Effectiveness of Needle Exchange Programs

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Abstract In America, The number of Needle exchange programs has increased in recent years as a result of rising demand for clean syringe needles for injection drug users. It is still controversial whether an increase in NEPs may lead to positive social externalities or result in increased illegal drug use and a waste of funds. To determine whether to provide a needle exchange program, the related organizations such as government, foundation and community organizations should take various factors into considerations. It is difficult to evaluate NEPs from all angles. This paper conducts a differences-in-differences Analysis to find out the effect of starts dates of NEPs in New York State, New Mexico and Massachusetts on drug overdoes deaths and HIV/AIDS-related health outcomes, and then analyze the effectiveness of needle exchange programs in these three states.

Key words: NEPs, Differences-in-Differences Analysis, New York State, Massachusetts, New Mexico, Effectiveness

1. Introduction

Human immunodeficiency virus (HIV) and acquired immune deficiency syndrome (AIDS) are the most destructive infectious diseases. In America, in 2013 it is estimated that there are 47,352 people diagnosed with HIV infection in the United States, and an estimated 26,688 people were diagnosed with AIDS. Overall, approximately 658,507 people in America who have been diagnosed with AIDS have died after AIDS began to spread around the world for the first time in the 1920s. [1], [2]

In order to address these serious issues, there are currently 416 undersigned organizations that have made a commitment to address the public health threat of HIV/AIDS. Over one tenth of these organizations, about 43 organizations are from New York [7]. It is a reflection that people think highly of finding measures to decrease HIV/AIDS rate. It resulted an increased HIV/AIDS funding and stimulates people's interest at surveying the factors that increase the infectious rate.

Usually people become infected with HIV by having sex with an infected partner or homosexual intercourse. Sometimes the virus can be transmitted through blood transfusions, and during pregnancy or delivery or through breast-feeding. [8] Additionally, AIDS/HIV can be acquired from injection drug use through the sharing of infected needles. [3], [4] In the process of sharing needles, needles are collected and saved by injection drug users. Therefore many injection drug users use dirty needles. And these dirty needles are health hazards, potentially exposing the public to diseases like HIV which are transmitted through blood. At the beginning of an injection, blood is brought into the needle and syringe. Consequently, a needle and syringe that an HIV/AIDS-positive person has used can contain blood infected by the virus, that is to say, transmission occurs when another people uses the same syringe without cleaning it as the blood with virus is introduced to the used needles and syringes. The reuse of a blood-contaminated needle or syringe by another person can be an effective means of transmission because a large quantity of blood can be injected directly into the

bloodstream. [5]

Research shows the main reason for injection drug users to share needles is that they do not have access to obtain clean equipment and cannot afford clean needles. For injection drug addicts, they don't care about their heath and they would spend their money on their next fix rather than buying a fresh syringe off the street until it is absolutely necessary for them. What's more, illegal drug users usually inject drugs with their friends in order to have fun together [9]

The advent of needle exchange programs is regarded as a way of providing the public with clean needles in order to address rising rates of infectious diseases including HIV/AIDS.[10] To be more specific, the long-term objective of a needle exchange program is to prevent HIV infection due to needle-sharing. And the immediate goal is to minimize harm by reducing needle-sharing through the supply of clean needles. [11]

Nevertheless, it is still controversial whether increases in NEPs may lead to positive social externalities or result in increased illegal drug use and a waste of funds. People who oppose needle exchange programs argue that the apparent "acceptance" of illegal drug use will results in a higher rate of drug abuse and most of NEPs raise funds from local or state government, that is to say, many of these programs are being funded by taxpayers. It seems unfair to those taxpayer who don't use illegal drugs. But those who support needle exchange programs believe that NEPs can not only protect the drug addicts, but also protect the public from the consequences of spreading diseases. [21]

Basically, most of Americans think NEPs may offer benefits from a societal viewpoint in addition to financial ones. It has been suggested that the purpose of a health care system is to maximize health subject to available resources rather than to save costs. As an opportunity to encourage risk reduction and to offer counseling and access to health care for individuals at high risk, NEPs should be emphasized as it plays an important role in reducing infectious diseases.

2. Background

2.1 History of NEPs in America

Needle exchange programs have been operated since the 1980s, and the first distribution of NEPs was made by Jon Parker, a normal injection drug user as well as a student in Yale University majored in public health. When Parker heard of the comment from his professor that addicts should not be the focus of HIV prevention efforts because they would not change their behavior, Parker was motivated to visit injection drug users and warn them of the dangers of HIV transmission. In November 1986, Parker started to distribute and then exchange needles on the street of Boston, Mass and New Haven. Right then, some of NEPs are not legal and are considered as acts of civil disobedience, Parker has been arrested many times in eight states but he still has publicly challenged the law that it is illegal to purchase needles and syringes without a prescription. Parker thought it will be more effective to distribute clean needles than recommending injection drug users to use clean needles. [10]

In 1988, the first American needle exchange program was organized by Dave Purchase in Tacoma, Wash. And this program was funded by the Mahatma Kane-Jeeves Memorial Dope

Fiend Trust. Sooner, the first needle exchange program has been developed into the Point Defiance AIDS project and operates under the contract of local public health department. The content of this program is very simple, like most common NEPs do, Dave set up a table in the downtown of Tacoma to exchange needles and syringes. [10]

In the past, needle American needle exchange programs provide drug users with free sterile syringes and collect used syringes as a way to reduce infectious diseases. Currently in addition to exchanging syringes, many NEPs provide related prevention and care services that are vital to helping illegal drug users reduce risks of acquiring and transmitting blood-borne viruses as well as maintaining and improving their overall health. These include HIV/AIDS education and counseling; condom distribution to prevent sexual transmission of HIV and other sexually transmitted diseases and referrals to substance abuse treatment and other medical and social services. [11]

2.2 NEPs in New York

New York State is the most populous area in America with nearly 8.5 million people in 2014. [15] HIV/AIDS has continued to be a serious threat in New York. There is the largest AIDS case rate of America in New York. In 2002, the New York City Department of Health and Mental Health Hygiene found that the there are about 103,290 to 143,402 people diagnosed with AIDS. [24] The impact of injection drug use on the spread of the HIV/AIDS epidemic in New York is difficult to overstate. These risks were responsible for less than 42% of total AIDS cases at the end of 1990. [16] As of January 31, 1996, sharing of HIV-contaminated needles among drug users, sex with HIV-infected injecting drug users, and births to mothers whose HIV infection had together resulted in almost 60% of the nearly 97,000 cumulative AIDS cases in men, women, and children in New York.

In 1987, Mayor Koch began the first needle exchange program to address growing HIV/AIDS epidemic in New York City, it was soon banned because of the change in administration. [22] The first legal needle exchange program didn't start to run by the New York health department until November 7th in 1988. It declares that injection drug users cannot participate until their treatment slot become available and only one syringe can be exchanged on each visit. What's more, these syringes need to be imprinted with a health department logo. Clients also get laminated photo identification with a code number.

On February 1, 1995, a bill was introduced to amend the New York public health, general business, and insurance laws with respect to the sale and possession of needles and syringes. Introduction of the bill was predicated on "compelling evidence that the availability of clean hypodermic syringes and needles significantly reduces the transmission of HIV," and the view that "New York's law banning nonprescription sale and possession of hypodermics is, therefore, a major contributor to the HIV/AIDS epidemic." [17]

Since the start of the initiative, by 1996 these needle exchange programs have distributed more than 4.2 million syringes and collected more than 3.6 million with an 86% return rate in New York. These programs have made more than 4,500 referrals to drug treatment services, including methadone maintenance, and residential drug treatment and education of drug over-does. [17]

After approximately one decade, Time Subscribe posted an article to ask the American

Congress to support NEPs in the wake of Indiana's recent outbreak on June 24th in 2015. [18]

2.3 NEPs in New Mexico

It's estimated by United States Census Bureau that there are about 2,085,572 people in New Mexico State on July 1st 2014. [25] In 2012, 2558 people are living with HIV or AIDS diagnosis in New Mexico. In 2013, there is an increase of HIV diagnoses, 149 people are newly with HIV diagnoses. [26] But the number of deaths of those who live with HIV/AIDS in New Mexico has declined between 2008 and 2013. In 2008 there were 95 deaths, in 2013 there were only 50 in spite of the truth that new HIV diagnoses in New Mexico increased for these five years. [26]

New Mexico health department illustrates reasons that result in a decreased number of deaths in persons living with HIV/AIDS. One of them is a result of increased needle exchange programs. By 2015, there are 33 needle exchange programs in New Mexico. Since the Harm Reduction needle exchange program started in New Mexico, it is reported by New Mexico Department of Health that there have been more than 9,000 enrolled participants in the program and more than 6.6 million needles have been exchanged until 2006. [31]

2.4 NEPs in Massachusetts

Massachusetts is a state in the northeastern part of United States with New England religion background. There are approximately 6,745,408 people in 2014. [27] Massachusetts is more populous than New Mexico, but there are only seven needle exchange programs by 2014 as Massachusetts generally ranks highly among states in most health and disease prevention categories. In 2014, it is ranked as the third healthiest state in America by the United Health Foundation. [28]

In 1993, the creation of ten pilot needle exchange programs is allowed by the Massachusetts legislature. [29] Needle exchange programs in Massachusetts provide 11 kinds of services such as safe syringe disposal, HIV counseling and testing, and individual and group harm reduction education. [30] The goal of needle exchange programs in Massachusetts is to discourage reuse and to curb transmission of HIV and hepatitis C. The health department of Massachusetts claims that NEPs in Massachusetts has reduced risk behaviors such as drug over-does by these effective services.

2.5 Funds of NEPs

NEPs are non-profit programs, and they usually raise operating funds from four sources: local governments, foundation grants, private donation, and activist or community organizations that run NEPs. Most programs require multiple sources as they cannot raise enough funds from only one source. Federal law prohibits funding of NEPs (Webber, 1997), and local officials who accept what they see as the necessary evil of needle exchange are seldom willing to provide much sought after public money as they cannot get financial profits with large investment in NEPs. Therefore, most NEPs collect funds from governments, for

example, in 1993, of 13 legal needle exchange programs surveyed by Lurie and Chen, only one was without government funds (including direct and indirect government funds). [12] And a research done by NASEN (North American Syringe Exchange Network) reported that in 2000 approximately half of NEPs (63 out of 120) receiving state or local government funds in. Local and state government funding comprised almost 87% of a needle exchange program's average operating budget in 2004.

State and local government funding is associated with a number of desirable characteristics of NEPs. To begin with, it is strongly associated with the numbers of syringes exchanged by the programs. The goals of needle exchange programs are providing needles and syringes to reduce risk behavior and decrease HIV transmission rate. Secondly, government funding is also strongly associated with provision of multiple services by the programs. Therefore, NEPs with state and local government funding are more likely to be able to serve as part of comprehensive HIV prevention networks for injection drug users. It also includes provision of voluntary HIV/AIDS counseling and testing, which is central to the new Centers for Disease Control and Prevention strategy of working with HIV seropositive to reduce HIV transmission. [13]

Limited funds must be spent in the most cost-effective way, and controversial programs will need to justify costs to sponsors. Some donations may be lost because of the mismanagement of NEPs, and the effects of this would have to be factored into a cost–benefit analysis. In 2000, Reid advocates the use of cost–benefit analysis for evaluations of NEPs. Yet this is difficult to do when the needle exchange produces no revenue or easily measurable benefit to balance with costs. [14]

Even the real financial issues of an NEP are difficult to calculate, it is valuable and meaningful to do a research about surveying the effectiveness of NEPs as NEPs can reduce the rate of HIV/AIDS therefore protect people from HIV/AIDS epidemics. Then what value can be used to present cases of infectious diseases (HIV/AIDS)? How many needle exchange programs are newly established? This article is going to answer these questions by analyzing the start dates of needle exchange programs and drug over-dose deaths or HIV related health outcomes.

2.6 Former economic evaluation of NEPs

A past research conducted by University of California, University of New Hump and Center for disease control and prevention concluded that NEPs are cost effective. According to their study, at an average cost of $0.97 per syringe is distributed for the NEPs. And the total annual cost in U.S. dollars of providing 50% of the syringes needed for a single syringe for every injection ranged from $6 to $40 million for New York city, [23] NEPs can save money in all illegal drug users where the annual incidence exceeds 2.1 per 100 person years. [19] Additionally the cost per HIV infection prevented by NEPs has been calculated at approximately $4,000 to $12,000, considerably less than the estimated $190,000 medical costs of treating a person diagnosed with HIV. [20]

3. Methods

In this paper, I conduct a difference-in-difference analysis of NEPs in New York, New Mexico and Massachusetts. in order to investigate, in an American context, whether the provision of such a program produces overall benefits to society, especially for Americans' health.. I start by reviewing the literature in order to get a general understanding of NEPs, for example the history and background information of needle exchange programs, and the relationship between NEPs and HIV/AIDS. Then I collect the data by digging out online and send these needle exchange programs email. The data I plan to find include the start dates of Needle exchange programs in these three states and drug over-does deaths or HIV/AIDS-related health outcome cases. But as I spent lots of time on doing a financial analysis of NEPs in New York, I don't have time to get HIV/AIDS-related health outcome and drug over-does deaths. Out of this situation, I am going to assume that I have found all of data that I need to a difference-in-difference analysis. So as to do this analysis, I learn to understand difference-in-difference analysis and try to use this kind of analysis in my paper.

Difference-in-difference analysis is a method used to calculate the effect of a treatment on an outcome by comparing the average differences over time in a response variable or dependent variable or the treatment group to the average change over time for the control group. In this paper, treatment are the increased needle exchange programs in these three states, and the effect of this treatment is the change of drug over-does deaths or HIV/AIDS-related health outcome cases in more three time periods. By using start dates of needle exchange programs, we can tell how many needle exchange programs each state has in total. Then I choose a regression model to estimate HIV/AIDS incidence among injection drug users with increased needle exchange program in New York, New Mexico and Massachusetts. Afterwards I compare the "treatment effect", find whether it is advisable to operate a needle exchange program in New York.

4. Data Discovery

4.1 Data Collection

According to my methods for this paper, I found the start dates of needle exchange programs in New York, Massachusetts and New Mexico by searching online. At the beginning, I spent lots of time visiting some official websites to find data, but it doesn't work well since I even do not know how many needle exchange programs these three states have and what they are. Finally, I collected this information by searching North American Syringe Exchange Network, and I found there are 23 needle exchange programs in New York, 33 in New Mexico and seven needle exchange programs in Massachusetts. Since I found contact information of these needle exchange programs before, I do find their start dates but not all of them even I try to visit their official websites, search online and send them email.

Below table 1 is the start dates of NEPs in New York.

	A	B	C
1	**Programs**	**start dates of programs**	**Contact Information**
2	Harm Reduction Program	1910	Phone: (914) 699-6124 Email: SThomas0203@hotmail.com
3	Lower East Side Harm Reduction	1980	Phone: (212)-226-6333 Email: monique@leshrc.org
4	FROSTD	1980	Phone:(212) 924-3733 Email: rsmith@frostd.org
5	Family Services Network of NY	1981	Phone:(718) 573-3358 Email: lbobb@fsnny.org
6	Project Safe	1983	Phone:(215) 634-5272 Email: lindsay.a.roth@gmail.com
7	Streetwork Project	1984	Phone:(646) 602-6404 Email: jwelch@safehorizon.org
8	Tompkins County Prevention Point	1984	Phone:(607) 272-4098 Email: lfan@stapinc.org
9	Broome County Prevention Point	1984	Phone:(607) 798-1706 Email: lfan@stapinc.org
10	ACQC - Far Rockaway	1986	Phone:(718) 896-2500 Email: evasquez@acqc.org
11	ACQC - Jamaica	1986	Phone:(718) 896-2500 Email: evasquez@acqc.org
12	ACQC - Long Island City	1986	Phone:(718) 896-2500 Email: evasquez@acqc.org
13	ACQC - Woodside	1986	Phone:(718) 896-2500 Email: evasquez@acqc.org
14	Access Care and Resources Health	1987	Phone:(315) 475-2430
15	AIDS Rochester Harm Reduction Program	1989	Phone:(585) 545-5556 Email: lcastro@acrochester.org
16	St Ann's Corner of Harm Reduction	1990	Phone: (718) 585-5544 Email: info@sachr.org
17	Long Island Minority AIDS Coalition	1991	Phone:(631) 624-3357
18	New York Harm Reduction Educators, Inc	1993	Phone:(718) 842-6050 Email: clopez@nyhre.org
19	Positive Health Project	1993	Phone:(212) 923-7600 Email: taeko@cornerproject.org
20	Housing Works, Inc	1995	Phone:(347) 473-7404
21	Vocal-NY	1999	Phone: (718) 802-9540 Email: info@vocal-ny.org
22	After Hours Project, Inc	2002	Phone:(718)-249-0755 Email: afterhours748@aol.com
23	Washington Heights CORNER Project	2005	Phone: (212) 923-7600 Email: admin@cornerproject.org
24	BOOM! Health	2013	Phone: (917) 232-8582 Email: fjohnson@citiwidehr.org

Table 1

Table 2 shows start dates of NEPs in New Mexico.

	A	B	C	D
1	**Programs**	**start dates**	**Official Websites**	**Contact Information**
2	Western NM Medical Group	1901	http://www.pmsnm.org/	Phone:(505) 863-3828
3	North Valley Health Office	1905	http://www.northvalleyhealth.org/	Phone:(505) 897-5700
4	Lincoln County Health Office	1972	https://lincoln-county-medical-center.phs.org/Pages/default.aspx	Phone:(575) 258-3252 Email:Martha.ordorica@state.nm.us
5	ealth Care for the Homeless Albuquerq	1985	http://www.abqhch.com/	Phone:(505) 266-4188 Email:MartinWalker@abqhch.org
6	Navajo AIDS Network	1990	https://en.wikipedia.org/wiki/Navajo_AIDS_Network	Phone:(505) 863-9929 Email: jyazziehes@aol.com
7	BEHRS Syringe Exchange	2001	http://www.nmas.net/	Phone:(505) 938-7155 Email:jswatek@nmas.net
8	Casa De Salud	2004	http://www.casadesaludnm.com/#!home/mainPage	Phone:(505) 907-8311
9	Transgender Resource Center NM		www.tgrcnm.org	Phone:(505) 440-3402 Email:adrien@tgrcnm.org
10	Las Vegas Public Health Office		www.spaoa.org	Phone:(505) 425-9368 Email:carmelita.garcia@state.nm.us
11	Sandoval Health Commons		www.nmwic.org	Phone:(505) 867-2291 Phone:Ester.Acosta@state.nm.us
12	BEHRS Farmington		www.nmas.net	Phone:(505) 938-7100 Email:jswatek@nmas.net
13	El Centro Family Health		www.fyinm.org	Phone:(505) 753-7395
14	Chaparral Public Health Office		https://gettested.cdc.gov/organizations/new-mexico-department-health-8	Phone:(575) 824-3454
15	Sierra County Public Health Office		http://www.svhnm.org/health-care-community-health-center	Phone:(575) 894-2716
16	Santa Fe Mountain Center		http://www.santafemc.org/	Phone:(505) 901-9020 Email:dave@santafemc.org
17	Santa Fe Health Office		http://www.santafecountynm.gov/community_services/hhsd	Phone:(505) 476-2717 Email:carmelita.garcia@state.nm.us
18	Santa Fe Community Services		http://www.santafecountynm.gov/community_services/hhsd	Phone:(505) 310-3624 Email:homelesservices@aol.com
19	Hobbs Health Office		http://www.nmhealth.org/	Phone:(575) 397-2463 Email:Sharon.priller@state.nm.us

20	Topahkal Family Practice		http://www.breastfeedingnewmexico.org/topahkal-family-practice	Phone:(505)-319-9076; (505) 907-8311
21	McKinley County Health Office		http://www.breastfeedingnewmexico.org/mckinley-county-public-health-off	Phone:(505) 722-4391
22	Colfax Health Office		http://www.breastfeedingnewmexico.org/colfax-county-public-health-office	Phone:(575) 445-3601 Email:Sybil.dykes@state.nm.us
23	Clovis Health Office		http://usplaces.com/others/clovis-nm/clovis-health-office	Phone:(575) 763-5583 Email:Teresa.broeker@atate.nm.us
24	Carlsbad Public Health Office		http://nmhealth.org/	Phone:(575) 885-4191 Email:Angie.milligan@state.nm.us
25	Families & Youth Inc SEP		http://choopersguide.com/find-addiction-treatment/families-youth-inc-sep-	Phone:(575) 556-1654
26	Taos Health Office			Phone:(575) 758-2073 Email:Rose.williams@state.nm.us
27	South Valley Public Health Office			Phone:(505) 873-7477 Email:Shelly.Ogle@state.nm.us
28	Portales Health Office			Phone:(575) 356-4453 Email:carol.morgan@state.nm.us
29	Moriarty Public Health Office			Phone:(505) 832-6782 Email:Deborah.Chambers@state.nm.u
30	Mobile Van Needle Exchange			Phone:(505) 841-4164 Email:rthur.salazar@state.nm.us
31	Midtown Public Health Office			Phone:(505) 841-4100 Email:(505) 841-4100
32	Lovington Health Office			Phone:(575) 396-2853
33	Los Lunas Public Health Office			Phone:(505) 841-5315 Email:helen.jaramillo@state.nm.us
34	Espanola Health Office			Phone:(505) 753-2794 Email:terry.waters@state.nm.us

Table 2

Table 3 provides the information of NEPs in Massachusetts.

	A	B	C	D
1	**Programs**	**tart dates**	**Official websites**	**Contact Information**
2	CAB Health & Recovery Services	1965	http://healthinnovationsinc.com/	Phone:(978) 777-2121
3	Boston Needle Exchange AHOPE	1983	http://www.bphc.org/Pages/default.aspx	Phone: (617) 534-3963 Email: abutler@bphc.org
4	AIDS Action Committee	1983	http://www.aac.org/	Phone: (617) 661-3040 Email: jzimmerman@aac.org
5	Provincetown Needle Exchange	1983	www.asgcc.org	Phone: (508) 487-8311 Email: maxsandusky@asgcc.org
6	Cambridge Needle Exchange	1994	http://www.facebook.com/CambridgeNeedleExchange	Phone:(617) 599-0257 Email: bbradley@aac.org
7	Tapestry Health Needle Exchange	1995	http://tapestryhealth.org/index.php/services/prevention/	Phone (413) 315-3732 Email: lwhynott@tapestryhealth.org
8	Love and Safety	1996	http://loveandsafety.org/	Phone: (617) 549-9880 Email: awheeler@loveandsafety.org

Table 3

4.2 Probability

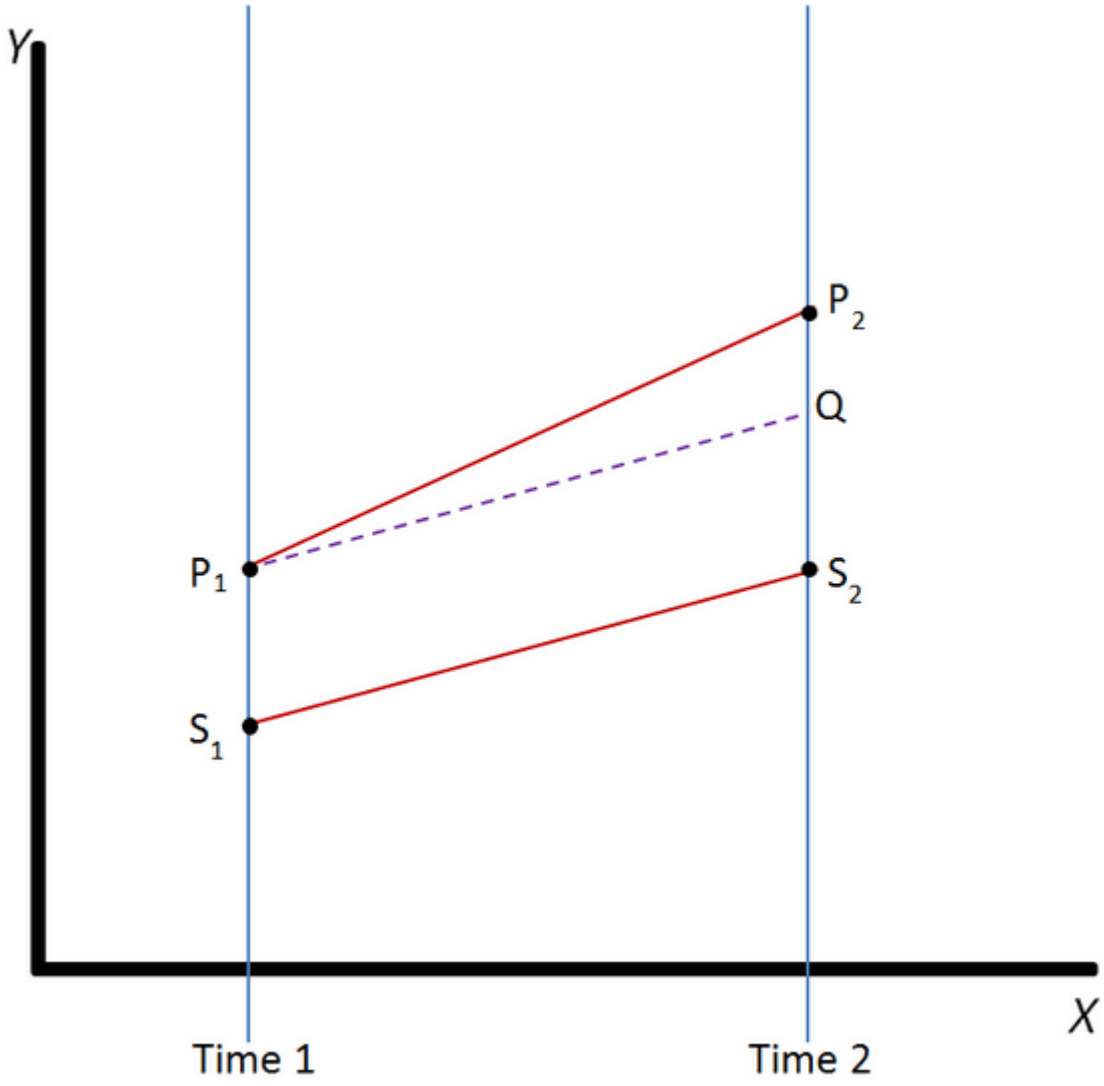
The data that I collected can be used to do differences-in-differences analysis as start dates of needle exchange programs provides information that how many needle exchange programs each state has yet and drug over-dose deaths or HIV-related health outcomes in different time periods show the differences in the differences between the treatment (increased needle exchange programs) and control group over time.

5. Empirical Strategy

5.1 What is Differences-in-Differences Analysis?

Differences-in-Differences is also called DID or DD. It is used to measure the differences between treatment and control group in an observational study over time; that is to say, it calculates the effect of a treatment on an outcome by comparing the average differences over time in a response variable or dependent variable or the treatment group to the average change over time for the control group. [30] To make it

more specific, I am going to use a liner graph to explain the most basic differences-in –differences analysis.



In this liner graph, let's do following assuming;

1) X (independent variable) is time and Y (dependent variable) is outcome.
2) Line P presents the treatment group; control group is presented by line S.
3) The slope from P_1 to Q is the same as the slope from S_1 to S_2.
   Since the treatment group and control group did start out at the same point at Time 1, not all of the difference between P2 and S2 can be described as an effect of treatment. The treatment effect is the difference between the observed outcome (P_2) and expected outcome (Q); that is (P_2-Q).

1.2. Estimate the relationship between start dates of NEPs and health outcomes by using a regression model

As there are many factors that will result in a change of drug over-does health or HIV-related health outcomes and some of them are not observable, this paper regards other factors except start dates of needle exchange programs in these three

states as fixed effects. What's more, there are three groups (states) and more than three time periods, I am going to use a regression model with fixed effects for time and group to estimate the effect of number of needle exchange programs in New York, New Mexico and Massachusetts on drug over-does deaths and HIV-related health outcome cases. The regression model can be described as below equation.

$$Y_{it} = \alpha_i + \sum_{\tau=1}^{T} \beta_\tau . 1(t = \tau) + \sum_{t=1}^{I} \gamma_t . 1(i = t) + \delta . D_{it} + \varepsilon_{it}$$

Where

1) Y_{it} are drug over-does deaths or HIV-related health outcomes in the state *i* in Period *t;* α_i are other fixed effects such as injection drug users' individual characteristics;
2) α_i are other fixed effects such as injection drug users' characteristics;
3) $\sum_{\tau=1}^{T} \beta_\tau . 1(t = \tau)$ are time fixed effects, that is the effect of increased needle exchange programs;
4) $\sum_{t=1}^{I} \gamma_t . 1(i = t)$ are time-varying covariates such as individual's age and annual income;
5) D_{it} is the intensity of the increased needle exchange programs treatment in state *i* in Period *t;*
6) ε_{it} is an error term;

The process of this differences-in-differences analysis can be summarized into following steps;

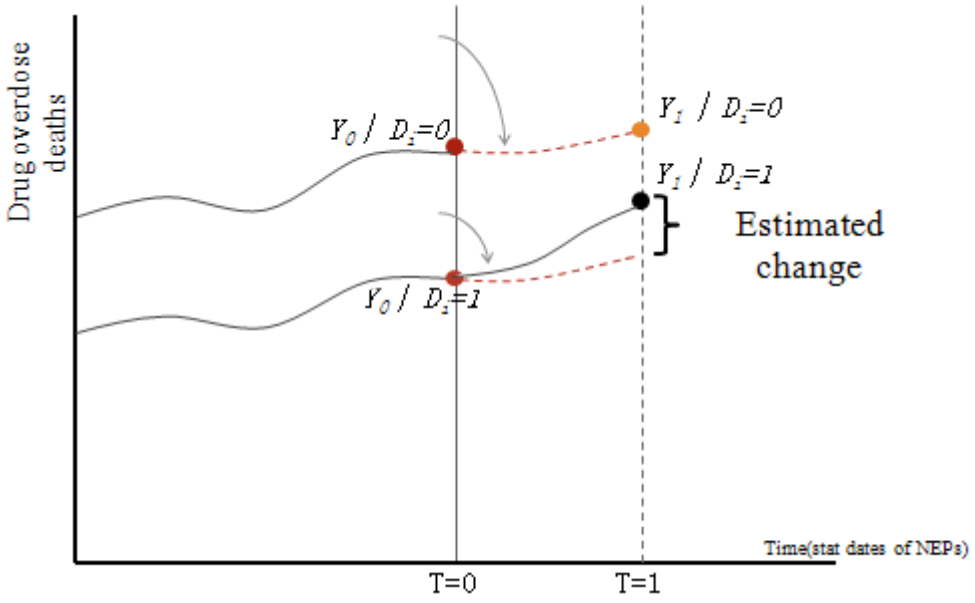
1) Figure out the differences of the sum of drug over-does deaths or HIV-related health outcomes between these three states:

$$VY_i = \frac{1}{N} \sum (Y_{i1} - Y_{i0})$$

2) Find treatment effect

$$\text{Treatment\_ Effect} = E(VY_i \mid D_i = 1) - E(VY_i \mid D_i = 0)$$

Here is a simulation of DD using a liner graph;



$$DD = E(VY_i \mid D_i = 1) - E(VY_i \mid D_i = 0)$$

1.3. Advantages of Differences-in-Differences Analysis

Comparing to simple difference analysis, differences-in-differences analysis can eliminate some of the effect of selection bias that the selection of data for analysis that is not randomized, therefore some conclusions of this study may be not accurate. What's more, it is captured by the inclusion of the state/time effects, group effects by capturing differences across groups that are constant over time and year effects by capturing differences over time that are common to all groups.

6. Conclusion

Unfortunately, I cannot get conclusion from my incomplete analysis since I do not get necessary data for this differences-in-differences analysis. But as I read some papers about the effectiveness of needle exchange programs, I will summarize the most important information for this part. Some studies show needle exchange programs result in decreased rate of HIV, HBV, hepatitis and AIDS. [32][33][34] What's more, there is decreased rate of needle sharing among HIV-negative and HIV-positive persons [35] decrease in syringe reuse [36] and increased rates of entry into drug treatment programs. [37]

Although there are lots of studies in needle exchange programs, more research is needed on NEPs especially in terms of financial aspects of NEPs and evaluations of the implementations of current needle exchange programs, so that people can sum up the experiences of operating needle exchange programs and give suggestions on improving the efficiency of NEPs. Additionally, as most of needle exchange programs are operated by the government, their annual reports are supposed to be posted online in time to be shared with residents especially for researchers who are interested in Needle exchange programs. Since I didn't get enough data while doing this research, I will continue to do a survey about NEPs after I know more about methods of collecting and analyzing data.

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