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An HIV Prevalence-based Model for Estimating Urban Risk Populations of Injection Drug Users and Men Who Have Sex with Men

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ABSTRACT *Issues of cost and complexity have limited the study of the population sizes of men who have sex with men (MSM) and injection drug users (IDUs), two groups at clearly increased risk for human immunodeficiency virus (HIV) and other acute and chronic diseases. We developed a prototypical, easily applied estimation model for these populations and applied it to Miami, Florida. This model combined HIV prevalence estimates, HIV seroprevalence rates, and census data to make plausible estimates of the number and proportion of MSM and IDUs under a number of assumptions. Sensitivity analyses were conducted to test the robustness of the model. The model suggests that approximately 9.5% (plausible range 7.7%–11.3%) of Miami males aged 18 years or older are MSM (point estimate, N=76,500), and 1.4% (plausible range 0.9%–1.9%) of the total population aged 18 years or older are IDUs (point estimate, N=23,700). Males may be about 2.5 times more likely than females to be IDUs. The estimates were reasonably robust to biases. The model was used to develop MSM and IDU population estimates in selected urban areas across Florida and should be replicable in other medium-to-large urban areas. Such estimates could be useful for behavioral surveillance and resource allocation, including enhanced targeting of community-based interventions for primary and secondary HIV prevention.*

KEYWORDS *Epidemic modeling, Injection drug users, HIV prevalence, HIV/AIDS, Men who have sex with men.*

INTRODUCTION

Recent budget pressures challenging American cities highlight the importance of efficient and thoughtful allocation of public health resources. Human immunodeficiency virus (HIV) prevention and treatment program allocation is often hampered by limited information about the size of two key at-risk populations: men who have sex with men (MSM) and injection drug users (IDUs). Accurate estimation of the size of populations at increased risk for HIV is important not only for resource allocation, but also for policymaking, program planning, surveillance, and evaluation of HIV prevention programs, including measurement of coverage and structural interventions. High cost and complexity, however, have limited our ability to determine

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the numbers of MSM and IDUs in a given geographic area.[1–8] Surveys to determine prevalence of male–male sexual contact and injection drug use have tended to result in undercounts, largely because of issues of non-self-disclosure associated with stigmatization of behaviors generally deemed illegal or unacceptable by society[1,9–11] and partly because of homelessness or institutionalization of IDUs.[12,13]

We developed an easily applied model that combines HIV prevalence estimates with HIV seroprevalence rates and census data to make plausible estimates of the number and proportion of MSM and IDUs in an urban setting. This HIV prevalence-based model can be readily adapted by many medium-to-large metropolitan areas. The estimates, if done for a large number of cities, could be used for structural analysis of HIV and other epidemics, as well as for modeling future disease burden. Analyses of which urban characteristics are associated with having more MSM or IDUs per capita could help us understand more about social–structural vulnerability and causation.[14,15]

METHODS

Our model utilized (1) HIV/AIDS (acquired immunodeficiency syndrome) surveillance data, (2) redistribution of cases with no identified risk (NIRs), (3) reasonably accurate HIV prevalence estimates by risk group, (4) census data, and (5) some acceptable framework in terms of HIV seroprevalence rates among MSM and IDUs.

Definitions

Persons living with HIV/AIDS (PLWHAs) were defined as those diagnosed and reported to the Florida Department of Health (FDOH) HIV/AIDS Reporting System as HIV cases or AIDS cases who were alive through December 2001. HIV prevalence estimates were defined as the estimated numbers of persons living with HIV infection at the end of 2001, including PLWHAs, those diagnosed with HIV or AIDS but not reported, and those not diagnosed. We defined an MSM as a male resident of a given metropolitan statistical area (MSA) aged 18 years or older who had any male–male sex contact after 1977. An IDU was defined as a male or female resident aged 18 years or older who injected drugs at any time after 1977. Unless otherwise specified, both MSM and IDUs included those with the joint risk factor of MSM/IDU. Our time period for MSM and IDU activity was developed to be consistent with the classification conventions for HIV exposure developed by the Centers for Disease Control and Prevention (CDC) for HIV/AIDS surveillance.[16]

Cases With No Identified Risk

Risk information for HIV and AIDS cases was generally obtained by FDOH staff from medical records in hospitals and doctors' offices, as well as data collected from publicly funded HIV counseling and testing sites. PLWHA NIR cases were redistributed into recognized risk groups according to the historical pattern of how cases initially reported as NIR were subsequently found to have a specific risk. The redistribution procedure was modified from one developed by Green,[17] which used AIDS data from all southeastern states as the basis for redistributing Florida's NIRs. We used Florida- and MSA-specific PLWHA data on reclassified NIRs to account for reclassification patterns that may differ by more local geographic area. We took the proportion of the number of historically reclassified PLWHA NIR cases in each risk group and multiplied it by the total remaining number of PLWHA NIRs. The resultant cases were added to the number of actual PLWHA cases in the risk group, thus redistributing the NIRs.

In redistributing the NIRs, we assumed that the distribution of risk among the reclassified NIR cases was similar to that among cases that remained as NIRs. The HIV prevalence estimates for MSM and IDUs reflected the redistribution procedure, for which we assumed that the data set of all PLWHAs with risk redistributed was representative of all prevalent HIV-infected persons for whom no epidemiological follow-up was conducted. To the extent that these assumptions were not true, bias may have been introduced. Sensitivity analyses, described in detail separately, were conducted to assess the effects of bias.

HIV Prevalence Estimates

HIV prevalence estimates were the foundation of the model. CDC estimates that as of 2000 there were approximately 850,000–950,000 persons living with HIV in the United States.[18] Florida has 11.1% of the national morbidity, as estimated by its share of the number of persons living with AIDS (PLWAs) through 2001 (40,373/362,260)[19]; this proportion has been quite stable over time. The HIV prevalence point estimate for Florida as of 2001, extrapolated from the national estimate, was approximately 100,000 or 11.1% of the midpoint of the national estimate; a plausible range was 93,000–107,000 or plus or minus 7% of the Florida point estimate. The plausible range around the HIV prevalence point estimate was treated similar to the standard deviation around a mean. It was assumed that the plausible range varies up and down the scale the same way that probability-derived confidence intervals would vary; the smaller the point estimate, the greater the relative uncertainty will be. The methods for computing the plausible ranges are available from the first author.

The statewide HIV prevalence point estimate was broken down by MSA based on each MSA's share of the reported PLWHAs through 2001. The MSA-specific HIV prevalence point estimate was further disaggregated by subgroup (e.g., by risk group, with NIRs redistributed) by assuming that the subgroup's share of the MSA's HIV prevalence was equal to its share of the MSA's number of PLWHAs, and that PLWHA risk characteristics were representative of those of all HIV-infected persons. It was assumed that there were similar timeliness/completeness of reporting, start times, and histories of the epidemics in different communities. Potential biases were examined through sensitivity analyses.

The HIV Prevalence-Based Model

The HIV prevalence-based model was tested against the six largest MSAs in Florida. The findings for the Miami MSA are presented here as a prototype. Population data for those aged 18 years or older were obtained from the 2000 US decennial census for the Miami MSA. The point estimate of the HIV prevalence among MSM in Miami was designated as k. The estimated numbers of MSM a and the estimated HIV seroprevalence rates among MSM b were variables related by the function $k = ab$. The relationship among these parameters was graphed and tabulated to illustrate the number of MSM, $a = k/b$. The equivalent analysis was conducted to illustrate plausible numbers of total IDUs, male IDUs, and female IDUs, derived from values of the corresponding HIV prevalence estimates k and HIV seroprevalence rates b.

A context for the MSM estimates was provided by an empirically derived MSM HIV seroprevalence rate of 17% based on the average rate from the Urban Men's Health Study, the details of which are described elsewhere.[3] That study obtained a probability sample of 2,881 MSM in four large non-Florida cities. A context for the

IDU estimates was provided by other empirical HIV seroprevalence rates (19% overall [18% among males, 21% among females]) based on a research study of 600 Miami IDUs.[20] Those researchers recruited IDUs from multiple communities at different times of day to increase the representativeness of the data and mitigate limitations of their nonprobability sample, which was drawn via a targeted sampling design often used for community-based studies of illicit drug users.[21,22] The adaptability of the model to other urban areas in Florida and beyond was addressed.

Sensitivity Analyses

Because biases may be associated with possible misclassification of risk among heterosexual contact cases,[23–25] we conducted sensitivity analyses to assess the robustness of the model by modifying the HIV prevalence estimates. Extreme examples of potential biases in HIV seroprevalence rates were also considered to evaluate the effect on the corresponding estimated numbers of MSM and IDUs.

RESULTS

HIV Prevalence Estimates

Through 2001, 17,502 (28%) of 62,303 PLWHAs in Florida were reported from Miami (Table 1). Consequently, the HIV prevalence estimate for Miami was approximately 28,000 (= 0.28 × 100,000 [the statewide HIV prevalence estimate]), with a plausible range of 24,300 to 31,700 or plus or minus 13% of the point estimate. Based on reclassification investigations by FDOH surveillance staff, 4,923 (45%) of 11,049 PLWHAs initially classified as NIR in Miami have been reclassified into recognized HIV exposure categories. Of these 4,923 cases, we found that 37% were reclassified as MSM, 14% as IDUs, 2% as MSM/IDUs, 47% as heterosexual contact cases, and less than 1% as all other categories. These redistribution fractions were applied to the remaining 6,126 PLWHA NIRs. Based on PLWHA data by risk group with NIRs redistributed, the HIV prevalence point estimates for Miami were approximately 13,000 MSM (includes 12,400 MSM and 600 MSM/IDUs) and 4,500 IDUs (includes 3,900 IDUs and 600 MSM/IDUs) (Table 1).

Men Who Have Sex with Men

The schematic representation of the model in Fig. 1 illustrates the relationship among (1) the HIV prevalence estimate among MSM in the Miami MSA (N = 13,000 [plausible range 10,500–15,500 or ±19% of the point estimate]), (2) the estimated number of MSM, (3) the estimated HIV seroprevalence rate among MSM (variable, although a point estimate of 17% is highlighted), (4) the MSA's population of males aged 18 years and older (2000 decennial census data), and (5) the percentage of males who are MSM. The effect of varying the percentage of males who may be MSM from 3% to 14% is shown, noting that the number of MSM and the HIV seroprevalence rate are inversely related. If 3% of males were MSM, there would be about 24,100 MSM (= 0.03 × 803,323). This appears to be implausibly low, however, as it would imply that 54% of them were HIV infected (= 13,000/24,100), an implausibly high HIV seroprevalence rate, in view of other research, such as the Urban Men's Health Study[3] and a smaller, Miami-based study, which found a rate of 15% among MSM aged 18–29 years.[26]

At the other "extreme," if 14% of adult males were MSM, then the HIV seroprevalence rate would be about 12% (= 13,000/112,500). But, most research suggests

TABLE 1. Numbers of persons living with HIV/AIDS* and estimated HIV prevalence by risk group, Florida and Miami, as of December 31, 2001†

	Florida			Miami		
Risk group‡	No. PLWHAs§	Percentage of total	Estimated HIV prevalence	No. PLWHAs§	Percentage of total	Estimated HIV prevalence
MSM	25,096	40.3	40,300	7,763	44.4	12,400
IDU	9,838	15.8	15,800	2,453	14.0	3,900
MSM/IDU	2,173	3.5	3,500	345	2.0	600
Heterosexual	23,843	38.3	38,300	6,552	37.4	10,500
All others¶	1,353	2.2	2,100	389	2.2	600
Total	62,303	100	100,000	17,502	100	28,000

Percentage distribution of the HIV prevalence estimates differs slightly from the percentage distribution of PLWHAs because of rounding.

AIDS, acquired immunodeficiency syndrome; HIV, human immunodeficiency virus; IDU, injection drug user; MSM, men who have sex with men; PLWHA, reported persons living with HIV/AIDS.

*Data include homeless and institutionalized persons.

†Data were run in April 2003 to help adjust for delays in reporting of HIV/AIDS cases and deaths.

‡The categories MSM and IDU are mutually exclusive in this table.

§Adjustments have been made for the redistribution of PLWHA cases with no identified risk (see text).

¶Includes those with hemophilia/coagulation disorder; receipt of blood transfusion, blood components or tissue; and pediatric risk.

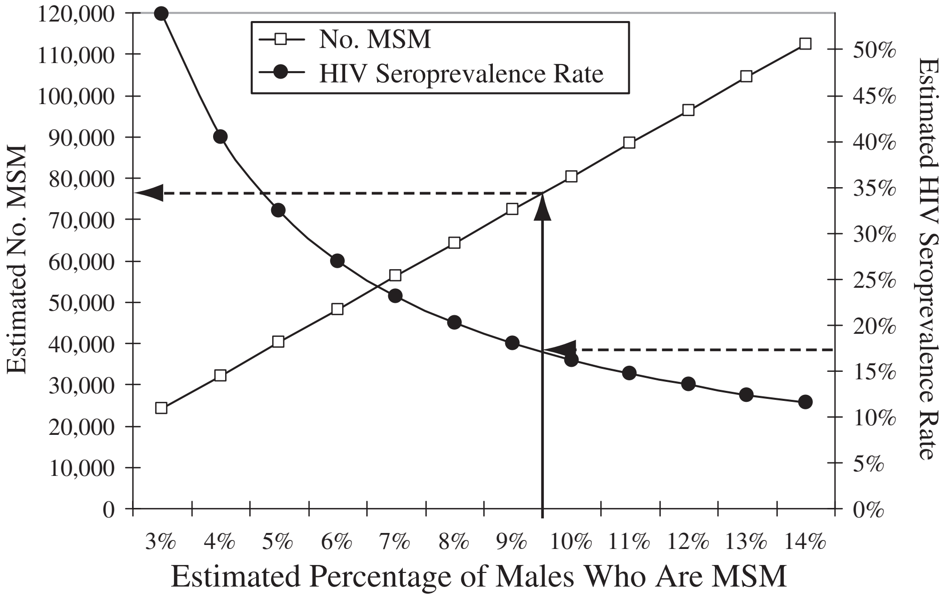

FIGURE 1. Men who have sex with men (MSM) estimation model, Miami. MSM includes MSM and MSM/injection drug users (IDUs). Male population of Miami metropolitan statistical area (18 years or older) = 803,323 (2000 decennial census). Estimated human immunodeficiency virus (HIV) prevalence among MSM = 13,000. In this schematic, if 17% of MSM were HIV infected, there would be approximately 76,500 MSM (= 13,000/0.17) or 9.5% of males. A continuum of other possibilities is shown.

that fewer than 14% of adult males are MSM, even in large urban areas (with the possible exception of San Francisco).[1,3,27] Thus, according to the model, the corresponding HIV seroprevalence rate of 12% may be unrealistically low. Moreover, publicly funded HIV counseling testing data for Miami in 2001 indicated 11% of tests among MSM were confirmed positive (FDOH, unpublished data, 2002), which may help set a lower bound. Counseling and testing tends to undersample those who have already tested positive and thus underestimates HIV seroprevalence rates.

If the HIV seroprevalence rate among Miami MSM was the same as the average rate found in the Urban Men's Health Study (17%),[3] the model would suggest that roughly 76,500 males were MSM (= 13,000/0.17) or 9.5% of the Miami MSA male population aged 18 years or older. A plausible range would be plus or minus 19% of this number or proportion. Figure 1 displays various other possibilities along a continuum of HIV seroprevalence rates among MSM and numbers/percentages of males who may be MSM. This aspect of the model provides a means to navigate plausible estimates of one variable while simultaneously visualizing implications for the others.

Injection Drug Users

If the HIV seroprevalence rate was 19%, as found in the Miami IDU HIV serosurvey[20] and an earlier, similar Miami IDU study,[28] then there would be approximately 23,700 IDUs (= 4,500/0.19); this point estimate would suggest that roughly 1.4% of the total Miami MSA population aged 18 years or older (N = 1,708,190) are IDUs (Fig. 2). A plausible range would be plus or minus 33% of these point

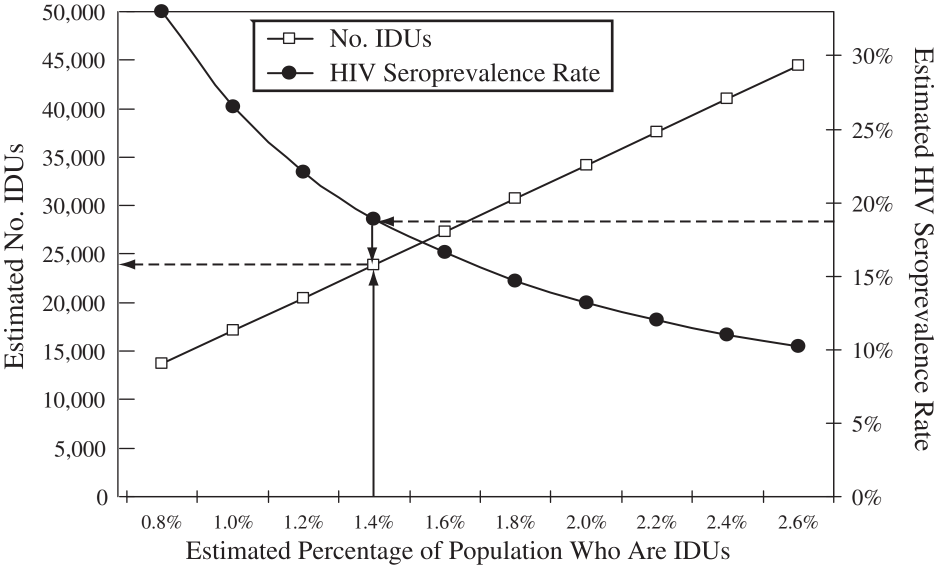

FIGURE 2. Injection drug user (IDU) estimation model, Miami. IDUs include IDUs and men who have sex with men (MSM)/IDUs. Total population of Miami metropolitan statistical area (18 years or older) = 1,708,190 (2000 decennial census). Estimated HIV prevalence among IDUs = 4,500. In this schematic, if 19% of IDUs were HIV infected, there would be approximately 23,700 IDUs (= 4,500/ 0.19) or 1.4% of the population. A continuum of other possibilities is shown.

estimates. A lower bound for the HIV seroprevalence rate among IDUs might be 14%, which was the percentage of confirmed HIV positive tests in 2001 in Miami counseling and testing settings (FDOH, unpublished data, 2002).

A similar, modeled analysis was conducted for male and female IDUs. Given a male IDU HIV prevalence estimate of 2,900, if there is an 18% HIV seroprevalence rate among males,[20] the model suggests there would be roughly 16,100 male IDUs or 2.0% of all males aged 18 years or older. The corresponding numbers for females would be 1,600 (HIV prevalence estimate), 21% (HIV seroprevalence rate),[20] and 7,600 female IDUs or 0.8% of all females aged 18 years or older. These point estimates would imply that Miami males might be about 2.5 times more likely than females to be IDUs (2.0/0.8 = 2.5). In addition, discounting those in the overlapping category of MSM/IDU, the estimated number of MSM in Miami may be approximately three-fold greater than the number of IDUs.

The spreadsheets in Table 2 illustrate the various computations in the model. Values of the HIV seroprevalence rates in the first three rows are most likely too high, suggesting that the corresponding percentage and number of MSM or IDUs would be too low. The table further demonstrates how the model may proceed from plausible HIV seroprevalence rates b to plausible numbers of MSM or IDUs a, and vice versa, as they are both linked to the HIV prevalence estimate k by the function $k = ab$.

Adaptability of the HIV Prevalence-Based Model

The model was tested against data from five other MSAs in Florida (Ft. Lauderdale, Jacksonville, Orlando, Tampa–St. Petersburg, and West Palm Beach). The PLWHA data (and derived HIV prevalence estimates) were sufficient to enable reasonably

TABLE 2. Spreadsheet computation of men who have sex with men (MSM)* and injection drug user (IDU)† estimates

MSM, %	No. MSM *a*‡	HIV seroprevalence rate *b*‡, %
3	24,100	53.9
4	32,133	40.5
5	40,166	32.4
6	48,199	27.0
7	56,233	23.1
8	64,266	20.2
9	72,299	18.0
10	80,332	16.2
11	88,366	14.7
12	96,399	13.5
13	104,432	12.4
14	112,465	11.6
15	120,498	10.8
IDUs, %	No. IDUs *a*‡	HIV seroprevalence rate *b*‡, %
0.4	6,833	65.9
0.6	10,249	43.9
0.8	13,666	32.9
1.0	17,082	26.3
1.2	20,498	22.0
1.4	23,915	18.8
1.6	27,331	16.5
1.8	30,747	14.6
2.0	34,164	13.2
2.2	37,580	12.0
2.4	40,997	11.0
2.6	44,413	10.1
2.8	47,829	9.4
3.0	51,246	8.8

MSM includes MSM and MSM/IDUs); IDUs include IDUs and MSM/IDUs.

HIV, human immunodeficiency virus; MSA, metropolitan statistical area.

*Estimated MSM HIV prevalence (k) = 13,000. Given: Male population of Miami MSA (18 years or older) = 803,323.

†Estimated IDU HIV prevalence (k) = 4,500. Given: Total population of Miami MSA (18 years or older) = 1,708,190.

‡The parameters are related by the function $b = k/a$. The first three rows of each section may include implausible values of b (the HIV seroprevalence rate) and thus implausible values of a (the estimated number of MSM or IDUs); k is the HIV prevalence estimate.

robust estimates of the numbers of MSM and IDUs in each of these MSAs, using HIV seroprevalence rates similar to those for Miami (data not shown). (Details on how other urban areas could replicate the model are provided in the Discussion section.) It is suggested that many cities and MSAs with an estimated HIV prevalence of more than 500 among MSM or IDUs may be able to take advantage of the model to estimate the size of these risk populations. Below that threshold, the upper plausible bound might exceed 100% of the midpoint estimate. However, the lower plausible bound can never be lower than the number of MSM or IDU PLWHAs.

Sensitivity Analyses

In the first sensitivity analysis, we varied the NIR redistribution fractions by risk group. We considered that the reclassified NIRs were unrepresentative of the remaining NIRs. In this scenario, we assumed that heterosexuals were over-reclassified, and that the actual redistribution fractions were 55% (vs. the original 37%) for MSM, 25% (vs. 14%) for IDUs, 5% (vs. 2%) for MSM/IDUs and 15% (vs. 47%) for heterosexuals. Then, the number of MSM would increase to 93,300 (data not shown), an increase of 22% over the original point estimate of 76,500. The number of IDUs would increase to 32,000, an increase of 35% over the original point estimate of 23,700. These percentage increases are similar to those of the calculated plausible upper bounds (19% and 33%, respectively) above the original point estimates of the numbers of MSM and IDUs.

In the second sensitivity analysis, we considered that 50% of the male heterosexual PLWHAs were misclassified (an arbitrary, high percentage) and should have been MSM. The corresponding increase in the HIV prevalence estimate would be from 13,000 to 15,200 (data not shown), and the point estimate of the number of MSM would thereby increase from 76,500 to 89,400 (= 15,200/0.17), an increase of 17%. Next, we considered that 30% of female heterosexual PLWHAs were IDUs and 20% of male heterosexual PLWHAs were IDUs. In this scenario, the number of IDUs would increase from 23,700 to 34,000 (data not shown), an increase of 43%. This increment would imply that 2.0% of the population were IDUs, as opposed to the original point estimate of 1.4%, and that the corresponding HIV seroprevalence rate would be 13% (4,500/34,000) rather than 19%.

Bias may have been introduced to the extent that the Miami-specific HIV seroprevalence rate among MSM differs from that found in the Urban Men's Health Study[3] (17%; four-city range 14%–20%). The impact of even greater extremes than the four-city range was considered in the final sensitivity analysis. If as many as 25% MSM were HIV infected, for example, there would be only 52,000 MSM; if only 10% MSM were HIV infected, there would be 130,000 MSM, indicating that 6% to 16% of the male population, respectively, would be MSM. Table 2 illustrates the general effect of over- or underestimating the HIV seroprevalence rate among MSM and IDUs.

DISCUSSION

More than 20 years into the HIV/AIDS epidemic, behaviors associated with male–male sex contact and injection drug use continue to contribute significantly to the reservoir and spread of HIV.[3,20,29–32] These at-risk populations remain hard to reach and even more elusive to quantify.[8,11] Yet, public health authorities must still allocate often-scarce resources in the absence of good estimates of the potential scope of the problem. Our HIV prevalence-based model, applicable to many large urban areas, provides insight via a simple mechanism to estimate the size of two key HIV risk groups, MSM and IDUs.

The model suggests that, as of the end of 2001, a quantifiable, high proportion of adult males (aged 18 years or older) in the Miami MSA may be MSM (9.5% [plausible range 7.7%–11.3%]); a smaller, but still substantive, proportion of the total adult population may be IDUs (1.4% [plausible range 0.9%–1.9%]). Our finding that Miami males may be roughly 2.5 times more likely than females to be IDUs is similar to that in other studies of street-recruited, out-of-treatment IDUs in Miami[20,33–35] and other urban areas of the United States.[12] Although our model suggests that Miami MSM might outnumber IDUs by three to one, undercounts of IDUs among the PLWHAs (and consequent HIV prevalence estimates) are possible. The question of who tends to be tested should be considered in interpreting this finding and how this affects the number of reported HIV/AIDS cases. It is not known whether MSM are more likely to make this choice than IDUs. Another reason for possible undercounts of IDUs may be late diagnosis of AIDS because 16.3% of IDUs in Miami have been diagnosed within 1 month of death, compared with only 12.0% of MSM (FDOH, unpublished data, 2002).

Much recent research based on probability samples suggested that at least 3%–6% of adults in the general population are homosexual.[1,5,27,36] Based on national survey data, Binson et al.[1] found that 5.3% of men aged 18 to 49 years reported same-gender sexual activity, and Fay et al.[5] estimated that 6.7% of adult men in the United States reached orgasm with another man after age 19 years. Black et al.[36] also used national survey data to find that 4.7% of men aged 18–59 years reported having sexual contact with another man at least once since age 18. One study, using random sampling, found that about 1% of adult men in rural areas, 4% in suburban areas, and 9% in large cities self-identify as gay.[27]

Among 96 MSAs, Holmberg[7] estimated that 0.4%–1.3% of the adult population were IDUs in the past year, which is consistent with our point estimate of 1.4%, particularly because our time period for IDU behavior was longer than 1 year. His IDU estimates for Miami were somewhat higher than ours (N=31,000 vs. 23,700). However, the prevalence of IDU behavior may have fallen since the time of Holmberg's estimates (1992) because of fatality and competing patterns of non-injection drug use.[37] A CDC survey[38] in 2001 found that 1.6% (95% confidence interval 1.0%–2.2%) of Miami high school students injected an illegal drug at least once during their lifetime. Kaplan and Soloshatz[39] estimated that between 1.5% and 2.1% of the population of New Haven, Connecticut, were IDUs. Using back-calculation and a spreadsheet analysis, Aldrich et al.[40] estimated there were 13,000 heterosexual IDUs in San Francisco.

A variety of sophisticated or alternative methods to estimate the numbers of MSM and IDUs already exist (e.g., capture–recapture,[11,14,15] ratio estimation method,[13,41] two-phase adaptive sampling,[2] components models,[7,42,43] combinations of multiple databases[44]), but these advanced models have not been extensively adopted by statewide or urban public health planning agencies, perhaps owing to their complexity or cost. Other analyses have also combined two or more different databases to estimate the numbers of MSM and IDUs.[7,11] However, our model is the first to provide a simplified procedure that produces not only point estimates, but also a method to navigate simultaneously the key parameters: prevalence of risk behaviors, HIV seroprevalence rates, and HIV prevalence.

In interpreting our findings, certain assumptions, limitations, and biases need to be considered. The time period we used for MSM or IDU activity is broadly inclusive. Our definition of MSM and IDUs (activity since 1977) thus captures infrequent or past experimenters, as well as those who are actively MSM or IDUs. Our method of extrapolation for estimating HIV prevalence by area and risk group may be regarded as somewhat crude.[45] However, to the extent that the logic of our model is sound, the reasonable, estimated numbers/proportions of IDUs and MSM that we arrived at a and the empirical HIV seroprevalence rates that we deployed b tend to validate the approximate values of our HIV prevalence estimates k (= ab) for the Miami MSA. To the extent that reported PLWHAs and those with NIRs redistributed are not representative of all living HIV-infected persons, bias may have occurred, although a strength of the model is that the HIV/AIDS reporting system captures data on homeless and institutionalized persons. We relied on HIV serosurvey data that were either not Miami specific (for MSM) or were derived from nonprobability samples (for IDUs), which could have introduced bias. The sensitivity analyses, however, suggest that overall our findings are reasonably robust to most such errors and biases.

Following pilot testing of our HIV prevalence-based model in five Florida MSAs, an evaluation was conducted; researchers, planners, analysts, consumers, and providers of HIV prevention and AIDS services documented the utility of the model.[46] Numerous other urban areas that have developed their own HIV prevalence estimates could readily adapt the model to produce risk population estimates. One option for areas that have not had HIV infection reporting in place for some time (and thus do not have PLWHA data) would be to extrapolate an HIV prevalence estimate from the national estimate based on their share of the national number of cases of PLWAs. This area-specific estimate could be further disaggregated by risk group based on each risk group's share of the area's HIV prevalence, with NIRs redistributed. An essential resource for these procedures is a CDC report, which includes PLWAs through 2001, by MSA (with population $\geq$500,000), state, and risk group, with NIRs redistributed.[19]

Two additional CDC reports on serosurveillance projects provide a valuable context for estimating HIV seroprevalence rates among MSM and IDUs in 12–15 cities.[47,48] The HIV seroprevalence rate b is the only parameter other than the HIV prevalence estimate k that is needed to calculate the estimated number of MSM or IDUs a ($= k/b$). There is a certain degree of between-city variability. Rates among MSM may tend to be overestimated because testing was conducted in sexually transmitted disease clinics.

There may be cities and MSAs that have independently conducted their own HIV serosurveys, which could provide the necessary framework for computing the estimated number of MSM and IDUs according to the HIV prevalence-based model. In the absence of such studies, current HIV counseling and testing data may provide a sense of minimum HIV seroprevalence rates in these populations. Holmberg's estimated risk group–specific HIV seroprevalence rates for 96 MSAs[7] could be used, noting that there has been a general downward trend in rates over time.[48] Finally, an in-progress draft of updated HIV seroprevalence rate estimates among IDUs for the same 96 MSAs is available from the second author of this article (S. R. F.). To adapt our model, a plausible starting point is more important than a highly accurate, single point estimate of HIV seroprevalence because the model enables visualization of a continuum of possibilities.

Those involved with resource allocation and planning of community-based primary and secondary HIV prevention, like Health Resources and Services Administration (Ryan White CARE Act) and CDC planning coalitions, often rely on preconceived and mainly anecdotal estimates concerning HIV prevalence and the size of urban MSM and IDU populations. The simplicity and affordability of our HIV prevalence-based model offers great utility to these planners by enabling them to test the plausibility of one estimate through assessment of the implications on other estimates. Such perspective could be invaluable to ground allocation and planning activities in reasonable estimates of key concepts like HIV prevalence, seroprevalence rates, and risk populations. Moreover, the model presented here is relevant and timely in view of recent CDC initiatives concerning behavioral surveillance[49] and other HIV prevention strategies.[50,51] Defining MSM and IDU populations at risk for non-HIV sexually transmitted diseases,[9,52–54] viral hepatitis,[54–61] bacterial endocarditis,[58] and malaria[58,62] would be yet another benefit of the HIV prevalence-based model.

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