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Introduction

Marijuana legalization has been a very controversial topic for decades, however it gained momentum with the Compassionate Use Act of 1996, when California allowed medical use for very sick patients. It is highly addictive, which is why the Drug Enforcement Administration has classified it as a Schedule I under the Controlled Substances Act of 1970, without any approved medical uses from the U.S. Food and Drug Administration (Drug Enforcement Administration, 2020). Nevertheless, almost all states in the U.S. have legalized marijuana for medical, recreational, or both purposes. According to the Insurance Institute for Highway Safety (2023), sixteen states have legalized medical marijuana only: UT, ND, SD, MN, OK, AR, LA, MS, AL, FL, KY, OH, WV, PA, NH, and HI. Twenty two states allow both medical and recreational marijuana: CA, WA, OR, MT, NV, AZ, NM, CO, AK, MO, IL, MI, VA, DC, MD, NJ, NY, DE, CT, RI, MA, VT AND ME. Some states such as TX, IA, WI, IN, TN, GA, and NC, only have laws pertaining to limited medical use of marijuana, while ID, WY, SC, and KS have not legalized any uses.

As the issue of legalization floats in many legislatures each year, many studies have evaluated the effects such legalization policies have had on the healthcare, economic, criminal, and educational platforms. In particular, many researchers have focused on the relationship between marijuana legalization and crime rates or health outcomes, however, fewer studies have focused on marijuana and alcohol specifically. My research focuses on determining whether there is a relationship between the legalization of marijuana and alcohol consumption, both substances that affect the physical and mental health, as well as lifestyles of consumers. The states that have

legalized marijuana for either medical or recreational purposes may also have decreased alcohol consumption among their populations. The data from the Insurance Institute for Highway Safety for the Independent Variable (legalization) will explain what marijuana laws are in place in all fifty states, and vinepair.com provides the corresponding alcohol consumption per capita (Dependent Variable) data for each state. A Point Biserial Correlation analysis is necessary to determine whether there is an association between the legalization of marijuana and alcohol consumption. In addition, box and whisker plots for the categories of recreational and medical marijuana in states where it has been legalized or not, will provide descriptive statistics for the dependent variable of alcohol consumption per capita.

Significance/Background

Existing literature suggests that there may be a correlation between the two variables, although the extent and nature of the correlation can vary. A few studies have shown that the legalization of marijuana for recreational use is associated with a decrease in alcohol consumption. For many years proponents of legalizing marijuana including consumers, have argued that it may have benefits not just to manage chronic pain and illnesses, but also because it helps offset cravings for more dangerous drugs such as cocaine or heroine. According to Jaeger (2022), researchers at the University of Washington found that between 2015-2019, people aged 21-25 decreased the consumption patterns of dangerous drugs after marijuana was legalized in their state. This is a debatable argument however, because opponents of marijuana emphasize why marijuana has been labeled a "gateway drug" due to its negative effects on a biological level. According to dea.gov, marijuana produces psychoactive effects due to its main

ingredient THC, which reaches the brain through the bloodstream, and influences the activity of cannabinoid receptor cells.

The goal of this research is to analyze whether the legalization of marijuana as an independent variable has an effect on alcohol consumption patterns as the dependent variable across the Unites States. Determining such a relationship is important because if legalizing marijuana exacerbates alcohol consumption, then the states and the federal government need to amend their policies in order to reverse or ban marijuana use, especially for recreational purposes. In contrast, if marijuana use does not correlate with dangerous levels of alcohol consumption, or if it helps reduce it, then perhaps critics will have one less argument for banning such legalization in every state.

Studying the relationship between these two variables is important because many consumers in USA drink alcohol, and when in excess it has negative consequences such as "…between 2006 and 2010, it was responsible for an average of almost 88,000 deaths per year and in 2006 alone it amounted to a median state-cost of 2.9 billion dollars" (Guttmannova et al., 2015). According to worldpopulationreview.com, the United States ranks 25th for alcohol consumption, with an average of 8.7 liters per person compared to the global average of 8.3 liters.

Existing research has produced ambiguous findings on the relationship between marijuana use whether for medical or recreational purposes and alcohol consumption. For example, a narrative review of previous studies published in PubMed Central found that "cannabis policy liberalization was associated with decreases in alcohol use measures…" (Pacula et al., 2022). Similarly, Macha et al., (2022), cites regression studies that found a substitute effect between marijuana and alcohol use, rather than a complementary one.

This implies that when demand for one substance increases, demand for the other decreases. Some studies such as the 1997 National Longitudinal Survey of Youth failed to establish any association between marijuana and alcohol use. A few studies using data from the National Survey on Drug Use and Health found that recreational marijuana use could lead to a decline in alcohol consumption, while others found that recreational marijuana had an increasing effect of alcohol consumption.

The largest survey study that established a relationship between legalization of marijuana use and alcohol consumption in the United States, examined ten states and the District of Columbia, which had legalized marijuana between 2010-2019. This study published in JAMA Heath Forum in 2022, had 4.2 million individual subjects, who responded to a cross-sectional survey between 2010-2019. The authors Macha et al., performed data analysis to examine the association between recreational cannabis and alcohol consumption. The surveys by individuals of a wide age-range were based on self-reporting on the Behavioral Risk Factor Surveillance System sponsored by the CDC. They reported consumption of alcohol and marijuana before and after marijuana was legal in their state. The study found that alcohol consumption increased 0.9 percent in the states, which legalized marijuana within the first year. However, they did specify that the figures mostly applied to a younger, non-college educated demographic of 18-24 year olds.

Another study with a sample of 281 youth who filled out surveys between 2002-2018, focused on analyzing whether legalizing recreational marijuana would predict "a higher likelihood of …alcohol use in a longitudinal sample of youth aged 10-20 years"

(Bailey et al., 2020). The researchers found that legalizing recreational marijuana predicted higher levels of alcohol consumption when controlling for factors such as race, parent education, and sex.

An older study examined whether policies that reduced alcohol consumption on college campuses between 1993-1999 increased marijuana use by 22 percent during that period. The results showed instead "…that alcohol and marijuana are economic complements, and that policies that increase the full price of alcohol decrease participation in marijuana use" (Williams et al., 2001). When colleges banned alcohol on campus, students were less likely to consume both alcohol and marijuana.

Alcohol has long been a dangerous substance, even more so than marijuana, because evidence has shown severe health consequences due to alcoholism, as well as an increase in crimes, and vehicle accidents. Consuming alcohol may increase the incidence of side effects such as impaired coordination, judgment, and delayed reaction times (Moskowitz & Fiorentino, 2000). High Blood Alcohol Concentration (BAC) correlated with higher incidences of vehicle crashes, and specifically fatal crashes. According to Voas et al., (2012), fatal incidents increased significantly when the driver had a BAC higher than the typical limit of 0.08 percent. Forty-nine states in the USA have laws criminalizing the operating of a vehicle with a BAC of 0.08 or greater, while Utah's legal threshold is 0.05 percent. In addition, all states have laws preventing drivers under 21 years of age from operating any vehicle with any BAC percentage (Insurance Institute for Highway Safety, 2023).

It is important to understand the effects of legalizing marijuana on alcohol use in order to estimate social and economic costs, along with prevention or intervention for any substance abuse. Studies like these are significant because special interest groups lobby for policies that benefit their agenda instead of the public interest. For example, I am skeptical of one such study conducted by the Distilled Spirits Council of America, which examined only three states where recreational marijuana has been legalized for the longest period. Their findings claimed there was "No evidence that legalization has had any impact on spirits sales, nor is there any evidence that it has impacted total alcohol sales" (Ozgo, 2019). Their study has several flaws not simply because it may be biased rather than being conducted by independent researchers, but also because their sample size is quite small, only three states rather than accounting for all states that have legalized recreational marijuana.

Theory and Argument

My argument is that individuals who consume marijuana may consume less alcohol per capita in those states that passed legislation to legalize it. There are several reasons why the legalization of marijuana may lead to a decrease in alcohol consumption. My prediction was that individuals who prefer using marijuana to manage their severe medical issues may use it as a substitute substance for alcohol to manage such issues. Some consumers may use marijuana to substitute alcohol as a recreational substance, because they may experience the same relaxing effects as they feel with alcohol. Additionally, consumers perceive marijuana as a less harmful substance than alcohol, and hoping to maintain a healthier balance, they may smoke more marijuana rather than drinking.

The study sample consists of all states and District of Columbia in the USA, thus pulling data from disa.com, I constructed a visual map of the legal status of medical and recreational marijuana in each of them for the year 2023.
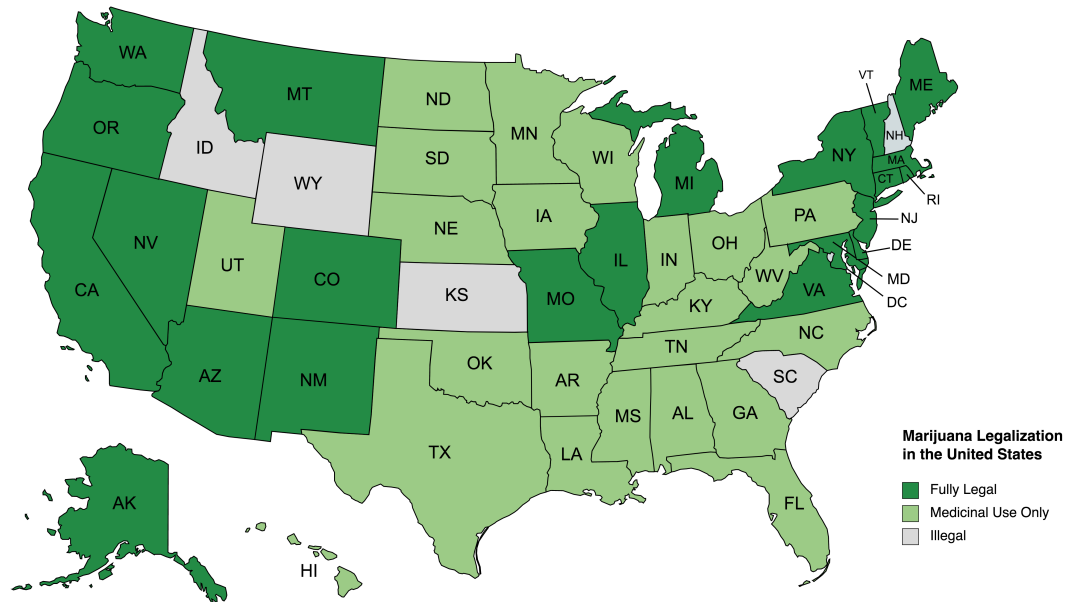
Created with mapchart.net

The independent variable in this study is the legalization of marijuana, and the dependent variable is alcohol consumption per capita. The causal mechanism in this study is as follows: when consumers find out that marijuana is legal, they adjust their use patterns to consume more marijuana to replace their need for alcohol. This reduces alcohol consumption by each individual, who will drink fewer gallons per capita.

Of course, there could be confounding factors that explain the findings, for example, characteristics of the populations in each state. Some may have lower income populations that may not be able to afford both marijuana and alcohol as recreational

substances, or even as self-medicating substances. Some states may have a different racial makeup, which affects the marijuana and alcohol consumption patterns. For example, the study by Macha et al., (2022), found that the heaviest consumers of alcohol were younger white men, without any college education. I hypothesized that alcohol consumption per capita decreases in states where marijuana is legalized in any capacity. In this study, I focused on the single relationship between one independent variable (legalization of marijuana-both medical and recreational), and the dependent variable of alcohol consumption, while controlling for all other factors such as gender, age, race, income, education, religious or political ideology, and more.

Research Design and Data

In order to test the hypothesis that legalizing marijuana may decrease alcohol consumption per capita, I ran a Point Biserial Correlation on Excel to establish whether such a relationship exists. The reason I used this type of correlation is because it is appropriate to measure the relationship between a dichotomous variable and a continuous variable. I operationalized my categorical independent variable (marijuana legalization) by naming each USA state and labeling YES/NO for the legal or illegal status. This is the dichotomous variable. To further operationalize my independent variable, I divided it into two tables of states based on whether legislatures passed laws for medical or recreational marijuana. Each table as shown below has three columns: one is assigned to the names of the states, the middle column describes the status of legalization for either recreational or medical marijuana in that state, and the final column contains all the numerical values for the alcohol consumption per capita in the corresponding state. I assigned values of zero to the states in which neither medical or recreational marijuana is legal in 2023, values of

one for the states with legal medical marijuana, and values of two for states with

recreational marijuana. I treated these as two mutually exclusive categories of marijuana

rather than creating a third category for those states in which both medical and

recreational marijuana are legalized as of 2023.

Table 1. Recreational Marijuana and Alcohol Consumption by State

STATE	LEGAL STATUS	ALCOHOL CONSUMPTION (GALLONS) PER CAPITA
CA	2	2.63
WA	2	2.26
OR	2	2.71
MT	2	3.32
NV	2	3.43
AZ	2	2.24
NM	2	2.30
CO	2	2.97
AK	2	2.83
MO	2	2.68
IL	2	2.42
MI	2	2.53
VA	2	2.27
DC	2	3.79
MD	2	2.15
NJ	2	2.63
NY	2	2.22
DE	2	4.01
CT	2	2.50
RI	2	2.71
MA	2	2.62
VT	2	3.22
ME	2	2.99
ID	0	2.94
NE	0	2.17
WY	0	2.94
KS	0	2.12
SC	0	2.16

0= NOT LEGAL
2= RECREATIONAL MARIJUANA

Table 2.   Medical Marijuana and Alcohol Consumption by State

STATE	LEGAL STATUS	ALCOHOL SALES (GALLONS) PER CAPITA
UT	1	1.36
ND	1	3.26
SD	1	2.34
MN	1	2.85
OK	1	1.85
AR	1	1.92
LA	1	2.59
MS	1	2.39
AL	1	2.08
FL	1	2.74
KY	1	2.12
OH	1	2.12
WV	1	1.82
PA	1	2.32
NH	1	4.83
HI	1	2.71
WY	0	2.94
KS	0	2.12
TX	1	2.41
IA	1	2.34
WI	1	3.11
IN	1	2.34
TN	1	2.30
GA	1	1.91
SC	0	2.16
NC	1	2.31
ID	0	2.94
NE	1	2.17

0= NOT LEGAL
1= MEDICAL MARIJUANA

The tables helped to organize the data columns on Excel, in order to run a statistical test of Point Biserial Correlation, to determine whether the two variables of interest had a relationship. The correlation coefficient takes on a range of values of -1 to 1, where a negative value corresponds with an inverse correlation, and a positive value indicates that both variables are moving in the same direction. I ran the correlation test separately for the recreational marijuana and medical marijuana.

To further get a picture of the recreational and medical marijuana relationship with the alcohol consumption, I created box and whisker plots for each of them. The reason I used box and whisker plots was because it provides a side by side visual of the medians of alcohol consumption of the groups of states with legal or illegal marijuana, for both recreational and medical categories.

Medical Marijuana & Alcohol Consumption
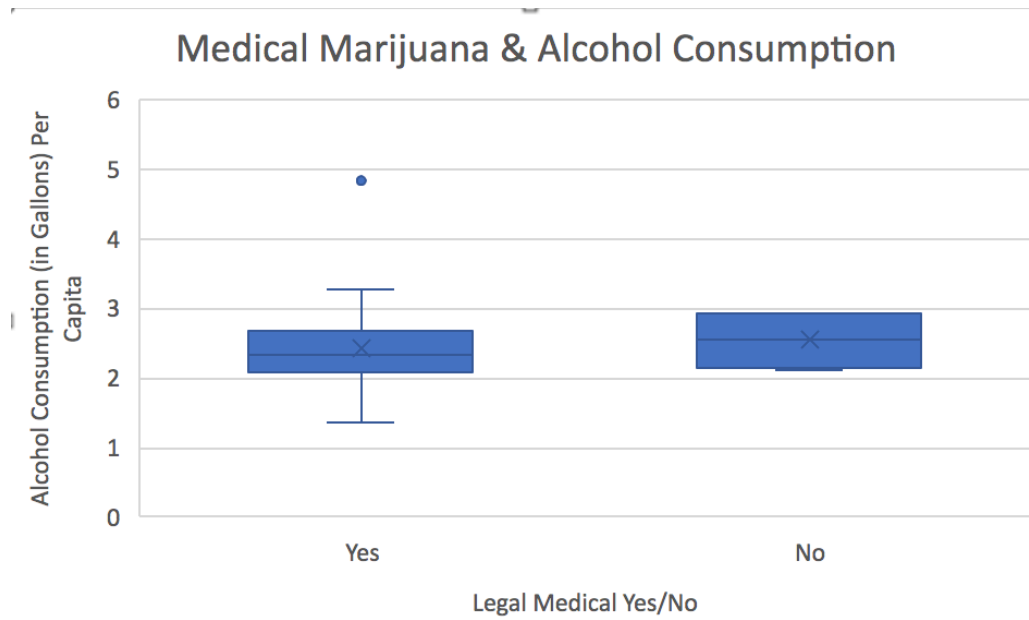
Population size: 24
Median: 2.33
Minimum: 1.36
Maximum: 4.83
First quartile: 2.09
Third quartile: 2.68
Interquartile Range: 0.59
Outlier: 4.83

Population size: 4
Median: 2.55
Minimum: 2.12
Maximum: 2.94
First quartile: 2.13
Third quartile: 2.94
Interquartile Range: 0.81
Outliers: none

Rec. Marijuana & Alcohol Consumption
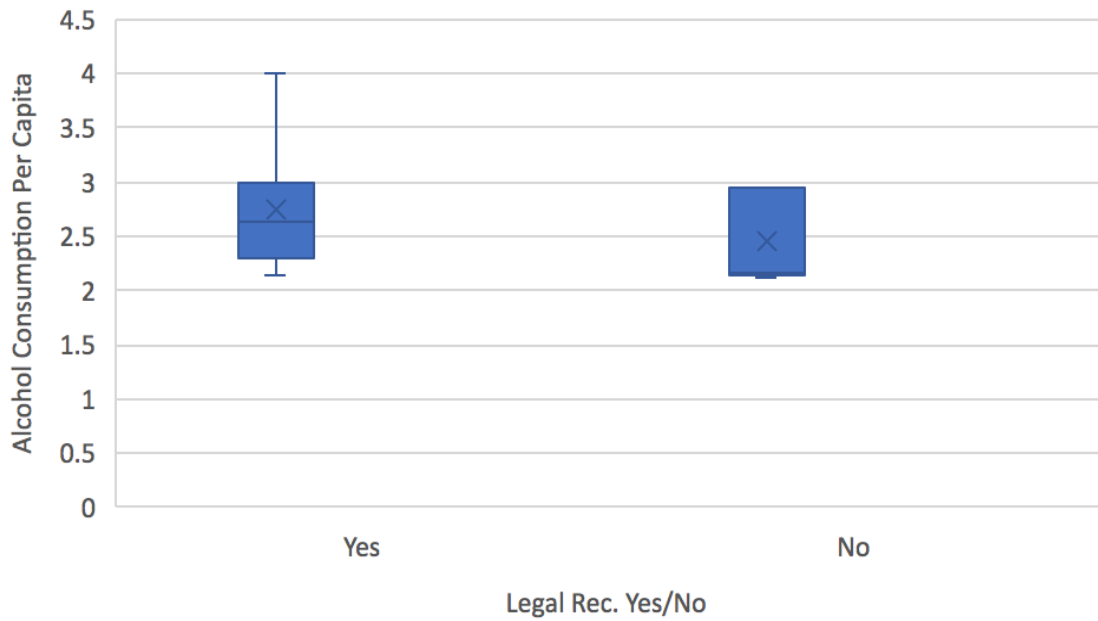
Population size: 23
Median: 2.63
Minimum: 2.15
Maximum: 4.01
First quartile: 2.3
Third quartile: 2.99
Interquartile Range: 0.69
Outliers: none

Population size: 5
Median: 2.17
Minimum: 2.12
Maximum: 2.94
First quartile: 2.14
Third quartile: 2.94
Interquartile Range: 0.8
Outliers: none

The dependent variable is quantitative/numerical and it is measured in the number of gallons of alcohol consumption per capita in each state for the latest available year in 2022. The dependent variable is counted by gallons and can take on values between 0-10 for each of the states in the USA. I cross referenced data from the Insurance Institute for Highway Safety and disa.com for all 50 states in the USA to determine whether marijuana is legalized or not in each state by 2023. For the dependent variable, I obtained data from vinepair.com to find out the annual alcohol consumption per capita in 2022 for each state.

This research design is based on data observations that I found readily available on the websites mentioned above. I did have data observation issues, because several sources reported conflicting data for both the independent and dependent variables. Depending on which websites I investigated, some states came up with legal status for marijuana, but on another website it showed the opposite. For example, South Carolina in 2023 was described as having limited medical marijuana use in the Insurance Institute for Highway Safety, while several websites including disa.com claimed it has no legal marijuana of any kind. Similarly, various websites reported minor differences in their annual alcohol consumption per capita, however, I chose the latest publication from vinepair.com to report the dependent variable in gallons of alcohol. This created weaknesses for the reliability of my study, because if another researcher tries to replicate it using other data sources, they may not obtain the same numbers for operationalizing the alcohol dependent variable, or the same policy status of legalization of marijuana for states like South Carolina. Similarly, this could also present a weakness for the validity of the study if the sources I relied on have not reported the accurate measures for my interest variables. If for example it is not correct that South Carolina needs to be categorized under the NO label for the column of the independent variable, this will contribute to an incorrect table of variables for both medical and recreational marijuana legalization. The same concern applies to the numbers representing the gallons of alcohol per capita displayed on the tables. Further, when I run statistics on Excel, the correlation coefficient may not be the correct value based on the labeling of the states and the measuring of the alcohol.

Analysis/Results

The Point Biserial Correlation coefficient for recreational marijuana and alcohol consumption is $r_{pb} = 0.23$. If the coefficient is a positive value then it indicates a positive relationship between my variables, they are both moving in the same direction: when marijuana is legalized, then alcohol consumption increases. However, because the correlation coefficient takes on values between -1 to 1, the closer it falls on either extreme, the stronger the correlation is. In this study, a 0.23 coefficient value is very far for the positive 1 value, thus this is a very weak positive correlation. Legalizing recreational marijuana does not have a strong relationship to per capita alcohol consumption patterns.

For the medical marijuana category, the Point Biserial Correlation $r_{pb} = -0.07$. When the correlation coefficient has a negative value, then the opposite is true, that when marijuana is legalized, alcohol consumption per capita decreases. However, this value in my study is so close to 0 rather than a -1 value, that is indicates an extremely weak negative correlation.

In addition, the box and whiskers plots indicate similar findings. When analyzing the plot for recreational marijuana, there are no outlier values for any of the twenty-three states with legal status or the five states where it is not legalized. The median for the legalized states is 2.63 gallons of alcohol consumption per capita, while the median for the states where it is not legalized is 2.17 gallons of alcohol per capita. The difference is not too great, which indicates that legalizing recreational marijuana in those twenty-three states did not decrease alcohol consumption per capita in a significant way.

The box and whiskers plot for the medical marijuana category has an outlier of

4.83 gallons of alcohol consumption per capita in states where marijuana is legalized (this

is NH), but not for the four states where it is illegal. Similarly to recreational marijuana,

the medians for the twenty-four states where medical marijuana is legal and the four

states where it is not legal do not vary much. Respectively those values are 2.33 gallons

of alcohol consumption per capita and 2.55 per capita. It is perhaps worth mentioning that

in the case of recreational marijuana, it seems that per capita consumption is almost half a

gallon more in states where it is legalized. However, in the case of medical marijuana the

opposite is true. The median for alcohol consumption is higher by 0.2 gallons per capita

in the states where it has not been legalized as of 2023.

The statistical analysis does not support my original hypothesis that alcohol

consumption per capita decreases in states where marijuana is legalized. This is evident

in the values for both categories of recreational and medical marijuana, because the

correlation tests did not establish a significant enough correlation in either a positive or

negative direction between the variables. Legalizing recreational and/or medical

marijuana in the USA did not result in a pattern of decrease or increase in alcohol

consumption per capita in 2023.

Implications

This study contributes to the existing research about marijuana legalization and its

relationship with alcohol consumption in every state of the USA and DC. If my statistical

results had supported my hypothesis that legalizing marijuana contributes to decreases in

alcohol consumption per capita, then this would provide an argument in favor of

decriminalizing and legalizing marijuana at a federal level. Such policies would reduce

the alcohol dependency that is so prevalent in the United States, as the leading global consumer of alcohol per capita, and would have significant social and fiscal consequences. By reducing alcohol consumption, the number of 88,000 deaths associated to it annually would decrease significantly. Alcohol contributes not only to many health problems such as liver disease, diabetes, addiction, mental issues, but also increased vehicle crashes and fatalities, and loss of employment or relationships.

Even though my results did not support my hypothesis, they did not indicate that legalizing marijuana has a detrimental effect either because while it did not decrease per capita consumption, it does not increase it either. The very weak correlation in both cases of recreational and medical marijuana indicates that the independent variable has no effect on the dependent variable, thus it lends support once again to the argument in favor of decriminalizing and legalizing marijuana at the federal level.

The very weak correlation between marijuana legalization and alcohol consumption patterns in this study may not simply be explained by the legalization policy, but perhaps is related to other confluent variables such as cultural norms, economic factors, or individual characteristics such as race, mental health, and gender. Additionally, there are specific regulations and policies implemented alongside marijuana legalization, such as taxation and availability, which can explain the insignificant relationship I observed between marijuana and alcohol use. Finally, the data for this research corresponds with the end of the COVID-19 pandemic, which altered many patterns of behaviors for substance consumers.

Conclusion

The goal of this study was to examine whether legalizing recreational and/or medical marijuana in the United States decreases alcohol consumption per capita. The subject of substances such as marijuana is only a few decades old, and the debate around state and federal policies is even newer, because the first policy on legalization did not pass until 1996 in California. This has created tensions in both proponent and opposition camps for several reasons such as health consequences, economic impacts, diverse religious and social points of view, and even life expectancy and death prevention.

While previous studies found some evidence to suggest that marijuana legalization may have some impact on alcohol consumption, the precise nature of this relationship is still a highly debated subject. Much of the existing literature has produced inconclusive results regarding the relationship between marijuana legalization and consumption following marijuana legalization in many states. Studies like these are important because they guide new policies to further evaluate whether legalizing marijuana has had detrimental effects on the population, such as increased alcohol consumption, which could lead to other issues such as car crashes, unemployment, and health risks. Opponents of legalizing marijuana cite such studies in favor of reversing legalization of recreational marijuana, and over the past eleven years, twenty states have banned recreational marijuana.

This study did not establish a causal mechanism between the independent variable of marijuana legalization and the dependent variable of alcohol consumption per capita. The correlation was insignificant, thus it did not align with most of the literature

presented in this research, some of which found the two substances to be economic

complements while others established that they were substitutes of each other. The

analysis of all fifty states and DC in this study sample revealed similar patterns of alcohol

consumption for all states whether they had legalized any type of marijuana or not.

Overall, while there is some statistical evidence to suggest a potential correlation between

marijuana legalization and alcohol consumption in the USA, this relationship remains

complex and requires further research to be fully understood. It is essential to consider

multiple factors and ongoing studies to determine whether legalization policies for both

recreational and medical marijuana should change at the state and the federal level.

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