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Estimating Numbers of Injecting Drug Users in Metropolitan Areas for Structural Analyses of Community Vulnerability and for Assessing Relative Degrees of Service Provision for Injecting Drug Users

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ABSTRACT *This article estimates the population prevalence of current injection drug users (IDUs) in 96 large US metropolitan areas to facilitate structural analyses of its predictors and sequelae and assesses the extent to which drug abuse treatment and human immunodeficiency virus (HIV) counseling and testing are made available to drug injectors in each metropolitan area. We estimated the total number of current IDUs in the United States and then allocated the large metropolitan area total among large metropolitan areas using four different multiplier methods. Mean values were used as best estimates, and their validity and limitations were assessed. Prevalence of drug injectors per 10,000 population varied from 19 to 173 (median 60; interquartile range 42–87). Proportions of drug injectors in treatment varied from 1.0% to 39.3% (median 8.6%); and the ratio of HIV counseling and testing events to the estimated number of IDUs varied from 0.013 to 0.285 (median 0.082). Despite limitations in the accuracy of these estimates, they can be used for structural analyses of the correlates and predictors of the population density of drug injectors in metropolitan areas and for assessing the extent of service delivery to drug injectors. Although service provision levels varied considerably, few if any metropolitan areas seemed to be providing adequate levels of services.*

KEYWORDS *Drug abuse treatment, HIV counseling and testing, Injection drug users, Population prevalence estimates, Service coverage, Structural analysis.*

INTRODUCTION

Estimates of the number of injection drug users (IDUs) in specific geographic areas are essential for deepening our understanding of both the etiology and effects of injection drug use and for designing and implementing drug-related public health programs and policies. These numbers are, however, inherently difficult to estimate

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because many injectors take great pains to hide their use. In this article, we present a method of calculating the number of IDUs in each of 96 large US metropolitan areas in 1998, describe the resulting estimates and assess their validity, and estimate the extent of service coverage of drug treatment and human immunodeficiency virus (HIV) counseling and testing for injectors in these 96 metropolitan areas.

Knowing the number of IDUs in specific geographic areas is an important prerequisite for investigating the social, economic, and policy characteristics that shape the proportion of the population that injects in a geographic area. Although considerable research has been conducted to identify the individual characteristics that predispose people to use and inject drugs,[1–9] few investigations have considered injection drug use as a population-level phenomenon with structural causes, including drug and other social policies. Studies by Hunt and Chambers, Bell and colleagues, Brugal and colleagues, and, for injectors, by Friedman et al., however, suggested the value of such population-level investigations: These researchers have found variations in the population density of drug use across geographically defined populations and identified community-level phenomena associated with these distributions, including social disorganization, chronic disease, income inequality, state syringe laws, and unemployment.[10–13] It is also possible that the density of IDUs in a population has consequences for other health and social conditions, such as HIV and hepatitis transmission and economic growth. By presenting a method of estimating the number of IDUs in 96 large metropolitan areas and the resulting estimates, this article provides the foundation for investigating the population-level causes and consequences of injection drug use rates in US communities.

In addition, given that injection drug use is a risk factor for many infectious diseases, including HIV/AIDS (acquired immunodeficiency syndrome), hepatitis B and C, endocarditis, and malaria,[14] knowledge of the size of local injecting populations would be useful for designing policies and services to reduce the burden of infectious disease in the population, allocating adequate funds for such services, and assessing the adequacy of existing services and policies. Data regarding the injecting population's size in a given geographic region would also facilitate evaluating the effects of drug-related services and policies on subsequent rates of injection drug use in the population. Thus, this presentation of estimates of the population density of drug injectors in each of 96 US metropolitan areas and of the proportions of injectors receiving services, as well as the associated estimation methods, should be useful to public health planning and evaluation efforts.

In the present analysis, the geographic units studied are the 96 US metropolitan statistical areas (MSAs) that had the largest populations (more than 500,000) in 1996. MSAs are defined by the US Census Bureau as contiguous counties that contain a central city of 50,000 or more people and that form a socioeconomic unity as defined by commuting patterns and social and economic integration within the constituent counties.[15,16]

The MSA was chosen as the unit of analysis for the larger study of which this article is a part for three reasons. First, it allows continuity with a previous set of estimates of IDUs, calculated by Holmberg for 1992 and used as a basis for some of the calculations in the present analysis.[17] Second, health data are more available for the county units that comprise MSAs than for municipalities. Third, the economic, social, and commuting unity of metropolitan areas makes them a reasonable unit in which to study drug-related HIV and other epidemics. For example, many IDUs live in the suburbs, but buy drugs (and perhaps get drug-related services) in the central city.

METHODS

We undertook three principal steps to estimate the number of IDUs in each of the 96 MSAs studied. First, we estimated the number of IDUs in the United States in 1998 by averaging three national estimates derived from the National Household Survey on Drug Abuse (NHSDA) and Holmberg data. Second, we created 96 MSA-specific estimates by applying four multipliers, derived from data on IDUs' encounters with health services, to this national estimate, and we calculated four IDU estimates for each MSA; these four estimates were then averaged to create a single IDU estimate for each MSA. Third, we validated these estimates using both construct validation methods and comparisons with local estimates of numbers of IDUs when high-quality data were available.

We chose this method—calculating a nationwide estimate and then apportioning its 96-MSA share among the 96 MSAs—to allow us to balance the biases in three data sets and thus possibly produce more accurate final estimates. The resulting IDU estimates were then used to estimate service coverage (i.e., drug treatment and HIV counseling and testing coverage) for the population of IDUs in each MSA. Given that Holmberg's estimates of the number of injectors in 96 US MSAs in 1992 formed the foundation of some of our calculations, we first describe Holmberg's methods and then our own procedures.

Holmberg's Methods for Estimating the Number of Injectors

Holmberg estimated the population who had injected drugs in 1992 in each of 96 US MSAs and the prevalence of HIV in these populations using a components model.[17] Specifically, he used a mixture of estimates of numbers of IDUs in each MSA, including estimates obtained by applying multipliers (derived from national estimates of the proportions of IDUs receiving each of these services) to the number of IDUs in drug abuse treatment and to the number receiving HIV counseling and testing services in each MSA. He then verified the estimates' credibility using exclusion criteria that ruled out any estimate of the proportion of the MSA's total population who inject drugs that fell outside specified upper bounds and lower bounds. To estimate HIV prevalence among injectors in these 96 MSAs, Holmberg relied on study-based estimates and ongoing serosurveillance to create initial seroprevalence estimates and then evaluated these figures using exclusion criteria derived from AIDS case data, HIV counseling and testing data, and Ryan White data.

Step 1: Calculating the Project Estimate of the Number of Injecting Drug Users in the United States

We based our estimate of the number of current injectors in the United States in 1998 on Holmberg's 1992 IDU estimates and an NHSDA estimate of the number of past-year injectors in the United States in 1998. Our calculations were designed to counter previously recognized biases in the NHSDA and update and extrapolate Holmberg's 1992 IDU estimates for 96 MSAs to a single 1998 national estimate.

The NHSDA estimated that 294,000 people in the United States in 1998 had injected in the past year.[18] Two threats to the validity of NHSDA data on injecting have been identified: underreporting of injection in the NHSDA's face-to-face interviews and undercoverage of populations in which a high proportion of individuals inject, including homeless people living on the streets and incarcerated individuals.[19]

Studies of undercounts using various survey methodologies imply that the NHSDA's use of face-to-face data collection methods in 1998, and subsequent underreporting, might have led to an underestimation of injection drug use by a factor of 3.7 in the survey.[20] By using capture–recapture methods with two databases (Uniform Crime Reports and the National Drug and Alcoholism Treatment Unit Survey), statisticians in the Substance Abuse and Mental Health Services Administration estimated that the NHSDA's undercoverage of populations at risk for hardcore drug use led to an underestimation of injection drug use by a factor of 1.55 in the survey.[19] Our NHSDA-based IDU estimate was therefore calculated as follows: For estimate 1,

$$294{,}000 * 3.7 * 1.55 = 1{,}686{,}090$$

Holmberg estimated that there was a total of 1,460,300 past-year injectors in the 96 largest US metropolitan areas in 1992; our calculations extrapolated this figure to the United States and updated it from 1992 to 1998. To obtain a national estimate for 1992, we multiplied the number of injectors in the 96 MSAs by the ratio of the number of incident injection-related AIDS cases nationwide in 1992 to the number of incident injection-related AIDS cases in those 96 MSAs in 1992 (ratio = 1.19).* We then updated the 1992 national estimate to 1998 in two ways: The first change estimate adjusts for trends in the NHSDA in the number of people reporting having injected drugs in the last year in 1992 and 1998 (ratio of 1992 to 1998: 0.446).† The second change estimate adjusts for trends in having ever injected drugs between these 2 years (ratio of 1992 to 1998: 0.940), an adjustment that should be less vulnerable to the effects of stigma to the extent that it involves long-past behavior. We therefore created two more Holmberg-based estimates: For estimate 2,

$$1{,}460{,}300 * 1.19 * 0.446 = 775{,}040$$

For estimate 3,

$$1{,}460{,}300 * 1.19 * 0.940 = 1{,}633{,}492$$

To create a single estimate of the number of past-year injectors in the United States in 1998, we averaged estimates 1 through 3 ([1,686,090 + 775,040 + 1,633,492]/3 = 1,364,874).

*Reassuringly, we obtained the same multiplier, 1.19, in an alternative calculation that compared the total number of overdose deaths in the United States to the total number of overdose deaths in the 96 MSAs using data from the 1988–1999 Multiple Cause of Death CD-ROM.

†It is somewhat more plausible than one might think for numbers of IDUs to have fallen by a fairly large percentage during this period. This is because of deaths—caused by both HIV and aging of the large number of persons who began injecting drugs in the 1970s. In addition, during this period, there were many people who delayed or avoided the initiation of injecting their drugs by using heroin intranasally or by smoking crack cocaine. Also, there were minor changes in question wording in the National Household Survey between 1992 and 1998 that might have affected these estimates. Finally, also accounting for the decline might be a shift for some IDUs from injecting to other modes of administration or to abstinence.

Step 2: Estimating the Number of Injecting Drug Users in Each Metropolitan Statistical Area

Overview. To estimate the number of injectors in each MSA, we first created four estimates of IDUs for each MSA (*component estimates*), derived by multiplying the national estimate by different multipliers. We then excluded extreme values and averaged the remaining, plausible estimates together to create a single IDU estimate for each MSA.

The following drug use indicators were used to create the component estimates: (1) the annual drug treatment census of IDUs; (2) the number of HIV testing and counseling events with IDUs; (3) data on annual incident AIDS cases among IDUs in 1998 and on HIV prevalence among IDUs 6 years prior to that; and (4) a weighting of 1992 estimates of numbers of IDUs adjusted for changes in national numbers of IDUs. We chose to combine four indicators to create MSA-level IDU estimates, rather than just relying on one indicator, because we believed that each indicator is biased and that the selected indicators have counterbalancing biases.

For example, estimates based on drug abuse treatment and HIV counseling and testing service encounters share the potential of being biased by differential budgetary or political decisions about the magnitude and locations of services. Thus, the number of injectors would be underestimated where these services do a relatively poor job of reaching them. It seems likely that areas where these services are most poorly provided are also areas where antiretroviral treatment and other medical care for IDUs are less available—which would mean that their HIV-positive IDUs would tend to develop AIDS more rapidly. In light of this potential bias, we created an estimate using two indicators that might be biased in the opposite direction from those based on service encounters: the estimated number of injectors based on AIDS cases and on HIV prevalence among injectors. See Appendix 1 for further information.

Making the Component Estimates: *Estimates based on drug treatment data*. The Substance Abuse and Mental Health Services Administration conducts an annual census of drug treatment centers called the Uniform Facility Data Set (UFDS) (since renamed the National Survey of Substance Abuse Treatment Services, N-SSATS).[18] UFDS collects facility-level data annually from all privately and publicly funded substance abuse treatment facilities in the country, as well as from state-administered facilities; data reflect program services on October 1 of each year.[21] People receiving drug treatment services on October 1 in facilities located in each of the 96 MSAs studied who reported that they injected drugs at admission were aggregated to the metropolitan area level; individuals were thus linked to MSAs through the location of the program they attended. Because the data for 1998 had an unusually large number of missing values, UFDS data for October 1, 1997, were used to estimate metropolitan area numbers of IDUs in 1998.

We then applied multiplier techniques to apportion our national IDU estimate of 1,364,874 to each of the 96 metropolitan areas using UFDS data.[22] Specifically, we took the number of injectors in drug treatment in an MSA and multiplied it by the ratio of the number of injectors in the United States in 1998 divided by the number of injectors in treatment in the United States as in formula 1 (below):

$$A_{\mathrm{MSAi}} = B_{\mathrm{MSAi}} * 1{,}364{,}874/C_{\mathrm{US}} = B_{\mathrm{MSAi}} * 8.53$$

where A_{MSAi} is the UFDS-based component estimate of the number of injectors in an MSA in 1998; B_{MSAi} is the number of injectors in treatment in an MSA on October 1, 1997; 1,364,874 is the number of injectors in the United States in 1998; and C_{US} is the number of injectors in treatment in the United States on October 1, 1997 (159,991). Thus, the UFDS-based multiplier applied to each MSA was 8.53.

Estimates based on data on HIV counseling and testing. In 89 of the 96 MSAs studied, the Centers for Disease Control and Prevention collects data on the number of injectors receiving services at HIV counseling and testing facilities, including free-standing HIV counseling and testing sites, family planning and sexually transmitted disease clinics, hospitals and private medical centers, drug treatment centers, and correctional facilities.[23] There are 11,640 such sites nationwide.[23] As with UFDS data, individuals were linked to MSAs through the location of the facility at which they received services.

Our method of apportioning our national IDU estimate to MSAs using counseling and testing data was similar to that used for UFDS data: We took the number of injectors receiving services at the counseling and testing sites in an MSA and multiplied that by the ratio of the number of injectors in the United States in 1998 divided by the number of injectors receiving counseling and testing services in the United States. The counseling and testing-based multiplier was 8.18 (1,364,874 injectors in 1998/166,919 injectors receiving counseling and testing in 1998).

Estimates based on Holmberg's prior estimates. Holmberg provided us with data on the number of IDUs in the 96 metropolitan areas studied in 1992; to update these data to create 1998 MSA-specific IDU estimates, we weighted Holmberg's 1992 data by a multiplier consisting of the ratio of IDUs in the United States in 1998 (1,364,874) divided by Holmberg's estimate of the number of IDUs in 1992 as expanded to the United States as a whole (as described above). This multiplier was 0.78 (1,364,874/1,742,600). This method assumes that the relative proportions of IDUs in the different metropolitan areas remained unchanged between 1992 and 1998, and that the ratio of US IDUs in these metropolitan areas to the number outside these MSAs also remained unchanged.

Estimates based on AIDS case data and on Holmberg's estimates. The final component estimate was derived from data on annual incident AIDS cases among IDUs in 1998 and on HIV prevalence among IDUs 6 years prior to that (1992). In developing this estimate, we made certain counterfactual assumptions that are not serious problems for an estimate designed to counterbalance the service–encounter biases. In particular, we assumed that IDUs in all metropolitan areas have equal access to highly active antiretroviral therapy, and that their times since infection are also similar. Under these assumptions, the following equalities will hold, with IDUs including both IDUs who are men who have sex with men and other IDUs:

$$A_{MSA}/A_{USA} = \text{(by assumption) } H_{MSA}/H_{USA} = S_{MSA} * I_{MSA}/S_{USA}/I_{USA},$$

Where A_{MSA} is the number of IDUs with AIDS in a metropolitan area; A_{USA} is the number of IDUs with AIDS in the United States; H_{MSA} is the number of IDUs with HIV in a metropolitan area; H_{USA} is the number of IDUs with HIV in the United States; S_{MSA} is the HIV seroprevalence rate among IDUs in a metropolitan area; I_{MSA} is the number of IDUs in a metropolitan area; S_{USA} is the HIV seroprevalence rate among IDUs in the United States; and I_{USA} is the number of IDUs in the United States.

There are some complex time lag issues in applying this equation. We used Holmberg's estimates for HIV prevalence among IDUs in both the metropolitan area and the United States; these estimates are for 1992. For AIDS cases, if the assumptions were true, the time would not matter. The assumptions of equal access to antiretroviral therapy and of similar epidemiological histories, however, are not true. What is needed is to use AIDS data that are from a time fairly close to 1996 (when highly active antiretroviral therapy began to be used), but that allow enough time since 1992 for AIDS cases to develop. The use of 1998 was a reasonable compromise; see Appendix 2 for additional information.

This gives us the following equations:

$$A98_{MSA}/A98_{USA} = \text{(by assumption) } H92_{MSA}/H92_{USA}$$
$$= (S92_{MSA} * I98_{MSA})/(S92_{USA} * I98_{USA})$$

where the symbols with 98 refer to data for 1998, the symbols with 92 refer to Holmberg's estimates for 1992, $I98_{MSA}$ is the value for the number of IDUs in the MSA in 1998 that we are trying to derive, and $I98_{USA}$ is the project estimate of the number of IDUs in the United States in 1998.

After some algebraic manipulation, this yields an estimation equation:

$$I98_{MSA} = 1{,}594 * A98_{MSA}/S92_{MSA},$$

where the coefficient $1{,}594 = S92_{USA} * I98_{USA}/A98_{USA}$ and incorporates the nationwide data into a constant.

Excluding Outliers, Imputing Missing Values, and Combining Component Estimates to Create Overall Metropolitan Statistical Area–Specific Injecting Drug User Estimates. We excluded component estimates that fell outside the plausible bounds for a value (see Appendix 3 for description of exclusion criteria and their rationale). These exclusion criteria resulted in the exclusion of 9 component estimates: Two UFDS-based values were excluded because they were too low; 1 high and 5 low values based on counseling and testing were excluded; and 1 HIV/AIDS-based value was excluded because it was too high. These 9 values were treated as missing data. In addition, 7 MSAs lacked data on the numbers of injectors who received HIV counseling and testing. In each of these 16 instances of missing data, we imputed a value for this component equal to the average of the values for the nonmissing components.

The four component estimates were then averaged to create a single IDU estimate for each MSA.‡ Using population estimates (provided by the US Census Bureau) for 1998 of the number of persons living in each MSA, we then calculated

‡We also combined these estimates using a factor analysis with one factor. Input variables were the estimated proportions of IDUs in the MSA population because otherwise the factor would be heavily determined by the magnitude of the metropolitan area population. The factor loadings were 0.34693 for the component based on HIV counseling and testing; 0.30039 for the UFDS-based component; 0.32041 for the component based on updating Holmberg's estimate; and 0.31305 for the component based on AIDS data and HIV seroprevalence data. The factor value was calculated by multiplying each loading by its corresponding component estimate. This estimate was then adjusted so that the sums of estimated numbers of IDUs for the 96 metropolitan areas would equal that computed by averaging.

These factor-based estimates were then correlated with the average-based estimates. The correlation between these two sets of estimates is 0.9990. Since these two estimates are essentially identical, we used the arithmetic averages for our analyses.

the population density of IDUs as a percentage of the population in these 96 MSAs and described the central tendency and dispersion of these estimates. To understand how these MSA-specific component estimates varied across databases, we calculated coefficients of variation (standard deviation divided by the mean).

Step 3: Validating the Estimates

Two methods were used to validate these estimates. Construct validity was tested by seeing if the estimated proportions of metropolitan area populations who injected drugs correlated with theoretically germane predictors. These predictors were variables that were associated in Friedman et al.[24] with the proportion of population who injected drugs in 1992 as estimated by Holmberg. These variables were (1) percentage of the population living in poverty in 1990 and 2000, (2) the existence of laws prohibiting over-the-counter syringe sales, and (3) income inequality in 1990.§

The second method we used to assess validity was to ask local health authorities or other experts in the 96 MSAs to comment on the estimates based on their studies, estimates, or, in many cases, educated guesses. This was done using not-quite-final values of our estimates based on a lower estimate of the number of drug injectors in the United States than our final estimate. Our final estimate is only 5.3% higher, and this translates into 5.3% higher estimates for each MSA. Given the inaccuracies of local estimation procedures as well as of those in this article, this is essentially a negligible distinction.

Estimating Service Coverage

Data on the numbers of IDUs who were in drug abuse treatment on October 1, 1997, and on the number of counseling and testing events provided to IDUs in 1998 were divided by the estimated number of IDUs in each metropolitan area to investigate the extent to which IDUs received prevention services. To avoid the circularity in these estimates that would result because the overall estimates of numbers of IDUs incorporate data on treatment and counseling and testing, service coverage calculations used alternative estimates of numbers of IDUs in each metropolitan area. For this purpose, the number of IDUs was calculated with three rather than four components, with the dropped component being counseling and testing–based estimates when calculating counseling and testing coverage and UFDS estimates when calculating treatment coverage. Details on the calculation of these alternative coverage estimates, and their relationship to the principal coverage estimates, are presented in Appendix 4.

RESULTS

The estimates of the number and population percentages of IDUs in each metropolitan area based on averaging the component estimates are presented in Table 1. The number of IDUs per 10,000 persons in the metropolitan population varied from 19 to 173 (mean 66.4; standard deviation 33.0; median 60; interquartile range 42–87).

§With the exception of data on income inequality, variables were obtained or derived from the following publicly accessible sources: the 1990 and 2000 Censuses of Population; the Lewis Mumford Center at the University of Albany, New York; and Lurie et al.[25] Data on income inequality in 77 MSAs were calculated from US Census data for 1990 and provided to us by John Lynch.[26] Because data from Holmberg's estimates of numbers of IDUs in 1992 were adjusted for use as a component of our estimation procedure, a portion of these correlations may be based on this circularity.

TABLE 1. Component estimates and average estimate of numbers of injection drug users (IDUs) in each of 96 large US metropolitan statistical areas*

Metropolitan area	Counseling and testing–based estimate	UFDS-based estimate	Estimate adjusting for HIV prevalence in 1992 and AIDS cases in 1998	Estimate made by adjusting Holmberg 1992 estimate for US trends	Estimated number of IDUs	Minimum of the component estimates	Maximum of the component estimates	Standard deviation of the estimated number of IDUs	Coefficient of variation (standard deviation divided by mean) for IDU estimate	Estimated number of IDUs per 10,000 population
Akron, Ohio	1,578	2,107	2,108	2,184	1,994	1,578	2,184	280	0.14	29
Albany–Schenectady–Troy, New York	1,439	1,954	2,535	3,432	2,340	1,439	3,432	855	0.37	27
Albuquerque, New Mexico	4,595	3,361	12,645	5,226	6,457	3,361	12,645	4,198	0.65	95
Allentown–Bethlehem– Easton, Pennsylvania	6,263	7,123	5,211	5,148	5,936	5,148	7,123	942	0.16	96
Ann Arbor, Michigan	1,349	674	1,076	1,170	1,067	674	1,349	286	0.27	19
Atlanta, Georgia	11,472	4,803	25,813	17,940	15,007	4,803	25,813	8,981	0.60	40
Austin–San Marcos, Texas	13,369	4,138	12,310	10,530	10,087	4,138	13,369	4,135	0.41	91
Bakersfield, California	6,435	4,666	14,162	7,176	8,110	4,666	14,162	4,170	0.51	128
Baltimore, Maryland	27,801	45,461	63,003	24,960	40,306	24,960	63,003	17,641	0.44	162
Bergen–Passaic, New Jersey	6,689	7,311	3,730	7,800	6,383	3,730	7,800	1,826	0.29	48
Birmingham, Alabama	—	2,636	3,195	2,886	2,906	2,636	3,195	280	0.10	32
Boston, Massachusetts–New Hampshire	46,077	52,499	27,140	21,840	36,889	21,840	52,499	14,715	0.40	63
Buffalo–Niagara Falls, New York	3,982	8,284	5,459	4,680	5,601	3,982	8,284	1888	0.34	49
Charleston–North Charleston, South Carolina	613	1,919	2,662	2,028	1,806	613	2,662	860	0.48	33
Charlotte–Gastonia–Rock Hill, North Carolina–South Carolina	3,802	3,336	8,742	4,914	5,199	3,336	8,742	2,453	0.47	38

TABLE 1. ***Continued***

Metropolitan area	Counseling and testing–based estimate	UFDS-based estimate	Estimate adjusting for HIV prevalence in 1992 and AIDS cases in 1998	Estimate made by adjusting Holmberg 1992 estimate for US trends	Estimated number of IDUs	Minimum of the component estimates	Maximum of the component estimates	Standard deviation of the estimated number of IDUs	Coefficient of variation (standard deviation divided by mean) for IDU estimate	Estimated number of IDUs per 10,000 population
Chicago, Illinois	27,065	27,999	33,347	45,318	33,432	27,065	45,318	8,393	0.25	42
Cincinnati, Ohio–Kentucky–Indiana	2,944	3,975	5,324	5,460	4,426	2,944	5,460	1,194	0.27	27
Cleveland–Lorain–Elyria, Ohio	5,568	8,881	11,802	9,360	8,903	5,568	11,802	2,565	0.29	40
Columbus, Ohio	2,903	6,526	12,645	5,772	6,962	2,903	12,645	4,098	0.59	47
Dallas, Texas	12,282	5,153	52,624	12,714	20,693	5,153	52,624	21,568	1.04	65
Dayton–Springfield, Ohio	3,361	2,337	1,249	3,120	2,517	1,249	3,361	952	0.38	26
Denver, Colorado	12,919	10,493	19,078	12,246	13,684	10,493	19,078	3,739	0.27	71
Detroit, Michigan	19,886	40,036	20,266	27,300	26,872	19,886	40,036	9,415	0.35	60
El Paso, Texas	6,550	1,826	5,952	9,360	5,912	1,826	9,360	3,109	0.53	85
Fort Lauderdale, Florida	8,545	3,122	6,270	9,672	6,902	3,122	9,672	2,890	0.42	46
Fort Worth–Arlington, Texas	18,750	7,132	29,727	17,004	18,153	7,132	29,727	9,257	0.51	114
Fresno, California	12,004	14,477	24,447	9,360	15,072	9,360	24,447	6,590	0.44	173
Gary, Indiana	932	8,164	7,903	4,914	5,478	932	8,164	3,370	0.62	87
Grand Rapids–Muskegon–Holland, Michigan	2,052	3,464	2,918	2,574	2,752	2,052	3,464	593	0.22	26
Greensboro–Winston-Salem, North Carolina	4,236	3,276	6,573	6,240	5,081	3,276	6,573	1,585	0.31	44

TABLE 1. ***Continued***

Metropolitan area	Counseling and testing–based estimate	UFDS-based estimate	Estimate adjusting for HIV prevalence in 1992 and AIDS cases in 1998	Estimate made by adjusting Holmberg 1992 estimate for US trends	Estimated number of IDUs	Minimum of the component estimates	Maximum of the component estimates	Standard deviation of the estimated number of IDUs	Coefficient of variation (standard deviation divided by mean) for IDU estimate	Estimated number of IDUs per 10,000 population
Greenville–Spartanburg–Anderson, South Carolina	2,335	1,433	2,964	2,574	2,322	1,433	2,964	650	0.28	25
Harrisburg–Lebanon–Carlisle, Pennsylvania	1,676	1,988	13,431	3,354	5,112	1,676	13,431	5,594	1.09	83
Hartford, Connecticut	8,471	12,813	9,167	7,956	9,602	7,956	12,813	2,198	0.23	87
Honolulu, Hawaii	—	1,851	8,430	3,900	4,727	1,851	8,430	3,367	0.71	54
Houston, Texas	44,204	12,626	58,595	50,856	41,570	12,626	58,595	20,172	0.49	106
Indianapolis, Indiana	2,682	2,943	11,901	9,048	6,644	2,682	11,901	4,576	0.69	44
Jacksonville, Florida	6,983	2,935	6,885	11,154	6,989	2,935	11,154	3,356	0.48	67
Jersey City, New Jersey	4,514	2,662	3,290	9,984	5,113	2,662	9,984	3,337	0.65	92
Kansas City, Missouri–Kansas	8,778	6,356	10,972	8,892	8,740	6,356	10,972	1,888	0.22	50
Knoxville, Tennessee	2,935	3,924	6,182	2,730	3,943	2,730	6,182	1,581	0.40	59
Las Vegas, Nevada–Arizona	19,919	9,068	14,050	13,650	14,172	9,068	19,919	4,448	0.31	107
Little Rock–North Little Rock, Arkansas	—	1,007	8,767	4,680	4,818	1,007	8,767	3,882	0.81	87
Los Angeles–Long Beach, California	45,365	52,329	99,385	68,640	66,430	45,365	99,385	24,038	0.36	72
Louisville, Kentucky–Indiana	1,971	5,332	17,593	6,396	7,823	1,971	17,593	6,781	0.87	78
Memphis, Tennessee–Arkansas–Mississippi	1,725	4,001	8,652	4,212	4,648	1,725	8,652	2,897	0.62	43
Miami, Florida	4,137	5,255	8,545	24,180	10,529	4,137	24,180	9,291	0.88	49

TABLE 1. ***Continued***

Metropolitan area	Counseling and testing–based estimate	UFDS-based estimate	Estimate adjusting for HIV prevalence in 1992 and AIDS cases in 1998	Estimate made by adjusting Holmberg 1992 estimate for US trends	Estimated number of IDUs	Minimum of the component estimates	Maximum of the component estimates	Standard deviation of the estimated number of IDUs	Coefficient of variation (standard deviation divided by mean) for IDU estimate	Estimated number of IDUs per 10,000 population
Middlesex–Somerset–Hunterdon, New Jersey	4,563	3,651	3,053	5,928	4,299	3,053	5,928	1,251	0.29	38
Milwaukee–Waukesha, Wisconsin	4,661	2,440	7,081	4,680	4,716	2,440	7,081	1,895	0.40	32
Minneapolis–St. Paul, Minnesota–Wisconsin	3,197	3,054	17,422	5,148	7,205	3,054	17,422	6,878	0.95	25
Monmouth–Ocean, New Jersey	4,955	3,796	3,019	6,552	4,581	3,019	6,552	1,536	0.34	42
Nashville, Tennessee	1,374	1,595	19,670	5,070	6,927	1,374	19,670	8,662	1.25	60
Nassau–Suffolk, New York	5,528	24,876	6,180	10,530	11,779	5,528	24,876	9,010	0.76	44
New Haven–Bridgeport–Waterbury–Danbury, Connecticut	11,039	21,029	9,712	13,260	13,760	9,712	21,029	5,062	0.37	84
New Orleans, Louisiana	8,692	7,209	17,948	13,806	11,914	7,209	17,948	4,916	0.41	91
New York, New York	31,227	194,250	77,309	131,274	108,515	31,227	194,250	70,275	0.65	125
Newark, New Jersey	16,002	10,996	11,136	23,400	15,384	10,996	23,400	5,829	0.38	79
Norfolk–Virginia Beach–Newport News, Virginia–North Carolina	—	5,639	16,629	6,396	9,555	5,639	16,629	6,138	0.64	62
Oakland, California	21,922	21,242	20,607	16,380	20,038	16,380	21,922	2,497	0.12	87
Oklahoma City, Oklahoma	3,320	4,317	5,620	5,460	4,679	3,320	5,620	1,076	0.23	45
Omaha, Nebraska–Iowa	1,308	1,152	3,854	1,872	2,047	1,152	3,854	1,244	0.61	30
Orange County, California	16,583	8,830	22,328	14,118	15,465	8,830	22,328	5,603	0.36	57

TABLE 1. *Continued*

Metropolitan area	Counseling and testing–based estimate	UFDS-based estimate	Estimate adjusting for HIV prevalence in 1992 and AIDS cases in 1998	Estimate made by adjusting Holmberg 1992 estimate for US trends	Estimated number of IDUs	Minimum of the component estimates	Maximum of the component estimates	Standard deviation of the estimated number of IDUs	Coefficient of variation (standard deviation divided by mean) for IDU estimate	Estimated number of IDUs per 10,000 population
Orlando, Florida	6,182	2,849	11,729	6,240	6,750	2,849	11,729	3,678	0.54	45
Philadelphia, Pennsylvania–New Jersey	30,075	56,074	73,107	40,092	49,837	30,075	73,107	18,849	0.38	101
Phoenix–Mesa, Arizona	5,994	18,384	34,712	12,480	17,893	5,994	34,712	12,302	0.68	61
Pittsburgh, Pennsylvania	6,533	12,720	17,984	10,686	11,981	6,533	17,984	4,759	0.40	51
Portland–Vancouver, Oregon–Washington	16,108	22,317	21,677	13,182	18,321	13,182	22,317	4,417	0.24	101
Providence–Fall River–Warwick, Rhode Island–Massachusetts	1,243	10,101	5,458	4,134	5,234	1,243	10,101	3,691	0.71	58
Raleigh–Durham–Chapel Hill, North Carolina	3,884	4,579	4,323	5,460	4,556	3,884	5,460	664	0.15	42
Richmond–Petersburg, Virginia	—	5,025	8,545	6,396	6,655	5,025	8,545	1,774	0.27	70
Riverside–San Bernardino, California	15,708	15,270	36,249	19,500	21,682	15,270	36,249	9,895	0.46	70
Rochester, New York	2,993	5,810	4,181	3,900	4,221	2,993	5,810	1,174	0.28	39
Sacramento, California	16,877	16,960	16,378	11,154	15,342	11,154	16,960	2,804	0.18	99
Saint Louis, Missouri–Illinois	11,555	6,083	14,362	14,040	11,495	6,083	14,362	3,829	0.33	45
Salt Lake City–Ogden, Utah	4,056	13,786	14,518	4,134	9,124	4,056	14,518	5,814	0.64	72
San Antonio, Texas	8,839	7,985	17,484	17,940	13,062	7,985	17,940	5,384	0.41	85
San Diego, California	14,481	17,335	38,591	14,898	21,326	14,481	38,591	11,578	0.54	77

TABLE 1. *Continued*

Metropolitan area	Counseling and testing–based estimate	UFDS-based estimate	Estimate adjusting for HIV prevalence in 1992 and AIDS cases in 1998	Estimate made by adjusting Holmberg 1992 estimate for US trends	Estimated number of IDUs	Minimum of the component estimates	Maximum of the component estimates	Standard deviation of the estimated number of IDUs	Coefficient of variation (standard deviation divided by mean) for IDU estimate	Estimated number of IDUs per 10,000 population
San Francisco, California	24,659	28,024	27,783	17,940	24,582	17,940	28,024	4,698	0.19	146
San Jose, California	3,230	2,858	15,611	13,260	8,740	2,858	15,611	6,648	0.76	53
San Juan–Bayamon, Puerto Rico	—	12,745	17,901	17,160	15,935	12,745	17,901	2,788	0.17	79
Sarasota–Bradenton, Florida	3,884	2,508	5,620	2,028	3,510	2,028	5,620	1,612	0.46	65
Scranton–Wilkes-Barre–Hazleton, Pennsylvania	1,079	2,798	1,597	1,482	1,739	1,079	2,798	740	0.43	28
Seattle–Bellevue–Everett, Washington	3,197	19,306	30,813	13,260	16,644	3,197	30,813	11,549	0.70	72
Springfield, Massachusetts	7,948	7,985	5,058	4,290	6,320	4,290	7,985	1,927	0.30	107
Stockton–Lodi, California	4,358	9,205	14,987	4,290	8,210	4,290	14,987	5,070	0.62	149
Syracuse, New York	2,337	2,858	1,546	2,574	2,326	1,546	2,858	564	0.24	32
Tacoma, Washington	3,344	8,719	9,554	3,510	6,282	3,344	9,554	3,315	0.53	93
Tampa–St. Petersburg–Clearwater, Florida	14,015	9,154	20,162	13,728	14,265	9,154	20,162	4,518	0.32	63
Toledo, Ohio	1,447	904	2,199	2,340	1,723	904	2,340	672	0.39	28
Tucson, Arizona	11,775	7,038	18,733	6,552	11,025	6,552	18,733	5,653	0.51	139
Tulsa, Oklahoma	4,514	4,367	5,269	3,276	4,353	3,276	5,269	822	0.19	56
Ventura, California	965	4,385	5,058	4,290	3,675	965	5,058	1,838	0.50	50
Washington, D.C.–Maryland–Virginia–West Virginia	5,536	28,434	53,836	30,498	29,576	5,536	53,836	19,737	0.68	63

TABLE 1. *Continued*

Metropolitan area	Counseling and testing–based estimate	UFDS-based estimate	Estimate adjusting for HIV prevalence in 1992 and AIDS cases in 1998	Estimate made by adjusting Holmberg 1992 estimate for US trends	Estimated number of IDUs	Minimum of the component estimates	Maximum of the component estimates	Standard deviation of the estimated number of IDUs	Coefficient of variation (standard deviation divided by mean) for IDU estimate	Estimated number of IDUs per 10,000 population
West Palm Beach–Boca Raton, Florida	7,645	1,322	6,021	9,672	6,165	1,322	9,672	3557	0.58	60
Wichita, Kansas	—	1,519	2,108	1,170	1,599	1,170	2,108	474	0.30	29
Wilmington–Newark, Delaware–Maryland	4,227	4,530	9,484	4,680	5,730	4,227	9,484	2,510	0.44	101
Youngstown–Warren, Ohio	2,035	1,118	3,645	1,326	2,030	1,118	3,645	1,145	0.56	34

*Means of component estimates may not equal the arithmetic average because of rounding.
UFDS, Uniform Facility Data Set.

The intercorrelations of these component estimators appear in Table 2. The intercorrelations of the individual estimators with each other are moderate to moderately high, as would be expected from attempts to measure the same construct, but also are far from unity, which is why an estimate based on all of the measures is needed. The correlations of these components with the four-component estimate of injectors per 10,000 people are moderately high, ranging from 0.71 to 0.83. All in all, these correlations suggest that there is reasonable reliability of the estimators.

Similarly, we correlated the arithmetic average per 10,000 population with four additional estimators, each of which was the average based on three of the component estimates (with one component left out). These four correlations were all greater than 0.92. Some of this correlation is because these variables were constructed to have considerable overlap. If the data were normally distributed and

TABLE 2. Correlations among measures of numbers of injection drug users in 96 large US metropolitan statistical area populations

	Counseling and testing per 10,000 population	UFDS based per 10,000 population	Estimate adjusting for HIV prevalence in 1992 and AIDS cases in 1998	Estimate made by adjusting Holmberg 1992 estimate for US trends	Arithmetic average	Arithmetic average per 10,000 population
Counseling and testing per 10,000 population	1	0.44	0.49	0.61	0.18	0.78
UFDS based per 10,000 population	0.44	1	0.45	0.39	0.49	0.74
Estimate adjusting for HIV prevalence in 1992 and AIDS cases in 1998	0.49	0.45	1	0.41	0.23	0.83
Estimate made by adjusting Holmberg 1992 estimate for US trends	0.61	0.38	0.41	1	0.41	0.71
Arithmetic average	0.18	0.49	0.23	0.41	1	0.41
Arithmetic average per 10,000 population	0.78	0.74	0.83	0.71	0.41	1

UFDS, Uniform Facility Data Set.

TABLE 3. Correlations of the estimated percentages of injection drug users in the population in each of 96 large US metropolitan statistical areas with theoretically relevant correlates

	Estimate using average of components		
	N for analysis*	*r*	*p*
Percentage living in poverty, 1990	95	0.340	.0007
Percentage living in poverty, 2000	95	0.435	.0001
Laws against over-the-counter sales of syringes	96	0.227	.0263
Income inequality, 1990	77	0.048	.6779

*N's vary with availability of data about the independent variable.

random, then the expected correlations would be approximately 0.86; in the simulations discussed above, a correlation of 0.92 or more occurred in only 3 of 1,000 trials. Our correlations of 0.92 and above thus tend to lend some modest support to the reliability of the estimates.

Table 3 presents correlations of the estimate of the percentages of IDUs in metropolitan area populations with theoretically relevant predictors. Our estimates of the percentages of IDUs in MSAs correlated modestly with the percentages of the population living in poverty in 1990 and 2000 and with laws against over-the-counter syringe sales.

We asked 143 local experts knowledgeable about drug use in the 96 MSAs to respond to and comment on the project's penultimate estimated numbers of IDUs in each metropolitan area. Codable feedback (as defined in Table 4) was obtained on 80 (83%) of the metropolitan areas (see Table 4). In 65 (81%) of the 80 codable

TABLE 4. Assessment of project estimates for the number of injection drug users residing in each of 80 large US metropolitan statistical areas (MSAs) by 143 local experts,* codable responses only

Assessment of project's MSA estimate	Total number of MSAs with codable feedback (N = 80)	Number (%) of MSAs with cogent feedback† (N = 26)	Number (%) of MSAs with partially substantiated feedback‡ (N = 54)
Endorsed estimate	65 (81%)	23 (88%)	42 (78%)
Believed estimate too low	6 (8%)	3 (12%)§	3 (6%)
Believed estimate too high	9 (11%)	0 (0%)	9 (17%)

*Codable assessments were obtained on 80 (83%) of the 96 MSAs studied. An *uncodable assessment* was one in which no respondent for the MSA provided substantive feedback, all respondents for the MSA agreed that they had no substantive basis with which to assess our estimates, or respondents with similar levels of knowledge about the MSA disagreed substantially about the number of injectors in the MSA.

†*Cogent feedback* indicates that experts compared our estimates with their own estimates, calculated using reliable methods and reasonably commensurate definitions of injection drug use.

‡*Partially substantiated feedback* indicates that the experts compared our estimates with their own estimates, calculated using treatment data, simple extrapolation from the National Household Survey on Drug Abuse, or experiential data or used incommensurate definitions of injection drug use.

§The MSAs were Fort Lauderdale, Florida, for which the local estimates were 14,400, and our estimate was 6,933; Miami, Florida, for which the local estimates were 22,400, and our estimate was 10,607; and Orlando, Florida, for which the local estimate was 9,800, and our estimate was 6,770. Lieb et al.[28] made these alternative estimates for these Florida MSAs. Their differences are probably caused by differences in methodology, with their estimates based on estimates of the numbers of IDUs living with HIV and on HIV prevalence rate estimates.

TABLE 5. Measures of central tendency and dispersion for the proportion of injection drug users (IDUs) who were in drug abuse treatment and the ratio of HIV counseling and testing events to the estimated number of injectors in each of 96 large US metropolitan statistical areas in 1998

	Proportion of IDUs receiving drug abuse treatment (N = 96)	Ratio of HIV counseling and testing events to the estimated number of IDUs (N = 89)
Mean (SD)	0.102 (0.068)	0.089 (0.050)
Median (range)	0.086 (0.382)	0.082 (0.273)
Quartiles		
First	0.011–0.053	0.013–0.049
Second	0.057–0.086	0.056–0.084
Third	0.090–0.138	0.087–0.133
Fourth	0.140–0.393	0.134–0.285

cases, respondents endorsed our estimates; specifically, in these 65 MSAs, respondents reported that our estimate was credible or gave an estimate that was within 35% of our estimate. In 6 (8%) of the 80 codable metropolitan areas, they thought our estimates were too low, and in 9 (11%) of the metropolitan areas, they thought our estimates were too high.

Table 5 presents data on the proportions of IDUs who were in drug abuse treatment on October 1, 1997, and of the ratios of counseling and testing events provided to IDUs to the number of IDUs in 1998. (Data were not available on counseling and testing in seven metropolitan areas.) On the average, MSAs provided drug treatment and HIV counseling and testing services to approximately 10% and 9%, respectively, of the IDUs residing within their boundaries in 1998. The proportions of IDUs who were in drug abuse treatment in 1998 varied widely. The top quarter of the MSAs provided treatment to between 14% and 39% of resident IDUs (the next highest proportions treated were 33%, 28%, and 24%), and the bottom quarter all provided treatment to less than 5% of resident IDUs. The ratio of HIV counseling and testing events to IDUs was similarly disparate across geographic areas, with mean and median of 9% and 8%, respectively; the lower quartile all were less than 5%, and the top quartile ranged from 13% to 29% (with the second highest being 20%).

DISCUSSION

Limitations

Despite our efforts to validate the estimates of numbers of IDUs in each metropolitan area, serious limitations undoubtedly exist concerning their accuracy. They are based on averaging a series of imperfect estimators of number of IDUs and on using these imperfect estimators as approximate indicators of the range of possible errors. Efforts to construct validate the results by examining their correlates are limited by the paucity of research about the correlates of numbers of drug injectors, which is caused in part, at least, by the absence of good data about the numbers of IDUs in any localities. Similarly, efforts to validate the results by comparing them with local estimates are limited by the weakness of the local data in most localities. Ultimately, there is no gold standard against which to compare these results.

These data also depend on our estimate of the total number of IDUs in the United States. Because each component estimate, however, is a linear function of this number, any error in estimating the total number of IDUs in the country should only affect the absolute numbers estimated for each metropolitan area and not the relative proportions of IDUs in each locality. Thus, errors in estimating the number of IDUs in the United States will not affect analyses of which social or policy variables enter in as significant predictors of IDU population density.

One major limitation is that the various components for the estimates have different time frames. For example, AIDS cases and HIV prevalence are a function of drug injection experience since the circa mid-1970s beginning of the HIV epidemic among IDUs in the United States,[27] as to some extent are methadone maintenance program census and HIV counseling and testing data, but current drug treatment entry data are contemporaneous. Thus, allocating the US total of persons who injected drugs in the last year to metropolitan areas with multipliers based on these data can produce error to the extent to which past levels of IDUs per capita are not correlated with present values.

Our component estimate based on drug abuse treatment data is limited to the extent that the proportion of IDUs in treatment varies depending on the extent to which local IDUs inject heroin (which is in some ways the drug for which some treatment systems, particularly methadone, are designed) versus amphetamines or cocaine. In addition, drug treatment services are subject to many budgetary and political pressures. As part of the overall project, interviews have been conducted with knowledgeable informants from each metropolitan area. These interviews provide numerous examples that, at least in an era of both tight budgets and considerable pressure to increase treatment as a way to reduce HIV transmission, the variance of both treatment census and treatment entry data may have increased across MSAs. This is because, in some metropolitan areas, large budget cuts are reported to have taken place; in others, large treatment increases have taken place.

Biases may also exist in these data because of the different histories of HIV counseling and testing by IDUs in different cities. For example, in New York City, many have been tested before, so it may be that current rates of testing are low—particularly because the large numbers who have previously tested positive have little reason to keep being retested once their infection has been confirmed. Also, the counseling and testing data include repeat testers; if metropolitan areas vary in the extent to which IDUs get repeat tests, this will reduce the accuracy of the estimates. Further, in some metropolitan areas, counseling and testing centers may chiefly be in locations that are not convenient for many IDUs. Furthermore, as compared to drug treatment centers (at which application for admittance includes confirmation of drug usage), HIV counseling and testing centers may be prone to IDUs' denial that they are IDUs. As with drug abuse treatment, budgetary and political decisions may affect the availability of these services.

Caution needs to be taken with the use of MSA-specific estimates; this may be particularly important in terms of estimates of local service coverage. Our construct validation procedures provide estimates of overall reliability of the entire set of 96 estimates and are thus less meaningful for any given metropolitan area.

CONCLUSIONS

Despite these limitations, our analyses support the validity of the project's estimates: Experts in 81% of the 80 MSAs for which we had codable information endorsed our estimates, and the project IDU estimates correlated with many of the variables we believed were theoretically germane. Furthermore, the high degree of correlation between the IDU estimates based on averaging the four components and those based on the factor analysis suggests that both are probably responsive to an underlying causal variable, which, in all probability, is the number of IDUs (per capita) in the metropolitan area. It is likely that the relative magnitudes of IDUs per 10,000 population in the various metropolitan areas are not too inaccurate, if only because we took some care to provide a variety of component measures that derived from different parts of health service systems.

To the extent that these data are accurate, then they can be used (with proper acknowledgement of their limitations) for structural analyses of the correlates and predictors of the population density of IDUs in metropolitan areas. Specifically, the correlations we found between the project's IDU estimates and theoretically germane variables suggest that further research should be done to determine whether poverty rates or other indicators of socioeconomic distress and/or laws limiting syringe access in a locality are positively associated with drug injectors per capita. Our estimates can also be used to judge the extent to which health systems and social service systems are providing services to IDUs.

The data presented on the coverage of drug treatment and of HIV counseling and testing are worrisome. Few if any metropolitan areas seem to be serving IDU populations well. The median proportion of IDUs in drug abuse treatment and the median proportion of IDUs receiving HIV counseling and testing in 1998 were approximately 8% to 9%. These figures suggest that the public health would benefit by sizable increases in the budgets for these services and, perhaps, by changes in these services to make them more accessible, and appealing, to IDUs who might use them.

APPENDIX 1

Discussion of Indicators Selected to Estimate the Number of Injecting Drug Users in Each Metropolitan Statistical Area

Each indicator selected to calculate the IDU estimates has biases; efforts were made to create a set of estimates with counteracting biases. Each indicator that we considered in this study is based on a different way of "encountering" an IDU. HIV counseling and testing and drug abuse treatment are usually based on voluntary interaction with health agencies. To the (varying) extent that different jurisdictions mandate drug abuse treatment for offenders or ex-offenders or mandate HIV testing for any sizable section of the IDU population, such service-based encounters will have a (varying) degree of involuntariness associated with them. Semivoluntary encounters include AIDS diagnoses (which may sometimes be avoided or postponed, but may sometimes occur as the result of acute health episodes). All these encounters are partially dependent on budgetary and political decisions. Drug abuse treatment and HIV counseling and testing services may be funded more or less adequately, and this can change over time. HIV testing and counseling encounters also depend on the physical locations of sites where these services are provided. In some MSAs, they may focus primarily on areas near "gay ghettos," whereas in others they may be placed in areas more convenient for street drug injectors.

Another dimension on which these measures vary is their potential frequency. Drug abuse treatment "census" data (UFDS) measure how many IDUs are in contact with treatment agencies on October 1 of each year.[21] Data on HIV testing and counseling events depend on the desires of potential clients and on the availability of capacity at the service agency; they can happen multiple times a year for some persons and much less often for others. In many cases, furthermore, people who are told that they are infected with HIV either cease to be tested or do so only rarely, and this can create a downward tendency in the numbers of IDUs receiving testing and counseling that may be only loosely related to numbers of IDUs in the locality.

APPENDIX 2

The use of data from only 1 year could be problematic to the degree that AIDS case data are highly variable from year to year. Coefficients of variation (calculated as the standard deviation divided by the mean) were calculated for the period 1995–2000 in the ratio of AIDS cases diagnosed among IDUs in each metropolitan area in a given year to total AIDS cases diagnosed among IDUs in the United States for that same year. These coefficients of variation are mainly low (<0.40); of the 19 cases above 0.40, there were 18 for metropolitan areas with fewer than 100 AIDS cases per year among IDUs, on average. Thus, their relatively high coefficients of variation (with a maximum value of 0.89) are probably because of the law of small numbers. The 19th metropolitan area is Nassau-Suffolk; its coefficient of variation, 0.42, was the result of an above-average decline in its percentage of US IDU AIDS cases, which may well be the result of success in providing antiretroviral therapy to the infected.

In these calculations and in the following derivations, we used the most current AIDS Public Information Data Set (APIDS) version—as of August 26, 2002—to reduce underreporting because of time lags in reporting AIDS cases. We examined the correlation between Holmberg's estimate of seroprevalence in 1992 and the percentage change in reported IDU AIDS cases between APID1999 and APID2000 to see if this "error estimate" was correlated with HIV prevalence. This correlation equaled 0.031. This suggests that we can probably ignore the underreporting issue given that only 7 of 96 metropolitan areas had 25% or more change between APID1999 and APID2000.

APPENDIX 3

Exclusion Criteria for Component Indicators of Numbers of Injecting Drug Users in a Given Metropolitan Area

Sometimes a given indicator for a metropolitan area provides estimates that strain the bounds of credibility. This can result, for example, if budgetary or other reasons led to services unusually hard for IDUs to access. Thus, two sets of exclusion criteria were derived using methods similar to those that Holmberg utilized. Any estimate for a given metropolitan area that fell outside the ranges set by either of these exclusion criteria was considered missing data. (In practice, as described, only nine component estimates were excluded using these criteria.)

The first criterion started with the 1998 NHSDA survey's rather low estimate of the number of persons who injected drugs in the last 12 months (294 thousand). This was used to define a lower bound for the US total number of IDUs; an upper bound of 8.4 million was set at three times (to allow for underreporting) the estimate of ever-IDUs in this survey. Assuming that almost all of these IDUs were aged 12 years or older, this implies that the lower bound for the percentage of IDUs in the United States is 294,000/224 million (the number of US residents in this age range) = 0.13%. The upper bound is 8.4 million/224 million = 3.7%. Any component estimate for the number of IDUs in a metropolitan area that fell outside of this rather broad range (0.13%–3.7%) of the population aged 12 years or older was excluded.

The second criterion was based on Holmberg's estimates of the number of IDUs in metropolitan areas in 1992. The lower bound was set at 50% of Holmberg's estimate for the metropolitan areas where injection drug use was estimated to be least prevalent. The upper bound was set at 200% of his estimate for the metropolitan area where injection drug use was estimated to be most prevalent. Holmberg found that the Jersey City metropolitan area had the largest proportion of IDUs (2.31%) and Minneapolis–St. Paul the lowest (0.25%). This would give plausible ranges of 0.13%–4.62% of the total population, but this estimate needed to be adjusted for changes in the percentage of US population who inject drugs. To do this, we adjusted the upper and lower bounds by multiplying them by our project estimate of the number of IDUs in the United States in 1998 (1,364,874) divided by our extrapolation (see above) of the Holmberg estimate of the number of IDUs in the United States in 1992 (1,742,600), then we adjusted this for the increase in the US population between 1992 and 1998 by multiplying by the ratio of 255,029,699 to 270,248,003. These adjustments led to the second set of exclusion criteria: That each component estimate for the number of IDUs in a metropolitan area would have to fall in the range of 0.091% to 3.23% of the total metropolitan area population. Note here that this exclusion criterion uses the total metropolitan population, whereas the first criterion used the population aged 12 years or older as its basis.

APPENDIX 4

Estimating Alternative, Three-Component Service Coverage Estimates and Their Correlations With the Principal Coverage Estimates

To calculate alternative, three-component treatment coverage estimates, we estimated the number of IDUs as the average of three component estimates: (1) the component derived from HIV counseling and testing data, (2) the component based on updating and extrapolating Holmberg's estimate, and (3) the component based on AIDS data and HIV seroprevalence data. For areas that lacked data on counseling and testing, we used the average of the other two component estimates. Treatment coverage was then calculated as the number of IDUs in treatment divided by this alternative estimate of the number of IDUs.

Likewise, alternative, three-component counseling and testing coverage estimates were calculated by dividing the number of counseling and testing events provided to IDUs by an alternative IDU estimate, calculated as the average of (1) the component derived from UFDS data, (2) the component based on updating Holmberg's estimate, and (3) the component based on AIDS data and HIV seroprevalence data.

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