Chapter 16
Metropolitan Area Characteristics, Injection Drug Use and HIV Among Injectors

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Abstract Epidemics, behaviors, and programs to change behaviors and ameliorate epidemics are shaped by the characteristics of geographically and socially defined communities. This chapter presents the rationale, methods, and selected findings from a study of injection drug users, HIV, and services for drug injectors in the 96 largest metropolitan areas in the United States. It presents data that show that metropolitan areas vary widely in the prevalence of injectors in their populations; in HIV prevalence among injectors; and in the percentage of injectors who are in drug abuse treatment. Furthermore, theoretically specified locality characteristics, such as inequality, legal repression of drug users and others, the degree of popular organization and mobilization for helping drug users, fiscal constraints and others, help predict the values of these variables in metropolitan areas. These findings help us to identify metropolitan area characteristics, including some that can be changed by public authorities or as a result of popular demand and social movements, which can be targeted for intervention to address drug-related health issues. Future research on the social and geographic causation of injection drug use, of its sequelae, and of programs like drug treatment and syringe exchange is clearly warranted, and should include research interventions that change metropolitan area characteristics in ways that reduce drug-related problems.

Background

Many behavioral and epidemiologic processes are deeply shaped by the places in which they occur. Geographical locations in human society and the behaviors and epidemics that take place in them are imbued with historically and socially shaped

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structures, meanings, and resources (Tempalski 2007). As this chapter will show, the amount of injection drug use, services for injection drug users (IDUs), and HIV among drug injectors in a metropolitan area is related to the area's social, economic, and political conditions.

This chapter is an overview of the rationale, methods, and selected findings of the Community Vulnerability and Response to IDU-Related HIV project. This project is a study of how metropolitan area characteristics are related both to a variety of measures of community vulnerability to HIV among drug injectors and, also, to policy and program variables that may affect HIV in the community. Thus, it is a study of how different characteristics of one type of geographic unit, the metropolitan area, are related to each other.

The project was initially funded in 2000 as a cross-sectional study of the 96 largest metropolitan statistical areas (MSAs) in the United States (as of 1993). It has since been re-funded as a longitudinal study. As of this writing (2007), we are in final stages of creating estimates of the numbers (and population percentage) of IDUs, of racial/ethnic population densities of IDUs, and of HIV prevalence among IDUs in each MSA for each year, 1992–2002. We will study the predictors of change in these and other variables, including change in the presence or extent of syringe exchanges, drug abuse treatment coverage, and hard drug arrests per capita. Here, we present some findings about estimates we made for the year 1998 during the first phase of this project.

Characteristics of a Locality Predict Many Health Outcomes

Research that compares localities has a long tradition in public health. Most of this research has been cross-sectional, although in some cases independent variables have preceded dependent variables in time. Statistical associations have been found between state, MSA or neighborhood characteristics (like income inequality, per capita income, or poverty) and all-cause mortality, age-specific mortality, sedentary activity, medical care expenditures, low birth weight, malignant neoplasms, coronary heart disease, homicide, violent crime, social pathology, smoking, arrests related to illegal drugs, drug use, heroin, opioid, or narcotics addiction, initial cocaine usage (and perhaps the staging of drug "epidemics"), TB, and AIDS (Bell et al. 1998; Brugal et al. 1993; Chein et al. 1964; Faris et al. 1939; Hsing 1996; Kaplan et al. 1996; Kennedy et al. 1996; Lynch et al. 1998; Nurco 1972; Nurco et al. 1984; Petronis and Anthony 2003; Redlinger and Michel 1970; Wallace and Wallace 1998). Multilevel analyses have shown that individuals' behavior and health may be influenced by their social context, with neighborhood characteristics being related to low birth weight, preterm birth, and individual tobacco smoking (Ahern et al. 2003; Diez-Roux 2000; Duncan et al. 1999; Kawachi and Berkman 2003; O'Campo et al. 1997).

Thus, there is considerable evidence that the characteristics of different places may create spatially bounded socioepidemiologic processes that affect human health. Since IDUs are at high risk for HIV, hepatitis B and C, and many socially related

problems, it is important to study what causal factors are related to how many IDUs are there in a geographic area and how widespread HIV is among them.

Here, we briefly present selected analyses of predictors of (1) HIV prevalence among IDUs; and (2) the population density of IDUs (IDUs per 10,000 population) in large metropolitan areas of the US in 1998. We also summarize published findings about a related issue (Friedman et al., 2007 IJDP): the extent and predictors of the proportion of IDUs in a metropolitan area who were in drug abuse treatment in 1998.

Methods

"Sample" and its Statistical Implications

We operationalize "place" as MSA. The sample is the 96 largest MSAs in the United States in 1993. MSAs are contiguous counties that contain a central city of 50,000 people or more and that form a socioeconomic unity as defined by commuting patterns and social and economic integration within the constituent counties (Office of Management and Budget 2000; US Bureau of the Census 1998). This chapter thus studies a "population" rather than a sample, so there is no sampling error (though there is measurement error). Whether statistical inference is relevant is debatable. Some researchers studying similar populations use "*p*-values" or "confidence intervals" as heuristic devices to avoid over-interpreting model parameters (Friedman 1977a,b; Kaplan et al. 1996; Lynch et al. 1998; McCarthy et al. 1988; Turk 1977). Other analysts might view the population as a random sample of "possible universes;" in this interpretation, "pseudo-confidence intervals" have a probabilistic interpretation.

In some analyses, missing values on one or more variables reduce the N below 96.

Variables

Since the derivations of both dependent variables (injectors per capita and HIV prevalence among injectors) discussed in this chapter have been described elsewhere, we do so only briefly in this study.

Dependent Variables

Drug injectors per capita in the MSA population in 1998 was estimated in a three-step process (Friedman et al. 2004). The number of persons who had injected drugs in the USA in 1998 was first estimated by adjusting and averaging others' prior estimates (SAMHSA 1992; Holmberg 1996). This number was allocated to each MSA using four multipliers (using data on drug injectors among drug abuse treatment populations, HIV counseling and testing clients, and AIDS cases, and estimates of

numbers of injectors and HIV prevalence among them in 1993 (Holmberg 1996)). These four estimated numbers of injectors in each MSA were then averaged; and the mean divided by the MSA population.

HIV prevalence (defined as the proportion of IDUs who are HIV-positive) among IDUs in 95 MSAs in 1998 was estimated by taking the mean of two estimates (Friedman et al. 2005). (1) The first estimate was calculated by modifying CDC Voluntary HIV Counseling and Testing data to correct for their inherent underestimation of prevalence. Research-based data on HIV prevalence for 25 MSAs were used to calculate regression equations to perform these adjustments. (2) The second estimate was based on methods developed by Lieb et al. (2004). Briefly, the estimated total number of HIV-positive IDUs (including those who are also men who have had sex with men) living in an MSA was designated as $\boldsymbol{k}$ (and estimated by adjusting data on AIDS cases). The estimated numbers of IDUs (Friedman et al. 2004) (**a**) and the estimated HIV prevalence among IDUs (**b**) were variables related by the function, $\boldsymbol{k = ab}$; thus, $\boldsymbol{b = k/a}$.

Treatment coverage is the ratio of the number of IDUs in drug abuse treatment in each of 94 metropolitan areas to the number of drug injectors in the area as estimated above. Data on the number of IDUs in treatment in each MSA came from the Uniform Facility Data Set [US Department of Health and Human Services. Office of Applied Studies, Substance Abuse and Mental Health Services Administration (SAMHSA) 1999], which provides data based on a survey of each publicly or privately funded facility in the country that provides substance abuse treatment.

Independent Variables

Almost all of the independent variables precede the dependent variables in time so that the temporal sequence is correct. (This does not, of course, take account of the high degree of autocorrelation over time in many of these variables.)

1. Unemployment rate in 1990. A number of studies have found that economic conditions are associated with rates of substance use and/or HIV prevalence (Friedman et al. 2000; Geronimus 2998; Selik et al. 1988, 1989).
2. Three measures of legal repressiveness: (a) arrests for possession or sale of heroin or cocaine (1994–1997), taken from US Federal Bureau of Investigation (FBI) data; (b) police *employees* per capita (1994–1997), taken from FBI data (Police Employees Data; County-Level Detailed Arrest and offense Data); and (c) "corrections" expenditures per capita (1997), taken from United States Census Bureau data on government finances (US Census Bureau 1992). Arrest of drug users may be an indicator of pressures on police; and the fear of arrest may encourage drug users to become or remain drug injectors and also may lead injectors to inject less safely (Aitken et al. 2002; Bluthenthal et al. 1999a,b; Cooper, Moore, Gruskin, and Krieger 2005; Maher and Dixon 1999). Police *employees* per capita may reflect a public willingness to spend money and person-power on policing. It may also indicate more direct effects on HIV risk; for example, Corey et al. (2005)

found that police presence, as distinct from arrests, was associated with less use of syringe exchanges in Philadelphia. Correction expenditures are an indicator of public willingness to spend resources on local incarceration and probation systems as well as an indicator of the number of people arrested and the average time they spend in jail before and after trial, which would tend to increase fear of arrest and thus increase the risk of using drugs by injection in unsafe ways.

3. Proportion of the MSA population who are black (US Census Bureau 2003). Many studies have found that black injectors are more likely than other injectors to be HIV infected and/or to have AIDS (Friedman et al. 1987; Novick et al. 1988; CDC 2001, 2002; Selik et al. 1988, 1989); and earlier research from this project shows that higher percentages of black populations than of whites in these metropolitan areas are injection drug users (Cooper, Friedman, Tempalski, Friedman and Keem 2005).
4. For analyzing HIV prevalence, IDUs per 10,000 population in 1993 (Holmberg 1996) was also used as a control variable. It was a predictor of HIV prevalence among injectors in 1993 (Friedman et al. 2000).
5. Two measures of structural racism in 1990 as embodied in residential segregation (Massey and Denton 1992).
   - Black/white residential dissimilarity index.
   - Hispanic/white residential dissimilarity index.
6. Income inequality: ratio of total income of all households in the upper 10% to the total income of the bottom 10% (1989).
7. Region. US regions differ politically and culturally, and on the mean values of both dependent variables. On the other hand, their relevance for this project is unclear. We hope to determine predictors of IDUs per capita and of the proportion of IDUs who are infected with HIV in order to develop ways to reduce these health problems. The physical location of an MSA, however, cannot be changed. Thus, for us at least, finding that region is a significant predictor of one of our dependent variables just opens up more questions about what it is about a given region that leads to these effects. In order to make our categories for regions more homogeneous politically, culturally, and economically, prior to these analyses US Census categories for region were adjusted by moving Maryland, Delaware, and Washington, DC, to the Northeast Region; Texas to the West; and Oklahoma to the Midwest. Midwest was treated as the reference category because it had the lowest mean value on drug injectors per capita. (It had the second lowest mean value, 4.85%, on HIV prevalence, which was not statistically different $\{p[t] = 0.59\}$ from the mean 4.56% HIV prevalence in the West.)

Statistical Analysis

Since the unit of analysis in this study is the metropolitan area, dependent variables are rates for a given metropolitan area. Correlation and linear regression are used to estimate associations among variables. Standardized coefficients (betas) are

reported to facilitate comparisons of magnitudes of association. Statistical analyses were done in SAS version 9 (SAS Institute 2004).

Results

Description of Statistical and Geographic Distributions of Dependent Variables

Table 16.1 presents data on the distributions of IDUs per 10,000 population, HIV seroprevalence among IDUs, and drug abuse treatment coverage for IDUs. MSAs vary considerably on all of these measures, with the MSA with the lowest value having approximately one-tenth the value of the highest MSA for IDUs per 10,000 and for HIV prevalence. The range is even greater for treatment coverage.

Figures 16.1, 16.2, and 16.3 show how these variables are distributed across metropolitan areas in the USA. As Fig. 16.1 shows, the metropolitan areas with higher prevalence of IDUs per capita seem to fall mainly in the Northeast coast down through Virginia and in an arc from New Orleans through Texas, New Mexico, Arizona and on up the West Coast. HIV prevalence is considerably higher in the metropolitan areas near New York City and up and down the coast from it; with a secondary concentration in Florida (see Fig. 16.2). Treatment coverage for IDUs is low. Only 9 of 94 metropolitan areas provide treatment to one IDU in five or more; these are primarily old industrial areas (Buffalo/Niagara Falls, Detroit, Gary, New Haven/Bridgeport/Danbury, New York, Providence/Warwick, and Scranton/Wilkes Barre/Hazelton) although Nassau/Suffolk and Salt Lake City/Ogden also provide this level of coverage (see Fig. 16.3).

Predictors of HIV Prevalence of IDUs

To begin with, we present preliminary results that we have conducted in efforts to understand how prior results on the relationship of "legal repressiveness" to HIV prevalence in MSAs might be illuminated by incorporating measures of inequality as prior predictors in a causal change. The previous analyses (Friedman et al. 2006, *AIDS*) showed that three different facets of "legal repressiveness" were independently and positively associated with subsequent (1998) HIV levels among IDUs in these MSAs: mean arrests for hard drugs per capita, 1994–1997; (2) Police

Table 16.1 Distributions of dependent variables

Variable	Mean (Std Dev)	Median (IQR)	Min, Max
IDUs per 10,000 population, 1998	66 (33)	60 (42–87)	19, 173
HIV prevalence among IDUs, 1998	7.7% (5.5%)	5.5% (3.9–9.7%)	2.4%, 27%
Percent of IDUs in drug abuse treatment, 1998	10.2% (6.8%)	8.6% (5.7–13.8%)	1.1%, 39.3%

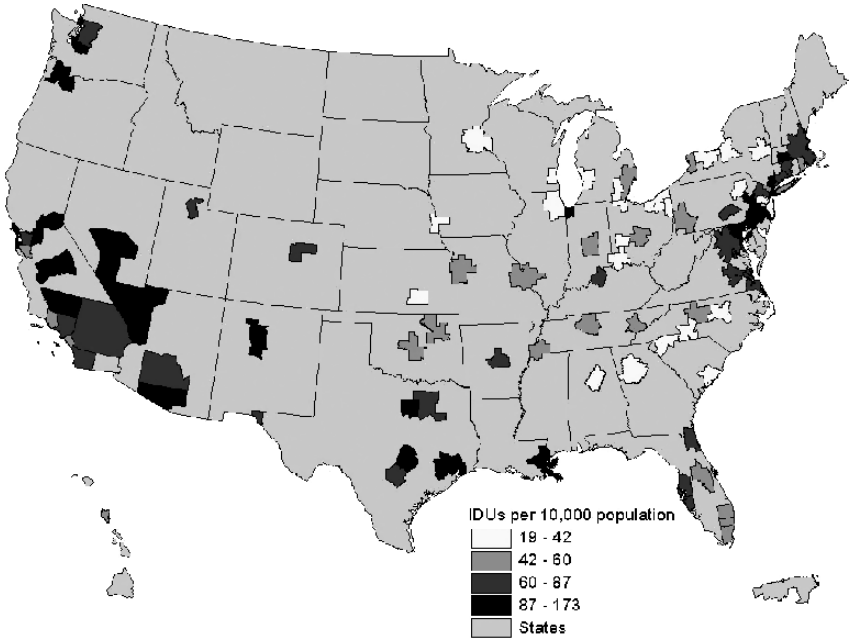


Fig. 16.1 96 large US metropolitan areas, 1998

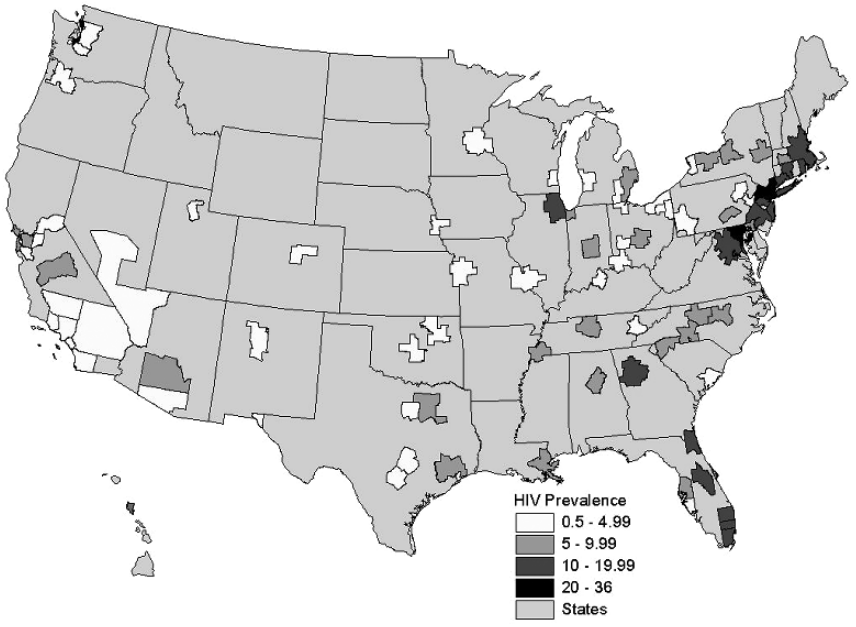


Fig. 16.2 Map of HIV prevalence (%) among IDUs in 95 large US metropolitan areas, 1998

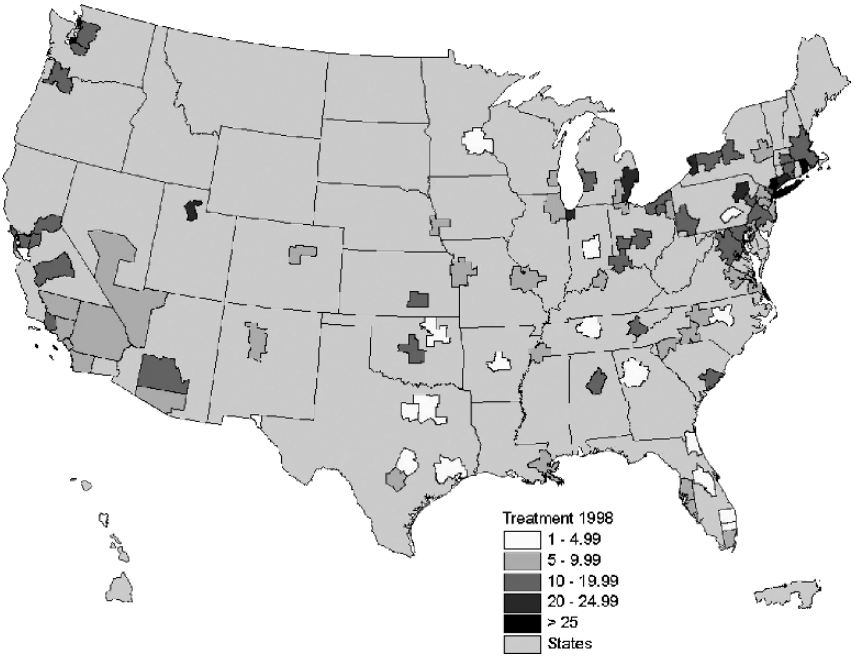
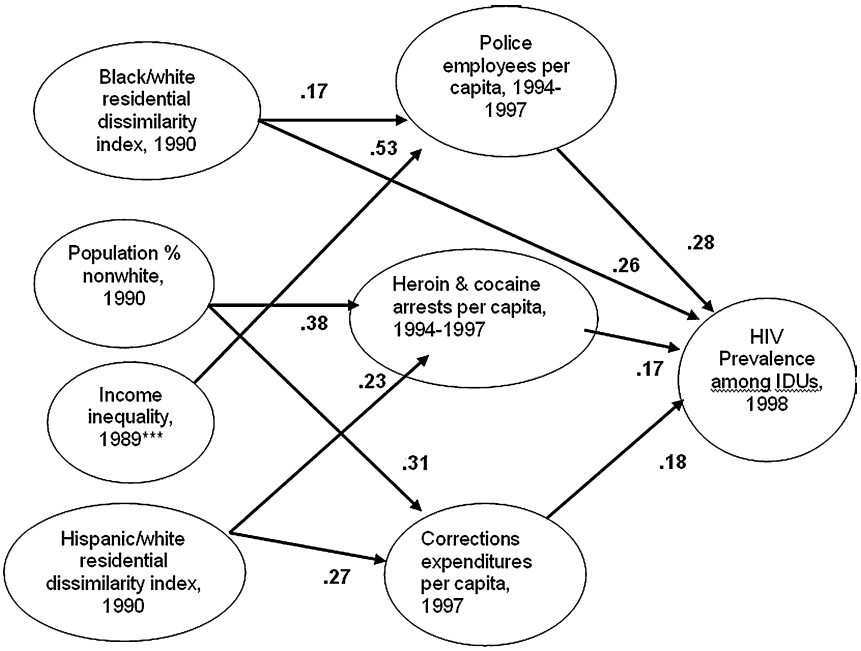


Fig. 16.3 Percent of injection drug users in drug abuse treatment in 94 large metropolitan areas, 1998

employees per 10,000 population (Mean 1994–97); and (3) Corrections expenditures in dollars per capita (1997).

Here, we extend these analyses in a path analysis to consider how forms of inequality and/or structural racism enter the picture. The results, as given in Fig. 16.4, must be considered preliminary since moderate instability exists in the coefficients depending exactly which predictors are included in the equations.

What we see in the path diagram is that the three measures of legal repressiveness remain as predictors of HIV prevalence with measures of income inequality, racial/ethnic inequality, and the size of the non-white population controlled. This may be because repression leads IDUs into hurried injection and/or because it is accompanied by greater stigmatization (and this stigmatization creates social and psychological conditions for higher risk) (Aitken et al. 2002; Bluthenthal et al. 1999a,b; Cooper, Friedman, et al. 2005; Maher and Dixon 1999). Residential racial segregation, the percent non-white, and income inequality are all associated with higher subsequent levels of legal repressiveness, although the magnitude of these associations seems to vary and different independent variables are related to different measures of legal repressiveness. One measure of racial segregation, the Black/white residential dissimilarity index, was also related to HIV prevalence directly as well as indirectly (through police employees per capita).



*These paths are considered preliminary because there is moderate instability in paths with modifications of the variables included in the model.
**Paths with p >= 0.10 not shown.
***Ratio of income of households in the upper 10% to the income of the bottom 10% (1989)

Fig. 16.4 Preliminary path analysis

Taken together, these data suggest that there may be a causal pathway of structural human rights violations (institutional racism and, arguably, income inequality) to legal repressiveness, and thence to higher HIV prevalence among IDUs.

Predictors of Population Prevalence of IDUs

Turning next to the characteristics of metropolitan areas that predict the population density of IDUs in 1998, Table 16.2 presents the results of theoretically-guided stepwise and backwards linear regression. The extent of unemployment is positively related to IDUs per capita. MSAs in the West have relatively more IDUs per capita, and those in the Midwest have fewer, than do those in the Northeast. There is a question about whether "Region" really tells us anything useful. What we really want to know (but have not been able to explain yet) is what it is about "region" that is associated with IDU population density. We will explore this further later in the project.

Table 16.2 Predictors of IDUs per 10,000 Population

	Adjusted Beta
Unemployment (%), 1990	0.29*
Midwest	–0.41*
South	–0.17
West	0.26*
R^2	0.46

*$p < 0.05$.

Predictors of Treatment Coverage of IDUs

Here, we simply report on findings from another paper (Friedman et al., 2007). (Since we do not report any new analyses of treatment coverage, we did not include descriptions of additional independent variables to our variable descriptions in Methods section; see the cited paper for this). Drug treatment coverage for IDUs was quite limited, with the median metropolitan area providing treatment to approximately 1 in 12 IDUs. In these conditions of shortage, an indicator of epidemiologic need (the per capita extent of AIDS among IDUs) did not predict treatment coverage. There is some indication that, given the shortage, competition for access by non-injecting drug users may limit the extent to which IDUs receive treatment. Stringent metropolitan finances (higher long-term governmental debt per capita) were associated with less treatment coverage. Political variables (racial structures, the presence of organizations that support drug treatment, and budget priorities) also appear to be important determinants of treatment coverage for injectors.

Limitations

These findings are subject to a number of limitations. First, causal mechanisms are hard to study at a single level of analysis since both higher-level and lower-level variables may affect observed relationships.

Although almost all independent variables precede the dependent variables in time, all variables are subject to considerable temporal autocorrelation and, in some cases, likely two-directional causation. Thus, causal inference would have been stronger if longitudinal data had been used. Such analyses are planned for the relatively near future, including further study of the possibly two-directional relationships between legal repressiveness and injectors per capita.

Some of the prediction equations may be mis-specified by leaving out important predictors or due to weaknesses in the variables we have. For example, in Fig. 16.4, where our explorations found some instability of results, residential racial segregation is only one aspect of structural racism, although a very important one, so it is possible that another dimension of institutional racism might underlie the results observed; and it is worth noting that police employees per capita is not the same as

police on duty in drug-using areas or in drug squads which may or may not have attenuated the effects of this variable.

Discussion

It is clear from these analyses that a number of metropolitan area characteristics are related to the subsequent prevalence of drug injection in the population, to HIV prevalence among IDUs and to treatment coverage for IDUs. The extent to which this reflects place as a concrete realization of various socioeconomic and political characteristics, geographic location as a cultural location, and geographic diffusion of behaviors and of HIV among localities will be important to study in our longitudinal analyses in the second phase of the Community Vulnerability project.

Our preliminary findings about structural inequality, legal repressiveness, and HIV prevalence among IDUs, if confirmed by additional analyses, have serious implications. First, they suggest that legal repressiveness is associated with higher HIV prevalence among IDUs in US MSAs; and is not associated with lower rates of IDUs per capita. These results also suggest that institutionalized racism and income inequality may produce the impetus for governmental repressiveness at the metropolitan level. They further suggest that programs and social movements to reduce or eliminate structural racism, inequality, and legal repressiveness have, in addition to whatever value they have in their own right, a role to play in the fight to contain HIV/AIDS and perhaps other infectious diseases. The presence of organizations or movements that support drug treatment also suggests the importance of political dynamics in shaping drug-related outcomes and programs. Further research might use historical and time-series research, as well as sociopolitical experiments, to investigate these hypotheses.

Thus, the findings in this chapter suggest that MSA characteristics, including some that can be changed by public authorities or as a result of popular demand or social movements, may be part of the causal chain that shapes the extent and patterns of drug use and related diseases, as well as of related services.

In conclusion, then, further research on social and geographic causation of drug-related problems is clearly warranted. This should include developing new models of intervention that change MSAs or their environments in ways that reduce drug-related problems.

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