said to be "bounded." In essence, offenders make choices based on limited information, made under pressure, are insufficiently planned, and attentive only to the immediate risks of apprehension rather than to the long-term consequences of their actions" (p. 342). The "bounded" rationality concept helps explain why an individual after smoking marijuana decides to operate a motor vehicle while impaired, potentially resulting in a traffic fatality.

Bounded rationality helps explain why an individual might decide to drive while under the influence, despite society's general idea that driving under the influence is not only dangerous but has serious consequences ranging from fines, jail time, and possibly death. An offender may only be considering the short-term risks of being apprehended compared to the possibility of being involved in a traffic fatality (Lilly et al., 2011). Rational choice theory helps explain why some individuals choose to drive under the influence and thereby allows researchers, scholars, legislators, and stakeholders to consider methods of reducing not only driving under the influence of marijuana but also

fatalities involving cannabinoids. The theory suggests individuals make decisions based upon the immediate possibility of being caught and whether they consider that risk to be high (Lilly et al., 2011). If they perceive the individual risk of being caught driving marijuana-impaired to be low, then they are likely to drive impaired with little or no thought of the long-term consequences of their actions (Lilly et al., 2011).

Critics of rational choice theory also argue that the notion that crime might be appealing, gratifying, pleasurable, or impulsive is not adequately explained by rational choice theory and question how rational an individual is acting upon their bounded rationality (Lilly et al., 2011). It should be acknowledged the term "rational" may be somewhat deceiving and a sticking point for opponents to this theory. However, we are often predisposed to quick decision-making not always based on all the available facts. This might characterize our decision making process as irrational at times. As such, one single theory does not necessarily provide an explanation or solution to social deviancy. As such, this research study applied the theory of perceptual deterrence to explain marijuana-impaired driving.

For example, an individual that routinely drinks to excess and drives home every Friday night without being stopped by a police officer or being involved in an accident might conclude that they are fine to drive despite being over the legal limit. Essentially, the individual may perceive the deterrence of possible apprehension to be relatively slim to none in light of not being stopped for driving under the influence. Lilly et al. (2011) stated social psychologists describe this as a heuristic decision-making approach to social deviancy (p. 345). Simply put, humans are flawed decision makers that do not always

weigh all the options and facts presented to them (Lilly et al., 2011). Alternatively, it could be argued that individuals are merely rolling the dice in their decision to drive impaired, weighing the possibility of just not getting caught in a multitude of other drivers on the road. Rational choice theory explains this decision-making process as how an individual weighs the likelihood of being caught (Lilly et al., 2011). This flawed decision-making process still fits within the theory as it only considers a short-term decision not thoroughly weighing the impact of being arrested for driving under the influence of marijuana or worse being involved in a traffic fatality.

The decision to drive a motor vehicle may be made before or after becoming impaired by marijuana but the act occurs during impairment. One might argue it is irrational to assume an individual makes a conscientious decision to operate a vehicle impaired, knowing the possibility exists of being arrested or involved in a fatal traffic accident. Rational choice theory is situational in nature, and the theory of perceptual deterrence examines the correlation between perceived deterrence and punishment (Lilly et al., 2011). The Washington Traffic Safety Commission's 2018 Highway Safety Plan has utilized in part the theory of perceptual deterrence as part of its strategy within Target Zero. The use of media outreach and traffic safety emphasis patrols specifically targeting driving under the influence are examples of the practical application of these theories. The theories of rational choice and perceptual deterrence go hand in hand when explaining the relationship between marijuana legalization and traffic fatalities involving cannabinoids.

Traditional deterrence methods have held legislators should craft laws and penalties that outweigh the benefits of social deviancy, to send the message crime does not pay. Classical school scholars examined how punishment impacted crime and found specific deterrence had modest results in lowering social deviancy (Lilly et al., 2011). Perceptual deterrence theory took a slightly different approach to explain social deviancy. Similar to rational choice theory, it posited an individual's *perception* of costs and benefits and not their underlying rational choice of costs and benefits factored into their decision making process when choosing whether or not to commit a crime (Hess & Orthmann, 2012; Lilly et al., 2011). Similar to rational choice theory, perceptual deterrence theory also has its limitations in explaining social deviancy. While individuals may have perceptions about the associated punishment of marijuana-impaired driving, if they routinely smoke marijuana and drive impaired, their perception of not getting caught may increase (Lilly et al., 2011). Additionally, perceptions of not being caught may also lead to the belief impairment from marijuana does not impact their driving abilities.

An individual's *perception* of deterrence factors is shaped by a number of different associations based on individuality, and therefore not everyone will perceive things the same (Lilly et al., 2011). The perception of being caught for instance may be developed from the personal knowledge of a colleague arrested for impaired driving. This may change their perception and deter them from driving impaired by marijuana. Additionally, their perception may be formed by observing a large police presence in the area making the likelihood of being caught more probable. These individual perceptions

are shaped differently, but the theoretical concept remains the same and helps explain why individuals may refrain from or drive marijuana impaired.

Limitations of the Study

The initial research study intended to utilize toxicology reports of those individuals under arrest for driving under the influence of marijuana from state laboratories. A significant number of data limitations existed when I sought to collect aggregated data in this study. First, not every state collected or tracked data on marijuana-impaired drivers. Secondly, some states only recently began tracking marijuana-impaired drivers, which did not provide a sufficient uniform sampling size. The lack of uniformity in data collection from state to state for aggregated data regarding driving under the influence of marijuana meant for a control group size that was too small. Drug recognition expert (DRE) data collected out in the field by police officers and housed by the National Highway Traffic Safety Administration (NHTSA), may have provided a sufficient control group. However, the data may not have been representative of the population as DREs are not utilized on all drug impaired DUIs. A request for DRE data was denied, citing NHTSA was the clearinghouse for the data and not authorized to release it without individual permission from each state. As a result, this research study shifted slightly to study whether a relationship existed between marijuana legalization and traffic fatalities involving cannabinoids.

NHTSA's Fatality Analysis Reporting System (FARS) data was publicly available online and provided aggregated data from all states regarding traffic fatalities involving cannabinoids. This research study utilized a regression point displacement

design to analyze whether a relationship existed between marijuana legalization and traffic fatalities involving cannabinoids. A fundamental limitation of FARS data involved determining marijuana impairment. States where marijuana has been legalized like Washington, have chosen to define a specific amount of delta-9 THC within the driver's blood as a per se definition of DUI. Other states have adopted a more definitive approach with a zero tolerance of THC to define impairment.

NHTSA aptly noted, if alcohol is present during the fatality, some states may not test for drugs due to the associated cost of testing (NHTSA, 2014). Additionally, some states may only test for a limited number of drugs, possibly missing others in the driver's blood and fail to recognize a poly-drug combination (NHTSA, 2014). Furthermore, some states merely screen for the presence and not the level of THC that exists in an individual's blood (NHTSA, 2014). This makes determining whether marijuana impairment was the sole cause of the fatality challenging to determine.

Another limitation of this study is the theoretical context from which rational choice and perceptual deterrence theory are applied. Traditional conservative approaches to deter social deviancy would suggest that harsh punishments would make the individual's cost outweigh the benefit of committing the crime (Lilly et al., 2011). Opponents to this approach have stated the concept of perception changes over time, past experiences, and new knowledge (Lilly et al., 2011). Further research in DUI arrests might take an expanded approach in individual perceptions, specifically from the arrestee's viewpoint when it comes to weighing opportunity and risk perceptions and how they act upon them when driving under the influence of marijuana. For example, what

part does an individual's degree of certainty of being caught caused them to refrain from driving impaired by marijuana when weighing costs and benefits?

This research study utilized secondary empirical data solely regarding traffic fatalities involving cannabinoids. Expanding upon this study to examine perceptual deterrence from a DUI arrestee's viewpoint, might provide insight in developing additional methods of deterrence. Lastly, this research study had limited funding and time constraints, which otherwise might have allowed for a mixed-methodology approach to explore individual perceptions and their development with regard to marijuana involved driving.

Recommendations

Decriminalization of marijuana and recent research studies show society's changing attitude shifting toward recreational marijuana legalization despite the federal classification as a Schedule I drug (Kohn et al., 2014; O'Malley & Johnston, 2013). As states move toward legalizing marijuana, the reclassification of marijuana should be considered by the federal government for research and funding purposes. The shift in attitude towards marijuana is reflected by states changing legislation from incarceration to decriminalization of marijuana, legalizing medical marijuana, and other states choosing to legalize recreational marijuana use. There is limited research on how public policy legalizing recreational marijuana impacts communities, the criminal justice system, and surrounding states as a whole. States considering legalizing recreational marijuana use should carefully consider the impact to communities when it comes to driving impaired and traffic fatalities involving cannabinoids.

Washington State's Strategic Highway Safety Plan of 2016 has a goal of achieving zero traffic fatalities and serious injuries by 2030. Further scientific research in marijuana-impaired driving and applied criminological theories would help explain why individuals decide to drive impaired. Furthermore, this would aid in crafting laws to address marijuana impaired driving and traffic fatalities involving cannabinoids.

Theoretical Applications

Rational choice and perceptual deterrence theories where applied to examine the relationship between recreational marijuana legalization in Washington State and traffic fatalities involving cannabinoids. However, marijuana-impaired driving also needs to be viewed through a social context lens, and further research studies could build upon this one. Social theories such as Hirschi's social control theory might also be applied to examine methods of deterrence and contribute to the existing body of knowledge. Lilly et al. (2011) noted that Hirschi redefined his definition of self-control in 2004 as, "[…] The tendency to consider the full range of potential costs of a particular act" (p. 128). This expanded upon his original theory and took into account factors such as the social bonds between people and groups such as one's family, friends, and employer in deterring social deviancy.

If the potential impact to these social bonds is too high, then it might also contribute to deterring social deviancy (Lilly et al., 2011). While these social bonds may deter people from criminal behavior, researchers should also consider applying Sutherland's 1973, Differential Association Theory of learned behavior to further help explain social deviancy. An individual who sees their friends driving under the influence

of marijuana may consider the behavior to be acceptable and less risky when combined with a lack of deterrence and be more likely to drive impaired.

Opponents to rational choice and perceptual deterrence have argued that humans exhibit certain character traits that make us prone to social deviancy (Lilly et al., 2011). Building upon Hirschi's original theory of self-control and social bonds, Sampson and Laub in 2003 (as cited in Lilly et al., 2011) revised and posited an age-graded theory of informal social control. This theory may also contribute to examining how positive social controls may constrain an individual from committing socially deviant crimes such as driving under the influence (Hess & Orthmann, 2012; Lilly et al., 2011;). The ability to identify underlying decision-making processes made by individuals may assist legislators and stakeholders as they consider legalizing recreational marijuana within their state and draft legislation with the aid of scientific research. Birkland (2011) aptly noted for the most part, "[…] Public policies fail to achieve all the goals their ardent proponents claimed that they would meet" (p. 289). Therefore, public policies should be thoroughly researched from all aspects before being implemented. One study suggested legalizing marijuana in Washington state had the potential of creating an increase in traffic fatalities (Archambault et al., 2013). Another research study conducted in Colorado showed a growing trend in marijuana-related traffic fatalities from 1994 through 2011 (Salomonsen-Sautel, 2014). Further research in marijuana-impaired driving will aid stakeholders in developing policies to reduce traffic fatalities and serious injuries.

This research study in its literature touched upon rising prison rates associated with the government's war on drugs. This conservative approach toward illegal drug

activity, primarily marijuana, led to an increased rate of minorities being directly impacted (BJS, 1990). Additionally, research in this area might show how marijuana legalization impacts minority groups and driving under the influence, serious injuries, and traffic fatalities. Sampson & Laub's 2003 age-graded theory of informal social control (as cited in Lilly et al., 2011) could potentially explain the impact of legalized marijuana and marijuana-impaired driving within diverse and low-income neighborhoods controlling for socio-economic impacts. This may also open research into recidivism with regard to marijuana-impaired driving.

Policy Applications

As advocates move to legalize marijuana, a number of policy recommendations based on scientific research studies should be considered. Research studies should consider focusing on analyzing delta-9 THC within an individual's whole blood and not plasma with regard to driving impaired (Huestis et al., 1992; Salomonsen-Sautel et al., 2014). A limitation of this study noted FARS data did not collect actual levels of delta-9 THC within a person's blood during a fatality. The lack of uniformity from state to state presents difficulty in analyzing the relationship between marijuana legalization and traffic fatalities. Washington State's toxicology laboratory already analyzes and collects the level of THC in an individual's blood. Without other states conducting the same investigatory analysis, it makes it difficult to analyze how legislation impacts communities. NHTSA should consider providing funding for a pilot project when marijuana is found to be present during a fatality, consisting of an analysis of the

individual's blood for delta-9 THC. This would allow future research studies to examine impairment levels from a fatality standpoint and explore marijuana-impaired DUI arrests.

Currently, there is no agreement on what defines marijuana-impaired driving and states differ in their legislative definition of marijuana-impaired DUI. This makes it difficult to analyze the legislative impact on marijuana-impaired traffic fatalities. Consideration should be given to defining what driving under the influence of marijuana is. The State of Washington determined it to be, "[…] within two hours after driving, a THC concentration of 5.00 or higher as shown by analysis of the person's blood made under RCW 46.61.506" (Washington State Legislature, 2018). Whereas, the State of Oregon defined it to be:

> A person commits the offense of driving while under the influence of intoxicants if the person drives a vehicle while the person:
>
> (a) Has 0.08 percent or more by weight of alcohol in the blood of the person as shown by chemical analysis of the breath or blood of the person made under ORS 813.100 (Implied consent to breath or blood test), 813.140 (Chemical test with consent) or 813.150 (Chemical test at request of arrested person);
>
> (b) Is under the influence of intoxicating liquor, cannabis, a controlled substance or an inhalant; or
>
> (c) Is under the influence of any combination of intoxicating liquor, cannabis, a controlled substance and an inhalant. (Oregon Legislature, 2018)

NHTSA's (1998) scientific research and validation of standardized field sobriety testing (SFST) assisted officers in making arrest decisions in blood alcohol below concentrations

of 0.10. The legislative implications of this research in conjunction with federal funding led to statewide legislation and policies lowering DUI limits to a uniform statewide standard of 0.08 breath alcohol concentration.

The same uniform standard should be in place if states are to consider legalizing marijuana. Currently, some states like Oregon utilize a subjective standard of marijuana impairment instead of a specific delta-9 THC measure. NHTSA's data collection process through FARS combined with grant funding to compensate for the costs associated with collecting delta-9 THC levels from traffic fatalities involving cannabinoids could be expanded to DUI arrests. Furthermore, blood toxicology in traffic fatalities should be conducted as soon as possible as THC levels continue to drop and may not be representative of the THC level at the time of the traffic accident (Huestis et al., 1992). If conducted out in the field, the blood sample would be more reflective of the individual's THC level at the time of the traffic fatality.

Differences in marijuana-impaired driving legislation may create confusion within society as a whole and make a standardized approach in curtailing marijuana-impaired DUI and traffic fatalities difficult on a statewide level. Federal reclassification of marijuana as a Schedule I drug would help researchers in determining levels of impairment as has been done with alcohol. Along with differences in marijuana-impaired DUI limits and definitions, additional research is necessary to identify standardized methods for officers to use in identifying impaired drivers. Conducting toxicology research for delta-9 THC levels involved in a traffic fatality could be used in conjunction with research in developing standardized field sobriety testing that would aid officers in

determining impairment out in the field. The use of a DRE is extremely helpful as they will typically determine that the arrestee's impairment is not consistent with alcohol (NHTSA, 2015). Additionally, DREs are able to rule in or out whether a medical condition is present and determine if an individual is under the influence of a specific type of drug(s) (NHTSA, 2015). Based upon the extensive training and testing of DREs, courts have deemed these individuals as experts within their field. Their ability to rule out possible medical conditions for impairment limits defense counsel's ability to offer an alternative to marijuana-impairment. However, a DRE's skillset must routinely be applied, or those skills become diminished. This makes placement of DREs more heavily concentrated within higher populated areas leaving rural communities without these valuable experts to assist during a DUI.

Washington State and others do conduct officer training in Advanced Roadside Impaired Drug Evaluations (ARIDE). The purpose of ARIDE training is to essentially bridge a gap between SFST training and DRE training by providing a general knowledge of drugs and drug impairment but not at the expert level of a DRE. While SFST training is conducted during an officer's basic academy, ARIDE training is an additional course after the academy. In light of marijuana legalization, academies should commit to completing this training as part of their regular curriculum providing every officer the ability to help recognize drug-impaired driving.

Both ARIDE and DRE training are invaluable tools in addressing marijuana-impaired driving. However, while ARIDE training might help identify whether an individual is under the influence of a particular drug, and DREs can rule out medical

issues and identify the specific drug of impairment, these programs identify factors of impairment but still rely on a blood toxicology to determine actual delta-9 THC levels to determine per se DUIs within Washington State.

Research studies explored the absorption phases of marijuana and possible impairment but these research studies used plasma instead of whole blood (Huestis et al., 1992). Huestis et al.'s research provided a valuable foundation to be built upon in marijuana absorption rates but should be examined with the use of whole blood. Combining those findings with methods such as identifying standardized field sobriety testing that assists officers out in the field in their arrest decision making process would be invaluable.

The National Safety Council's determined in 2013 that marijuana increased the risk of injury or death to self or others when operating a motor vehicle or heavy equipment. This should be used as a guide for those states considering legalizing recreational marijuana until a correlation in delta-9 THC impairment and SFST testing can be made to assist officers in the field when making a decision to arrest at a particular level of THC concentration.

Implications for Social Change

Within the United States, driving under the influence has had far-reaching consequences. It has affected community resources, impacted insurance rates as a whole, and stretched limited criminal justice resources to their limit. Traffic fatalities involving cannabinoids has devastated families, friends, and communities and marijuana legalization to should carefully consider its impact. As with Washington State's Strategic

Highway Safety Plan of 2016, the goal of reducing deaths and serious injuries to zero has tremendous implications for positive social change. This research study provides insight into marijuana legalization and policy implications. Researchers may continue building upon this research by identifying additional criminological theories that provide further understanding in social deviancy specific to marijuana-impaired driving and traffic fatalities involving cannabinoids.

Despite extensive outreach to communities through alcohol education in schools, universities, and various media campaigns in partnership with state, federal, and nongovernment organizations such as Mothers Against Drunk Driving, driving under the influence is still prevalent. Media outreach slogans within Washington State such as drive hammered – get nailed suggest robust deterrence methods through the judicial system such as incarceration, steep fines, and licensure suspension are successful. However, individuals still choose to operate a motor vehicle under the influence. The same type of marijuana-impaired education has not been implemented in the same manner as alcohol-impaired driving. Until this occurs, an individual's rational choice and perception may be more likely to drive under the influence of marijuana.

Further combined research that expands upon this study would allow legislative and public policy strategies to be developed that address driving under the influence of marijuana. Specific marijuana-impaired outreach is necessary to reduce traffic fatalities involving marijuana from both a rational choice and perceptual deterrence standpoint. While Washington State FARS data in traffic fatalities involving cannabinoids showed an increase of 58 in 2012 to 105 in 2016, this research study showed no relationship existed

between those fatalities and recreational marijuana legislation. Target Zero aptly asked the question as to what are acceptable figures when it comes to traffic fatalities and serious injuries, and the answer is zero. The findings of this research study will be available for stakeholders to develop additional strategies in reducing traffic fatalities involving cannabinoids.

Additionally, a quantitative time-series design like the regression point displacement design is an appropriate methodology to examine possible outcomes based on a treatment effect, such as legalizing recreational marijuana. The ability to use aggregated data collected on a statewide level provided for strong statistical power despite what appeared to be a low number of control groups. The use of large aggregated numbers and the use of the ANCOVA allowed for the detection of a treatment effect that was representative and could be generalized back to the population. This empirical study and method of analysis can be furthered through exploring additional covariates and thereby expand upon the existing body of knowledge facilitating further positive social change.

Conclusion

After decades of government involvement in restricting, taxing, and criminalizing marijuana, Washington State's Initiative-502 to legalize recreational marijuana was met with opposition that directly pointed to an increase in social deviancy, traffic fatalities involving cannabinoids, and serious injury that would directly impact communities. Some research studies showed an increase in marijuana-related crashes after commercialization of marijuana as in Colorado State. (NHTSA, 2015; Pollini et al., 2015; Salomonsen-

Sautel et al. 2014). The conclusion of this research study showed no significant difference exists between marijuana legalization and traffic fatalities involving cannabinoids. It is apparent much-needed research in marijuana-impaired driving is still needed if traffic fatalities involving cannabinoids are to be reduced to zero.

Studies have shown marijuana is used more by drivers than any other drug and is the most prevalent aside from alcohol when it comes to traffic fatalities (Bogstrand, & Gjerde, 2014; NHTSA, 2015; Wilson, 2012). Additionally, high school and college students would drive a motor vehicle after smoking marijuana. Furthermore, research studies have shown the perception that drinking alcohol poses a higher risk than smoking marijuana and operating a motor vehicle (Kohn et al., 2014; O'Malley & Johnston, 2013). High school and college students consider riding as a passenger with someone who has been drinking alcohol more dangerous than someone smoking marijuana (Kohn et al., 2014; O'Malley & Johnston, 2013). These perceptions are a perilous fallacy that potentially lead to traffic fatalities. Furthermore, it might also explain why the WTSC (2015) noted an increase in marijuana involved fatalities between 21-25 years of age the legal age at which recreational marijuana may be purchased within Washington State.

Individuals make bounded decisions but the theory of rational choice does not adequately explain on its own why individuals drive impaired by marijuana. If legislators are to make a difference in reducing marijuana-related traffic fatalities to zero, changing individual perceptions will be of vital importance as they decide whether or not to drive under the influence of marijuana. Additional theoretical lenses may provide further insight in this area as perceptions change over time through social bonds (Lilly et al.,

2011). Furthermore, since research studies have identified a potentially at-risk age group, educational outreach should specifically target the group for more significant impact in reducing traffic fatalities involving cannabinoids (Kohn et al., 2014; O'Malley & Johnston, 2013). Continued targeted outreach to this group can potentially change perceptions across generations in the long run and save lives.

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