THE SURPRISING EFFECTS OF DRUG POLICY

By

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Abstract: Overdose death rates have been increasing exponentially since 1979, leading me to ask how state-level drug access policy is affecting this trend. Previous research identifies three main approaches states take: restricting prescription medication, increasing medication-assisted addiction treatment access, and increasing marijuana legality. The findings of this research are inconclusive due to inconsistent measures of overdose deaths and a lack of inclusion of all policy approaches. Using previous preliminary findings and economic substitution theory, I create four hypotheses to test the interactive effects of the policy approaches. I remedy the issues in previous research by constructing a new dataset that includes the three main approaches, a measure of all drug overdose deaths, and other policies I think may confound the results. Using a two-way fixed effects model, I find that most policies and policy interactions lead to a significant increase in overdose deaths. When looking at the marginal effects of these policy interactions, all fail to reach significance. These findings call in to question the current approaches to overdose reduction and leave room for future research.

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CHAPTER I

INTRODUCTION

The nature of drug access policy has shifted in recent years. While the regulation of drug access has traditionally been something managed by the federal government, states have begun to create their own regulations. This leads me to ask, how does state level regulation of drug access affect overdose death rates? This question is becoming more important as states begin to craft their own policy in this area, as their efforts have led to a greater range of policies. An example of this range is the legislation on initial prescription limits for opioids. While some states have no limits on initial prescriptions, the states that do can range from a 14 day maximum to a 3 day maximum (Ballotpedia 2022). These limits could have a vastly different impact on the residents of these states, with some being unable to receive a script long enough to increase their likelihood of developing an addiction (Mayo Clinic 2022)

When previous researchers have looked at the effects of state level drug access policy, they have often focused on the effects of one policy (Haffajee et al. 2018; Powell, Pacula, and Jacobson 2018; Shover et al. 2019; Volkow et al. 2014), focused only on opioid overdoses (Babu, Brent, and Juurlink 2019; Krawczyk et al. 2020; Pardo 2017; Powell, Pacula, and Jacobson 2018; Shover et al. 2019), relied on country-level data or data from a single state (Babu, Brent, and Juurlink 2019; Johnson et al. 2014; Krawczyk et al. 2020; Volkow et al. 2014), or used shaky methodology that limits the strength of their findings (Haegerich et al. 2014; Strang et al. 2012). To combat this use of limited data and lack of comprehensive policy analysis, I compiled a new state-level dataset. This dataset includes state level laws regarding marijuana, pain management clinics (PMC), prescription drug monitoring programs (PDMP), limits on initial opioid prescriptions, the number of facilities offering treatment drugs for addiction, the total number of drug overdoses, naloxone access, and Good Samaritan laws. I also use a two-way fixed effects regression to analyze this data, as it allows for a sounder causal connection to be made.

The answer to my question is important to both policy makers and average citizens, as overdose rates have grown exponentially between 1979 and 2016, with 174 people dying of an overdose every day in 2016 (Jalal et al. 2018), and 68,630 people dying in 2020 (KFF 2022). Finding the most effective strategies to reduce the number of overdoses per year could save thousands of lives and countless families from heartbreak. The importance of this impact cannot be overstated, as the addiction that leads to these overdoses is often painful for the individual and damaging to their loved ones. Making effective policy choices with current research, however, is unlikely due to the lack of quality studies. I hope to fill that gap with this research, both in my findings and construction of a new dataset.

In the following sections of this paper, I will be reviewing the three main methods states use to alter drug access and the contradictory effects previous literature has found. After that, I will discuss how these policies should interact based on the effects they are purported to have and derive four hypotheses from this. Then, I will discuss the data I have collected and demonstrate how widespread these policies have become. Finally, I will discuss the results of my regression and interaction models. My findings run counter to the assumed effects of these policies, leaving a bigger question of what, if any, actions the state governments can take to reduce the overdose death rates they are facing. From these findings I suggest some ideas for future research.

CHAPTER II

LITERATURE REVIEW

There are currently three main approaches states take to alter drug access. The first is increasing regulation on prescription drugs, focusing mainly on opioids (Alpert, Powell, and Pacula 2018; Babu, Brent, and Juurlink 2019; Haegerich et al. 2014; Haffajee et al. 2018; Johnson et al. 2014; Pardo 2017; Strang et al. 2012). The findings of studies on these policies are mixed, with different dependent variables and a lack of inclusion of multiple restriction methods making it harder to draw a single conclusion. The second approach is to increase the availability of addiction treatment drugs (Babu, Brent, and Juurlink 2019; Krawczyk et al. 2020; Strang et al. 2012; Volkow et al. 2014). While the findings of these studies show a clearer decrease in overdose deaths, they use experimental designs or country level data, which ignores the uneven distribution of clinics across the states. The third approach is to legalize marijuana to varying degrees (Alpert, Powell, and Pacula 2018; Pardo 2017; Powell, Pacula, and Jacobson 2018; Shover et al. 2019; Strang et al. 2012). The findings on this method are also mixed, with studies finding an increase, decrease, or lack of effect on overdoses.

When looking at older research, the common conclusion is that the effects of drug access policy on overdose death rates are unclear. Haegerich et al. (2014) and Strang et al. (2012) compile and review an extensive amount of previous research regarding policies affecting drug use and overdoses and find that most research has weak methods and a lack of quality data. A similar lack of conclusive findings is shown in research that looks only at demographics, as there is no clear explanation for the variance of overdoses across age, race, gender, and location as there is a lack of variance in medical conditions that may increase prescription rates (Jalal et al. 2018; Paulozzi, Mack, and Hockenberry 2014). This lack of clear risk factors makes the research of policy effects a better approach, as there is not a clear group or area to address directly.

One of the more prominent approaches that states use to combat increasing overdose rates is the restriction of access to prescription drugs through PMC regulations, PDMPs, and initial prescription limits. In theory, PMC regulations increase scrutiny on these clinics, so they are unable to prescribe and dispense large quantities of opioids. PDMPs work in a similar way but increase monitoring on all doctors and dispensers in the state, requiring them to report prescriptions to the monitoring system. Initial prescription limits reduce the number of opioids a doctor can prescribe when beginning pain management treatment for a patient, although these regulations usually only apply to acute pain rather than chronic pain. Studies on these policies have the widest variation in design, with Babu, Brent, and Juurlink (2019) and Strang et al. (2012) using federal level data, Alpert, Powell, and Pacula (2018), Haegerich et al. (2014), Haffajee et al. (2018), and Pardo (2017) using state level data, and Johnson et al. (2014) using Florida as a case study. These studies also fail to include all three policies, and most do not include a measure of total overdoses. When looking at the findings for the individual restriction policies, Haegerich et al. (2014) and Johnson et al. (2014) finds that PMC regulations decrease overdose deaths while Alpert, Powell, and Pacula (2018) finds that they have no effect. Haegerich et al. (2014), Haffajee et al. (2018), Johnson et al. (2014), Pardo (2017), and Strang et al. (2012) all find that PDMPs reduce overdoses and improper use of drugs, but Alpert, Powell, and Pacula (2018) find that they have no effect. Initial prescription limits have received the least research out of the three restriction measures, with Strang et al. (2012) finding a reduction in overdoses.

Despite what seems to be promising results from these studies, they become less convincing when realizing that most only focus on the reduction in opioid overdoses rather than a reduction in overall overdoses. Focusing only on opioid overdoses means these studies fail to capture overdoses of people switching to a more dangerous street drug such as heroin. The studies that do focus on overall deaths find evidence of people switching to different drugs, with Johnson et al. (2014) finding that heroin overdose deaths increased from .3 to .6 people per 100,000 people after Florida enacted restrictions in 2010-2012 and Alpert, Powell, and Pacula (2018) found that the reformulation of Oxycontin to deter abuse in 2010 led to heroin overdose deaths tripling by 2014. This suggests that reducing access to opioids alone will not drastically reduce overdose deaths by itself, as a portion of drug-seeking people will switch to less well-regulated drugs that could increase their likelihood of overdosing.

The second approach states take to reducing overdose rates is increasing the availability of medication to treat opioid addiction. There are currently three main medications used for this purpose. The first medication is buprenorphine, which reduces opioid cravings (SAMHSA 2022a). The second is methadone, which reduces opioid cravings, reduces withdrawal symptoms, and blocks opioid effects (SAMHSA 2022a). The third is naltrexone, which blocks the effects of opioids (SAMHSA 2022a). The availability of these drugs when receiving treatment for opioid addiction has received the strongest empirical support of the current policies, and has been found to reduce the rate of overdose during treatment when compared to treatments that required abstinence from drugs (Babu, Brent, and Juurlink 2019; Krawczyk et al. 2020). Methadone and buprenorphine specifically are more effective treatment measures because naltrexone requires the person to stop taking opioids for 7-10 days before beginning treatment (Babu, Brent, and Juurlink 2019). The studies on the effectiveness of these drugs are clinical experiments (Babu, Brent, and Juurlink 2019; Krawczyk et al. 2020; Strang et al. 2012; Volkow et al. 2014), meaning while they are very effective in trials, real world barriers may lower their impact.

Despite the increase in access to these treatment drugs over time, their availability remains limited, with less than 1 million out of the 2.5 million people with an opioid addiction receiving treatment using these drugs (Volkow et al. 2014). This is due to policy hurdles that often require addicts to fail in a previous treatment program to gain access to these drugs, impose limits on individual dosage, and limit the timeframe a person can access them. The lack of treatment drug access is also caused by structural problems such as a lack of providers, with 88.6% of large rural counties lacking an adequate number of opioid addiction treatment programs (McBournie et al. 2019; Volkow et al. 2014).

The third alteration to drug access that many states have adopted is the legalization of marijuana. The effects of this measure are the most unclear out of the three approaches, with Pardo (2017) and Powell, Pacula, and Jacobson (2018) finding that it decreases overdoses, Strang et al. (2012) discussing its unclear effects on opioid use, Alpert, Powell, and Pacula (2018) finding no effect, and Shover et al. (2019) finding that it actually increases overdoses. The differences in these studies findings could be due to the different types of overdoses focused on, with Pardo (2017), Powell, Pacula, and Jacobson (2018), and Shover et al. (2019) focusing only on opioid overdoses while Alpert, Powell, and Pacula (2018) use all overdoses. The increase found in Shover et al. (2019) may be due to the reformulation of Oxycontin, as they discuss that there was a decrease in overdoses after medical marijuana was legalized until the effects reversed in 2010. This reversal in overdose deaths aligns with the trends noted in Alpert, Powell, and Pacula (2018) that were also due to the Oxycontin reformulation. These studies also fail to consider the range of marijuana policies across the states, with it being completely illegal in the most restrictive states and available recreationally in the most lenient.

Table 1: Policy Summaries

Prescription restrictions	Pain management clinic (PMC) regulations – Regulates the licensing and operations of clinics that specialize in treating pain.
	Initial prescription restrictions – Limits the number of opioid doses a first prescription can contain.
	Prescription drug monitoring programs (PDMPs) – Monitors the prescription and dispensing of prescription drugs.
Treatment drugs	Methadone – reduces opioid cravings, withdrawal symptoms, and blocks opioid effects.
	Buprenorphine – suppresses opioid cravings.
	Naltrexone - blocks the effects of opioids.
Marijuana legality	Decides the legality of marijuana possession and use, whether that be no access, CBD/low THC products only, medicinal, or recreational.

The contradictions in the research above leave room for me to address a clear problem in this paper. While other researchers look at the implementation of a few policies and how they affect overdose deaths, they fail to consider the broader range of policies that are present in the states. They also often fail to look at the net effect of these policies on overdose rates, with many choosing to only focus on overdoses caused by opioids. This could be falsely contributing success to a policy when drug users have actually switched to an alternative drug. I want to address these issues by including all three of the above methods of altering access in my analysis, to look at both their individual effects as well as their interaction with each other. I also want to focus on all overdoses rather than overdoses from a specific drug to account for people switching to more easily obtainable drugs when one becomes less accessible. Focusing on a specific type of overdose also misses overdoses caused by an unknown drug or a combination of drugs, as those are not always reported as being caused by each individual drug.

CHAPTER III

THEORY

Due to the lack of quality empirical research regarding the effectiveness of drug access policy (Haegerich et al. 2014; Strang et al. 2012), a consideration of the costs of obtaining different drugs may help to demonstrate how these policies could affect people. According to economic theory, people will seek the lowest cost version of a good. This is known as the substitution effect and can be applied to the consumption of drugs. With few restrictions, opioids may be the most cost-effective drug to obtain due to insurance covering the cost of doctor visits, being in less danger obtaining a prescription from a doctor rather than buying from a dealer, and being able to easily obtain refills. When restrictions on prescription opioids increase, this makes them harder to access as people will need to convince a doctor to prescribe them opioids at the risk of losing their license for over-prescription, will be unable to fill the prescription at multiple pharmacies due to reporting requirements, and will need to interact with an illegal dealer if other options fail (Haegerich et al. 2014; Haffajee et al. 2018; Johnson et al. 2014; Pardo 2017). This can increase the cost of obtaining opioids, causing people to seek alternatives (Alpert, Powell, and Pacula 2018; Johnson et al. 2014; Mars et al. 2014). The first option people may consider is heroin, as it is easier to obtain than prescription opioids because it does not need to be manufactured by a pharmaceutical company and obtained through a prescription (Mars et al. 2014; Johnson et al. 2014). This shift was observed nationally after the reformulation of Oxycontin (Alpert, Powell, and Pacula 2018; Cicero, Ellis, and Harney 2015), and may be continuing to take place at the state level as more restrictive measures are passed. The issue with switching to heroin is that it is illegal, making it riskier to obtain and riskier to use because there is no manufacturing quality control or safe seller. Knowing these risks, people may seek a different alternative to prescription opioids if it is easier to access and cheaper than both drugs. Treatment drugs could be a comparable alternative for people with an opioid addiction, as they reduce cravings for opioids (SAMHSA 2022a), mitigate the effects of withdrawal (Babu, Brent, and Juurlink 2019; SAMHSA 2022a), are covered by insurance (Department of Health and Human Services 2018), and are legal to use. What may hinder people from seeking this alternative is the lack of availability due to lack of treatment facilities (McBournie et al. 2019), but this availability has been slowly increasing over time. The other comparable alternative may be marijuana, as in recent trials it has been shown to be an effective option for pain management (Kramer 2015). This would allow people that were previously using opioids for pain management an alternative that is less likely to cause overdoses. This option may be hindered by state restrictions on who can purchase marijuana, but this has also changed significantly over time.

Before addressing my hypotheses, I test the individual effects of these policies to establish a base understanding of how they affect overdoses. After that, I test how these policy categories interact with each other. I look at the interaction between two categories of policies first, as it allows for a clearer examination of how these policies work in tandem to affect overdoses. I then look at the effect of all three policy categories interacting to determine if the implementation of all three policy categories is more effective.

The first policy interaction I want to look at is the combination of limiting prescription opioid access and increasing treatment drug access. According to previous research and the substitution effect, this should be the most effective pair for reducing overdoses because limiting access to prescription opioids will lead to a decrease in availability (Haffajee et al. 2018; Johnson et al. 2014; Pardo 2017). This will cause individuals to look for substitutions to prescription opioids, a process that has previously driven many to heroin usage (Alpert, Powell, and Pacula

2018; Johnson et al. 2014; Mars et al. 2014). Treatment drugs could act as an alternative to the transition from prescription opioids to heroin for addicted individuals, as increased access to treatment drugs might make them easier to obtain than heroin. Treatment drugs may also be cheaper than heroin usage, with the average methadone treatment being $126 per week and the average buprenorphine treatment being $115 per week (National Institute on Drug Abuse 2022) and treatments being eligible for insurance coverage (Department of Health and Human Services 2018). The availability of treatment drugs for people seeking prescription opioid alternatives should make this combination the most effective of the policy pairs.

H1: Decreased access to prescription opioids paired with increased access to treatment drugs will decrease overdose deaths the most.

The second policy interaction I want to look at is the combination of increased access to treatment drugs and increased access to marijuana. This pair should moderately reduce overdoses, but not as much as the combination in H1. This is because there will not be a change in prescription availability motivating a larger amount of people to seek prescription opioid alternatives due to increased cost. This will, however, offer both the alternatives of marijuana and treatment drugs if people decide to seek out a prescription opioid alternative for personal reasons. This combination of policies should have a moderate effect due to the effectiveness of treatment drugs in reducing overdoses (Babu, Brent, and Juurlink 2019; Krawczyk et al. 2020) and marijuana being a less dangerous pain management alternative, although the effects of increased marijuana access are less clear (Powell, Pacula, and Jacobson 2018; Shover et al. 2019).

H2: Increased access to treatment drugs paired with increased access to marijuana will lead to a moderate decrease in overdose deaths.

The third policy interaction I want to look at is the combination of limiting opioid access and increasing marijuana access. This pair should have the mildest effect on overdose reduction.

This is because increased restrictions for prescription opioids should reduce their availability (Haffajee et al. 2018; Johnson et al. 2014; Pardo 2017), and cause people to seek alternative drugs (Alpert, Powell, and Pacula 2018; Johnson et al. 2014; Mars et al. 2014), but marijuana may not be a viable alternative if the person has an addiction. It could be an acceptable alternative to people using prescription opioids to manage pain (Kramer 2015), but it does not affect cravings or withdrawals. A portion of people would likely switch to heroin rather than marijuana because of this, likely leading to a slight reduction in overdoses.

H3: Decreased access to opioids paired with increased access to marijuana will decrease overdose deaths the least.

I also want to look at whether the combination of all three policies has a larger effect than any of the policy pairs. The combination of all three policies should lead to the biggest reduction in overdoses. This is because people will be motivated to seek alternatives to prescription opioids after the implementation of prescription restrictions due to the increased cost (Haffajee et al. 2018; Johnson et al. 2014; Pardo 2017), and both marijuana and treatment drugs will be available as alternatives (Babu, Brent, and Juurlink 2019; Krawczyk et al. 2020; Powell, Pacula, and Jacobson 2018; Shover et al. 2019).

H4: Increased access to treatment drugs combined with increased access to marijuana and decreased access to prescription opioids should lead to a larger decrease in overdose deaths than the policy pairs.

CHAPTER IV

METHODS

I will be testing my hypotheses using quantitative methods rather than qualitative because it will allow me to better compare the differences between states and changes over time. This allows for a clearer examination of whether a policy that alters drug access has a consistent effect on overdose death rates. This is a quasi-experimental design because there is already a variation in the laws states have passed, and it would be both unethical and impossible to randomly assign policies to states to manipulate overdose rates.

The unit of analysis is state-years, with data from all 50 states and the District of Columbia from 1999-2020. This is both the time frame with the most consistent data, and coincides with the beginning of the increase in opioid overdoses (CDC 2021). Most of the policies I consider were also passed within this time frame, allowing me to collect data representative of both before and after policy adoption. I chose to stop in 2020 as this is the most recent year with complete data. While some data has been collected by other sources, I have compiled my own dataset because I could not find one with more than a few policies included. When a policy was passed or implemented in the middle of the year, I used the newer policy for that year.

My first independent variable is *prescription restrictions.* I measured this by first collecting data on PMC regulations (PDAPS 2018; PDMPTTAC 2022), state PDMPs (PDMPTTAC 2022), and initial prescription limits (Ballotpedia 2022). PMC regulation is a dichotomous variable, with 0 being no regulation and 1 being regulation presence. PDMP legislation is an ordinal variable, and due to the broad range of requirements in PDMP legislation I had to adopt a narrower and more practical definition of PDMP. 0 means the state has no PDMP. 1 means a state has a PDMP that receives data electronically, allows authorized users to access the database electronically, and requires prescriptions to be reported. 2 means the state has a robust PDMP with all the previous requirements plus a requirement for doctors to check patient history before prescribing. Initial prescription limit is also an ordinal variable, with 0 being no limit, 1 being a 14-day limit, 2 being a 10-day limit, 3 being a 7-day limit, 4 being a 5-day limit, 5 being a 4-day limit, and 6 being a 3-day limit. I only counted a state as having an initial prescription limit if the limit applied to all prescriptions for acute pain issued to adults, as many states had exceptions for chronic pain patients. After collecting data for the individual policies, I used item response theory to combine them into one measure of restrictiveness.

My second independent variable is access to marijuana (NCLS 2022b, 2022a). This variable is ordinal, with 0 meaning marijuana is completely illegal, 1 meaning CBD/low THC products are legal, 2 meaning medical use is legal, and 3 meaning recreational use is legal.

My third independent variable is treatment drug availability. This variable is continuous, and is the number of facilities in each state offering a treatment drug (SAMHSA 2022c) divided by the population of the state (US Census Bureau 2022), then multiplied by 100,000. The data on this specific variable is less consistent than the others, as the main survey of these facilities was missing for 1999, 2001, and 2010. I was able to interpolate the number of clinics for 2001 and 2010 but was unable to find usable data for 1999. The drugs the survey focused on also changed over time, with 2000 and 2002-2003 measuring clinics that offered methadone and LAAM, which is an older opioid withdrawal suppressant (SAMHSA 1995). The surveys for 2004-2006 and 2011-2012 only measured clinics offering methadone, and 2007-2009 measured methadone and buprenorphine clinics. Starting in 2012, the survey became more consistent and measured methadone, buprenorphine, and naltrexone clinics through 2020. Despite these discrepancies, this was the most consistent data I could find, with response rates for these surveys being 90% or higher and the number of clinics remaining consistent despite the changes in which drugs were measured.

My dependent variable is overdoses. I use the total number of drug overdose deaths per state (KFF 2022) and divide them by the population of each state (US Census Bureau 2022), then multiply the result by 100,000.

I use a two-way fixed effects regression with this cross-sectional time series data to capture a more accurate picture of how the effects of these policies on overdoses vary over time and between states. Using a two-way fixed effects regression allows me to control for the interdependence between state-years, as some characteristics of states will not change over time. This allows me to minimize the number of control variables I will need to add.

There two policies I want to control for, with the first being naloxone availability. I want to control for this because studies and clinical experiments have shown it to be an effective way to reduce overdose deaths (Katzman et al. 2020; McDonald and Strang 2016). Naloxone is a medication that can be administered intranasally, intramuscularly, subcutaneously, or intravenously, and temporarily blocks the effects of opioids allowing for time to transport the person overdosing to a hospital (SAMHSA 2022b). Increased availability of naloxone should affect overdose death rates as it can be administered without the assistance of a medical professional and can be carried by regular citizens in some states. I will be using naloxone availability data from the Prescription Drug Abuse Policy System (PDAPS 2022) and will be considering whether the state has an access law, and whether they have additional decriminalization measures. The decriminalization measures I chose to focus on are whether a pharmacist is allowed to dispense naloxone without a prescription and whether someone is criminally liable for the possession of naloxone without a script. This is an ordinal variable with 0 being no naloxone access law, 1 being the state has a naloxone access law, 2 being a state has a naloxone access law plus one decriminalization measure, and 3 being a state has a naloxone access law plus two decriminalization measures.

I also want to control for Good Samaritan laws, as they allow people to call for medical assistance when someone is overdosing without fear of legal repercussion for reporting. These laws have become more common over time and there is some evidence that they reduce the number of deaths from overdoses (GAO 2021). I will be using data from the Prescription Drug Abuse Policy System (PDAPS 2021). This is a dichotomous variable, with 0 being no Good Samaritan law and 1 being presence of a Good Samaritan law.

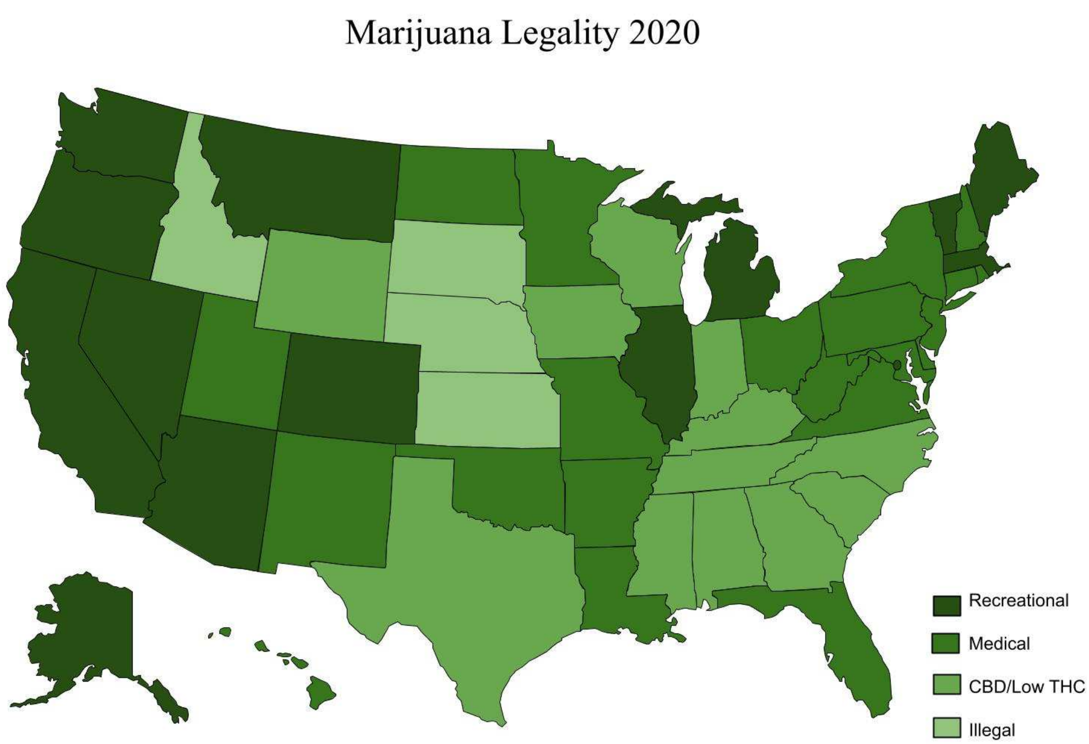
I am not including the availability of drug rehabilitation facilities in my research, as practices within the industry vary widely, with many providing a lack of evidence-based treatment (Szalavitz 2016; White and Miller 2007). This can be seen when searching for rehab facilities, with places like Narconon being recommended, which offers to treat addiction through exercise and saunas and is run by the organization Scientology (Narconon 2022). Equine therapy is also common in rehab facilities, although there is little evidence that it provides any benefit to those with addiction or other mental illnesses (Anestis et al. 2014; Selby and Smith-Osborne 2013). The lack of requirements for evidence-based treatment in these facilities make their effectiveness questionable at best, and difficult to measure only the evidence-based facilities.

CHAPTER V

ANALYSIS

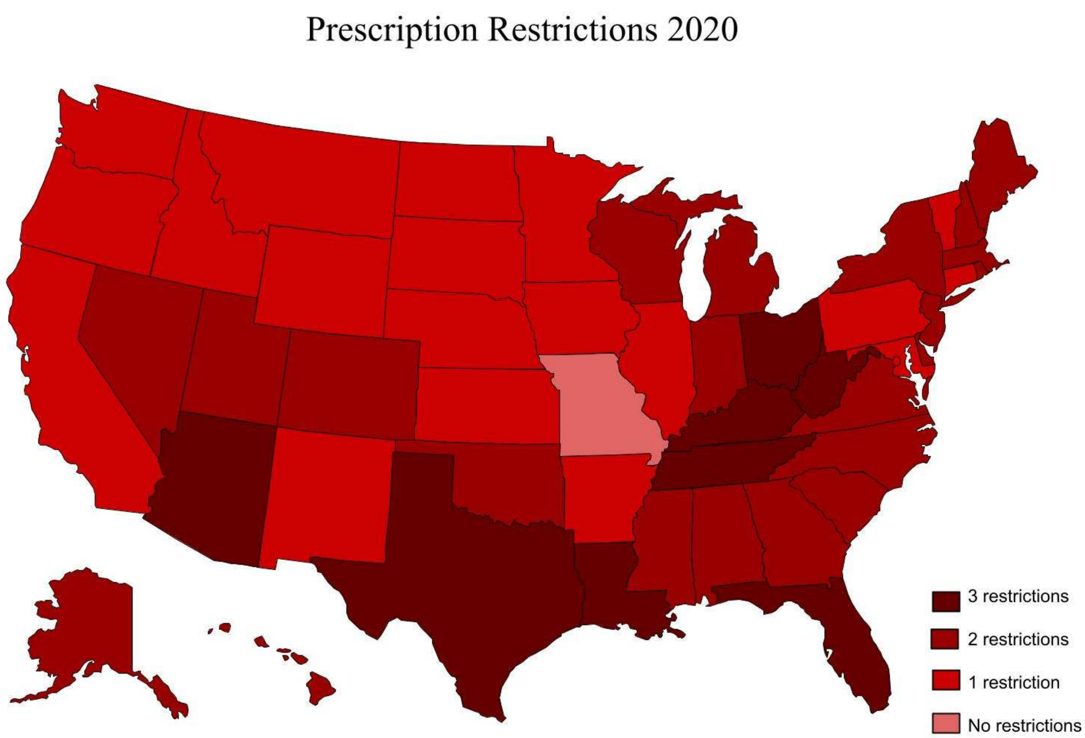
Before testing my hypotheses, I want to demonstrate how widespread these policies are, to show how they have become a common approach among states. Marijuana legalization is the most widespread, with only 4 out of the 50 states choosing to completely restrict access. This has changed drastically over time, as only 6 states had legalized any access to marijuana in 1999.

Figure 1



While all but one state has adopted at least one restriction on prescription drugs, only 8 states heavily regulate prescription drugs by adopting all three measures. This has also changed dramatically from 1999, as no states had PMC legislation, only 3 states had a PDMP with the requirements I listed previously, and no states had a limit on initial opioid prescriptions.

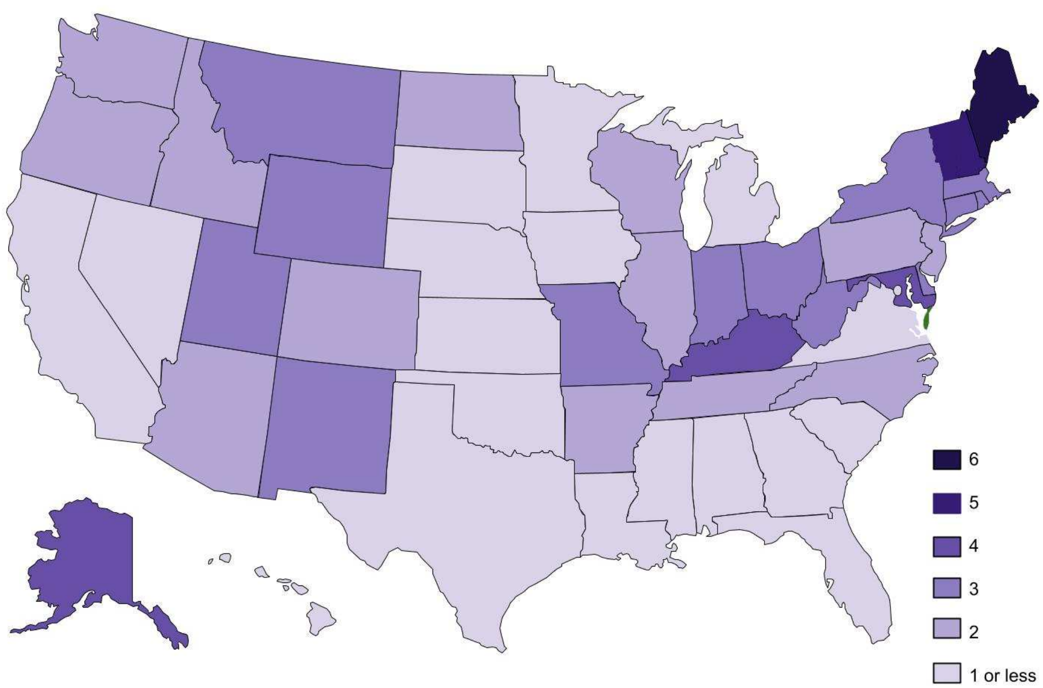
Figure 2



The map of treatment clinics demonstrates how all states have them, but most have an incredibly low number. The majority of states have one or fewer clinics per 100,000 people, leaving entire state populations with an inadequate access to treatment resources. This is still an improvement from 1999 however, as only Connecticut, New York, and the District of Columbia had more than one clinic per 100,000 people. In 2020 there were 28 states with more than one clinic per 100,000 people.

Figure 3

Treatment Clinics per 100,000 people 2020 (rounded)



The variation in state adoption helps to strengthen the analysis, as it allows for a broader combination of policies to exist. The variation in policy adoption over time also allows for a broader combination of policy adoptions.

Table 2: Regression Models

	1	2	3	4	5	6
	DV = Overdoses per 100,000	DV = Overdoses per 100,000	DV = Overdoses per 100,000	DV = Overdoses per 100,000	DV = Overdoses per 100,000	DV = Overdoses per 100,000
Clinics per 100,000	2.117*** (0.337)	2.296*** (0.336)	-0.067 (0.435)	0.255 (0.840)		0.708 (0.798)

Prescription Monitoring	0.821* (0.335)					
Prescription Limit	1.170*** (0.166)					
Pain Management Clinic Law	2.188*** (0.588)					
Marijuana Legality	1.019*** (0.273)	1.073*** (0.275)				
Naloxone Availability	0.399 (0.301)	0.261 (0.304)				
Good Samaritan Law	0.470 (0.539)	0.477 (0.548)				
Restrictions		2.057*** (0.319)	0.220 (0.389)		1.577*** (0.413)	-0.088 (0.527)
Clinics per 100,000 x Restrictions			2.152*** (0.251)			3.232*** (0.769)
CBD/Low THC				-2.683* (1.082)	-2.588** (0.890)	-1.392 (1.564)
Medical Marijuana				1.234 (0.807)	2.418*** (0.523)	2.739*** (0.785)
Recreational Marijuana				0.413 (1.492)	0.778 (1.231)	0.669 (2.070)
CBD/Low THC x Clinics per 100,000				2.676** (1.019)		-0.458 (1.487)
Medical Marijuana x Clinics per 100,000				2.069** (0.760)		-0.861 (0.778)
Recreational Marijuana x				1.838*		1.432

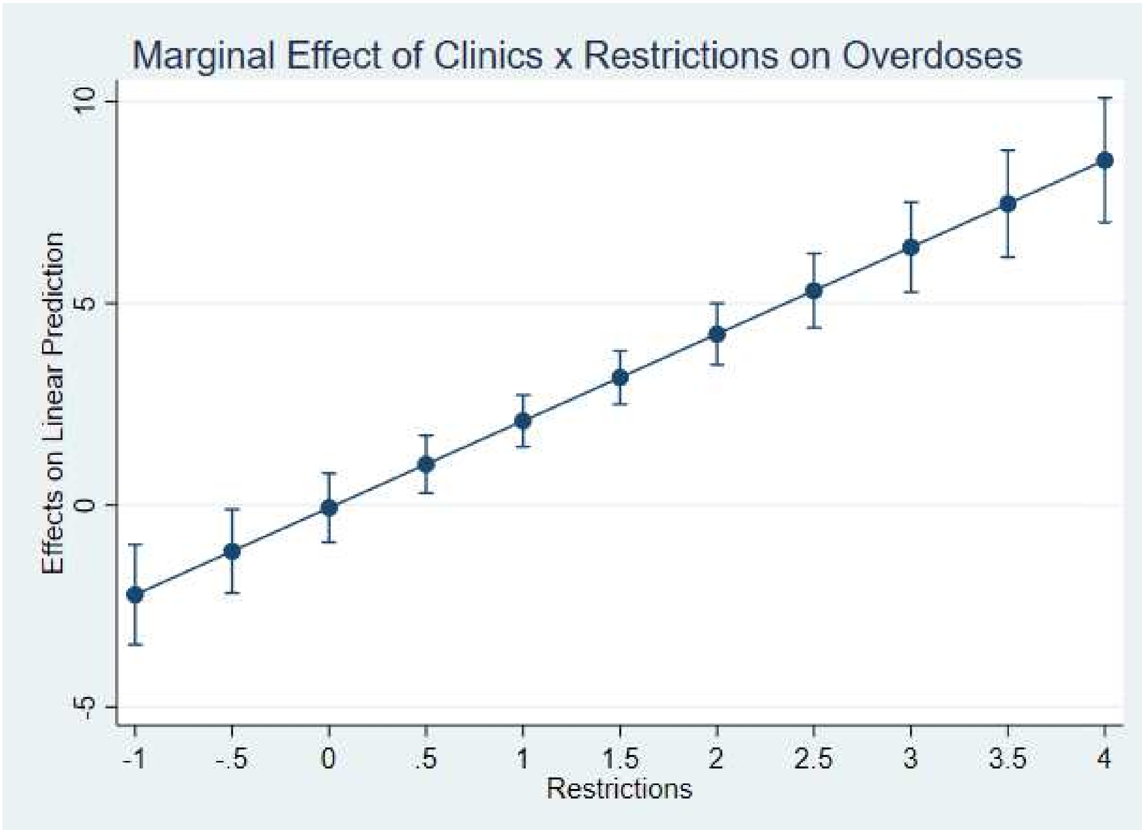
Clinics per 100,000				(0.900)		(1.469)
CBD/Low THC x Restrictions					1.938** (0.734)	1.523 (1.291)
Medical Marijuana x Restrictions					1.234* (0.482)	-1.287 (0.730)
Recreational Marijuana x Restrictions					1.900 (0.999)	2.581 (1.868)
CBD/Low THC x Restrictions x Clinics per 100,000						-1.654 (1.119)
Medical Marijuana x Restrictions x Clinics per 100,000						-0.014 (0.831)
Recreational Marijuana x Restrictions x Clinics per 100,000						-3.486** (1.280)
Constant	3.350** (1.132)	4.907*** (1.201)	6.565*** (1.060)	4.412*** (1.269)	6.299*** (1.162)	4.258*** (1.256)
State FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
R2	.8012	.7935	.8036	.7902	.7936	.8174
N	1071	1071	1071	1071	1122	1071

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Note: In interaction models, variables were held at means. Results were similar when using an error correction model and difference-in-differences model.

Model 1 shows that, when looked at individually, none of the policies reduced overdoses. All the policies do reach statistical significance, but their coefficients are positive. This means that the adoption of these policies is increasing the number of overdoses rather than reducing it. This trend remains in model 2 when combining PMC legislation, initial prescription limits, and PDMPs into a single measure of restrictions. The controls, naloxone availability and Good Samaritan laws, fail to reach significance in both models 1 and 2. These results could reflect the states with more overdoses adopting policies in an attempt to reduce them, but a single law being ineffective to combat the issue. Looking at interaction effects can help demonstrate whether a combination of these policies are more effective at reducing overdoses than a single law, which addresses the hypotheses.

Model 3 appears to contradict the assertion in H1. While the interaction between clinics per 100,000 people and restrictions is statistically significant, it has a positive effect. This effect is similar to the effects of the independent policies, meaning that they are not more effective at preventing overdoses when combined. The impact of this combination of policies can be further understood when looking at the marginal effects of their interaction.

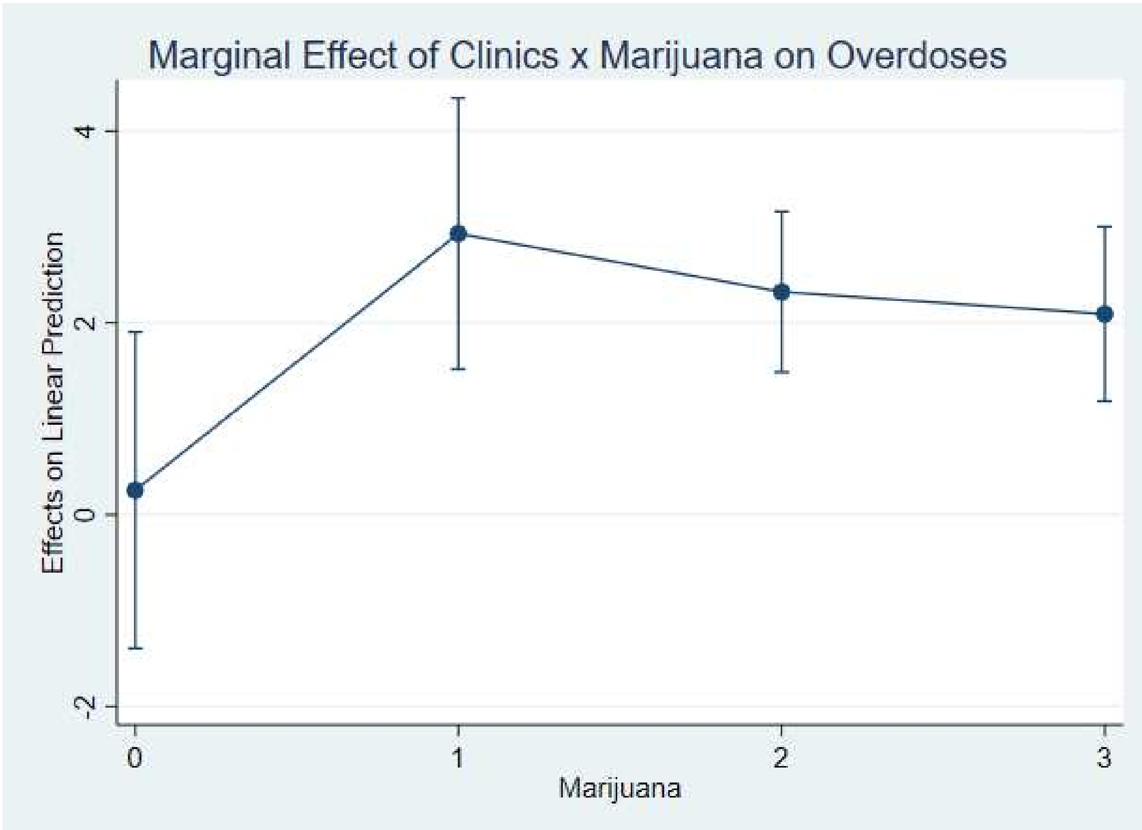
Figure 4



The margins plot of this interaction gives a more nuanced view of how the policies work together to affect overdose rates. It shows that the least restrictive laws on prescriptions have a significant effect on overdose rates when combined with the number of treatment clinics per 100,000 people, but as laws become more restrictive, they lose significance. This means that it may be in the states' best interest to focus their resources on areas other than the restriction of opioid prescriptions, as becoming more restrictive either has no effect on overdose rates or increases them.

Model 4 contradicts H2, as the interaction between marijuana legality and clinics per 100,000 people is statistically significant and positive. This means the combination is increasing overdoses rather than decreasing them, much like the policies on their own.

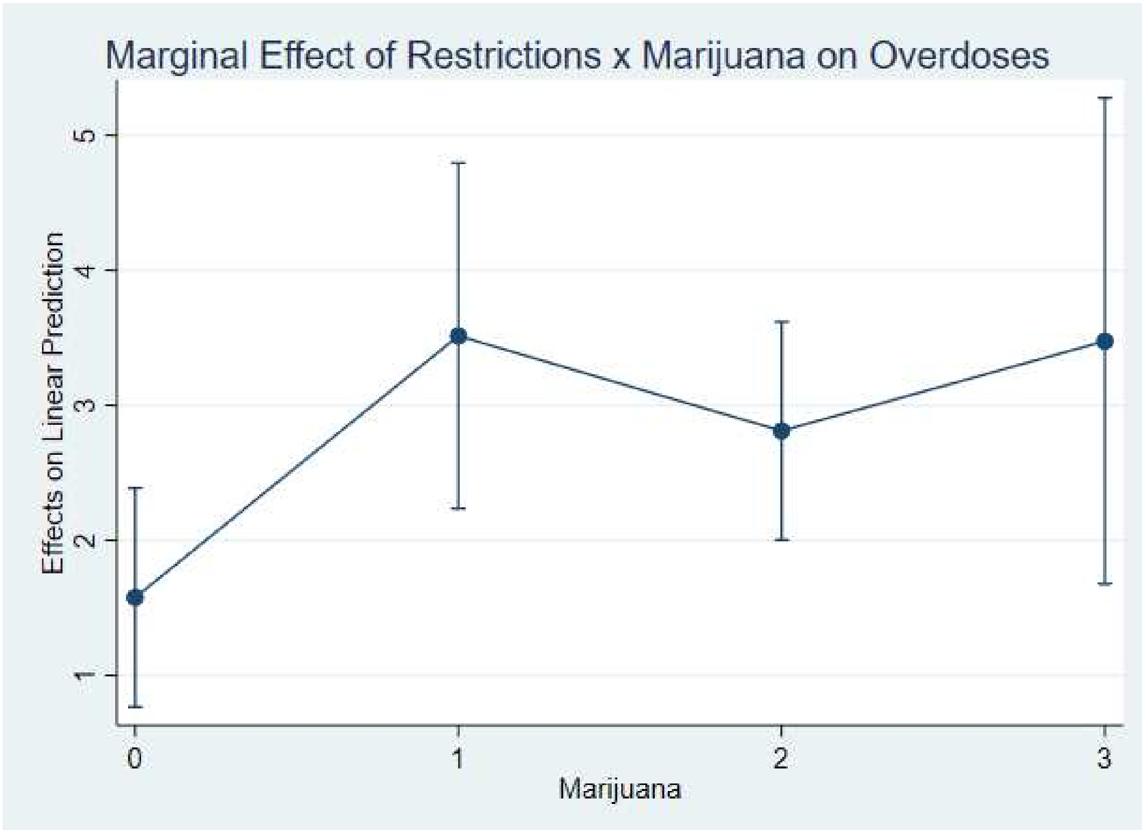
Figure 5



The margins plot further contradicts the hypothesis, as no level of marijuana availability combined with treatment clinics per 100,000 people is significant.

Model 5 appears to disprove H3 as well. While some levels of marijuana legality combined with restrictions are significant, they all have a positive coefficient, meaning they are increasing the number of overdoses. This effect is also similar to their individual effects in models 1 and 2.

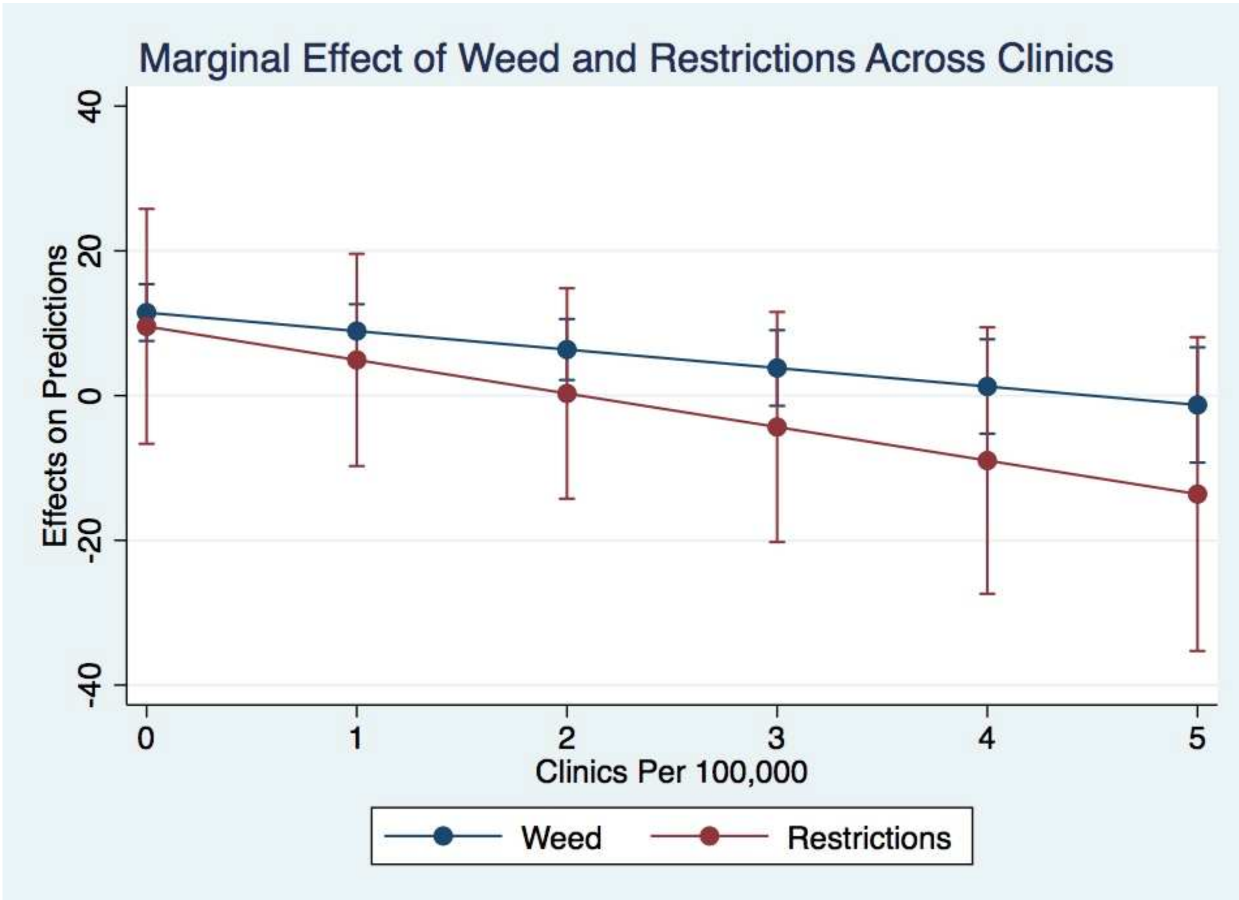
Figure 6



The margins plot further disproves H3, as no level of marijuana legality combined with restrictions reaches statistical significance.

Model 6 gives mixed support for H4, with only the interaction of all three variables containing the highest level of marijuana legality being significant, but all having a negative coefficient.

Figure 7



This significance in the model is contradicted by the margins plot, as none of the variables are able to reach significance. These results do not seem to support H4, and may be indicating that the combination of the three policies in Model 6 accidentally captured policy innovativeness rather than the actual effect of the policies.

CHAPTER VI

DISCUSSION

The lack of significance of treatment clinics per 100,000 people could be caused by the lack of clinics in general. While there is some variability among the states, the state with the most clinics per 100,000 people was Maine with 6.3. An increase in the number of clinics could lead them to be statistically significant in the future, but that would be impossible to test at this point. This lack of significance could also be due to lack of access to these facilities, as people in rural areas may have to drive much further to reach a clinic, and are expected to return frequently for administration of a treatment drug (McBournie et al. 2019). The barriers to access could be reducing the impact of these clinics, as they may help those that live closer to them, but not the broader population. This would explain why in clinical trials there was a significant reduction in overdoses in groups who received treatment drugs (Babu, Brent, and Juurlink 2019; Krawczyk et al. 2020), but at the state level the clinics did not have a significant impact.

The mixed, but mostly nonsignificant effects of marijuana could be caused by its lack of acceptance as an alternative to prescription drugs like opioids. While it is sometimes marketed as a way to reduce pain, marijuana is not the recommend treatment for chronic pain from most doctors due to a lack of research on its effects (Voth 2001). The clash of marijuana being legal in some states but illegal federally could also be influencing whether doctors recommend marijuana for pain, as they could still be prosecuted for the recommendation. It may also be possible that, while legalizing marijuana reduces the burden on the criminal justice system, it has a negligible impact on overdose rates.

The mix of positively significant and non-significant results for restrictions in the table combined with the significance of lower levels of restrictions in the margins plot seem to suggest an effect similar to the findings of Alpert, Powell, and Pacula (2018), where people are shifting their drug use to alternative drugs rather than quitting drug use. This would explain why, depending on the model, restrictions either had no effect or a positive one, as people switching to other drugs caused them to overdose at similar or slightly higher rates. The increase could be due to these drugs being less well regulated, as a portion of the drug-abusing population likely switched to heroin or other noncommercially-made substances.

The positive significant effects of the interactions between the policy pairs in the models and their lack of the significance in the margins plots could be due to states enacting more than one of these policies as a response to increasing overdoses. This introduces a possible reverse causality issue to these results, as the increased overdose rates may be causing the adoption of these policies rather than the policy adoption causing overdoses to increase. It may also be the case that these policies are not sufficient at addressing overdose death rates, and more research needs to be done to determine more effective measures.

The negative significance of the interaction between clinics per 100,000 people, restrictions, and recreational marijuana in the model combined with the lack of significance in the margins plot could be because the combination of these measures accidentally captured the overall innovativeness of the state policy makers rather than the effects of this specific combination of policies. This is likely also why it is only significant at the highest level of marijuana legality in the Model 6.

CHAPTER VII

CONCLUSION

Despite the variety of policies to combat overdoses, the more prominent ones examined in this paper do not seem to be addressing the issue. While these policies have been spreading across states over the past 20 years, there seems to be little evidence supporting their adoption when considering their overall impact on overdose deaths. It may seem inconsequential to quickly adopt a policy because other states adopted the same measure, but it could be a waste of state resources at best and push people toward more dangerous behavior at worst. Adopting policies in an attempt to alter drug use that would otherwise lead to overdoses has dire consequences for the residents of these states and could drive more people to overdose if done carelessly.

These findings, or lack thereof, seem to indicate a need for greater innovation in policy regarding overdoses. Further areas that could be explored include the impact of mental health resource availability, as this is spread unequally across the states much like the treatment clinics examined here. The availability of evidence-based rehabs may also have an impact on overdose rates as they may offer more comprehensive addiction treatment plans that reduce the risk of a person overdosing long-term. The merits of safe use sites may also be a promising area to research as they begin to appear in the US.

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