Persistence and Change in Disparities in HIV Infection Among Injection Drug Users in New York City After Large-Scale Syringe Exchange Programs

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Objectives. We examined racial/ethnic disparities in HIV infection among injection drug users (IDUs) before and after implementation of large-scale syringe exchange programs in New York City.

Methods. Participants were recruited from IDUs entering the Beth Israel drug detoxification program in New York City. Participants (n=1203) recruited from 1990 through 1994, prior to large-scale syringe exchange programs (pre-exchange), were compared with 1109 participants who began injecting in 1995 or later and were interviewed in 1995 through 2008 (post-exchange).

Results. There were large differences in HIV prevalence among pre-exchange vs post-exchange participants (African Americans, 57% vs 15%; Hispanics, 53% vs 5%; Whites, 27% vs 3%). Pre- and post-exchange relative disparities of HIV prevalence were similar for African Americans vs Whites (adjusted odds ratio [AOR]=3.46, 95% confidence interval [CI]=2.41, 4.96 and AOR=4.02, 95% CI=1.67, 9.69, respectively) and Hispanics vs Whites (AOR=1.76, 95% CI=1.49, 2.09 and AOR=1.49, 95% CI=1.02, 2.17). Racial/ethnic group differences in risk behavior did not explain differences in HIV prevalence.

Conclusions. New interventions are needed to address continuing disparities in HIV infection among IDUs, but self-reported risk behaviors by themselves may not be adequate outcome measures for evaluating interventions to reduce racial/ethnic disparities in HIV infection. (*Am J Public Health.* 2009;99:S445–S451. doi: 10.2105/AJPH.2008.159327)

Although sharing needles and syringes among injection drug users (IDUs) clearly leads to transmission of HIV regardless of the race/ethnicity of the persons doing the sharing, there is a common pattern of higher HIV infection among racial/ethnic minority IDUs. Higher HIV prevalence has been observed among racial/ethnic minority IDUs in many studies in the United States.[1–11] These differences emerged very early in the HIV epidemic—in the late 1970s—among IDUs in the United States.[12,13]

The phenomenon of higher HIV prevalence among minority drug users, however, is decidedly not limited to the United States. Substantially higher HIV prevalence has been found among disadvantaged ethnic minority IDUs in many different areas of the world, including the First Nations in Canada,[14,15] Germans in the Netherlands,[16] Vietnamese in Australia,[17] Roma in Eastern Europe,[18] ethnic Russians in Estonia,[19] "hill tribes" (Zhuang, Tay, Nung) in Southeast Asia,[20,21] and Uighurs in southwest China.[22]

At present, very little is known about how to reduce disparities in HIV infection among IDUs.[23] One concern in health disparity research is that interventions that are effective at a population level may actually increase relative disparities. For example, colorectal cancer mortality has been declining in the United States, but the difference between White and African American rates has been increasing.[24]

Providing legal access to sterile injection equipment, through syringe exchange programs or pharmacy sales, is generally considered to be a highly effective method for reducing HIV transmission among IDUs.[25] Syringe exchange programs received state government authorization and funding in New York beginning in late 1992. This produced a large expansion in syringe exchange activities, from approximately 250 000 syringes exchanged per year prior to legalization to 2 500 000 syringes exchanged from 1995 through 1998. Implementation of syringe exchange programs in the mid-1990s in New York City was associated with a dramatic reduction in HIV incidence among IDUs—from 4 cases per 100 person-years at risk to 1 case per 100 person-years.[26] In that study, however, there were too few incident cases to examine potential racial/ethnic differences. We examine whether implementation of this large-scale, highly effective HIV prevention program for IDUs was associated with reduction in racial/ethnic disparities in HIV infection.

METHODS

The data reported here are a part of studies of drug users entering the Beth Israel Medical Center drug detoxification program in New York City. The methods have been previously described in detail,[27,28] so only a summary will be presented here. The Beth Israel detoxification program serves the city as a whole; approximately half of its patients live in Manhattan, one quarter in Brooklyn, one fifth in the Bronx, and the rest (5%) elsewhere. Patients enter the program on a voluntary basis.

Participant Recruitment

Both injection and noninjection drug users were eligible to participate in the study. For this report, however, we used data only from persons who reported injecting heroin, cocaine, or other drugs in the 6 months prior to the interview. Patients of each gender were admitted on an "open bed" basis, without bias as to which ward a patient was assigned. Research staff visited the general admission wards of the program in a preset order. Research staff then examined all intake records of a specific ward and constructed a list of patients admitted within the previous 3 days. All of the patients on the list for the specific ward were then asked to participate in the study. Among patients

approached by our interviewers, willingness to participate was over 95%.

After all of the patients admitted to a specific ward in the 3-day period had been asked to participate, and interviews had been conducted with those who agreed to participate, the interviewer moved to the next ward in the preset order. As there was no relationship between assigning patients to wards and the order in which the staff rotated through the wards, these procedures should have produced an unbiased sample. Data reported here were collected from 1990 to 2008.

Data Collection

A structured questionnaire covering demographics, drug use, sexual risk behavior, and use of HIV prevention services was administered by a trained interviewer. The 2 variables "gender" and "men having sex with men" (MSM) were used to identify women, male MSM, and male non-MSM IDUs. Racial/ethnic identification was obtained by asking, as an open-ended question, "What racial or ethnic group do you consider yourself?" Responses were then coded as White, Black or African American, Hispanic or Latino/Latina, Asian/Pacific Islander, Native American, mixed, other, and "refuse to answer." The wording of this question did not vary over the course of the study. For the analyses presented in this report, we included data for only the 3 major racial/ethnic groups (African Americans, Hispanics, and Whites). The questionnaire included items on date of birth and age at first illicit drug injection, making it possible to calculate the year of first injection.

After completion of the interview, HIV pretest counseling was conducted and a blood sample collected. Per New York State law, a separate informed consent was administered for the HIV testing. HIV assays were performed at the New York City Department of Health Laboratory with repeated enzyme-linked immunosorbent assay (ELISA) testing with Western blot confirmation; commercially available assays were used.

Analytic Comparisons

To explore possible differences in the patterns of HIV infection among racial/ethnic groups before and after large-scale implementation of syringe exchange programs, we compared participants interviewed in 1990 through 1994 with participants who began injecting in 1995 or later and were interviewed in 1995 through 2008. The rapid expansion of syringe exchange programs in New York City occurred between 1992 and 1998, and we selected January 1, 1995, as a midpoint for this expansion. Participants interviewed in 1990 through 1994 would have spent almost their entire drug injecting careers (up to the time of interview) in an environment with highly restricted access to sterile injection equipment; there was only very modest syringe exchange activity in the city, and state law prohibited the sale of needles and syringes without a prescription.

Participants who began injecting in 1995 or later, and were interviewed in 1995 through 2008, would have spent their injecting careers in an environment with relatively good and legal access to sterile syringes. (The state law requiring prescription for the sale of needles and syringes was repealed effective 2001.) For convenience, we refer to participants interviewed in 1990 through 1994, before inauguration of the large-scale syringe exchange program, as pre-exchange IDUs, and participants who began injecting in 1995 or later and were interviewed in 1995 through 2008 as post-exchange IDUs.

There were some "underground" syringe exchanges in New York prior to legal authorization and funding; in addition, the rapid expansion of syringe exchange programs occurred over several years, it did not provide equal syringe exchange coverage for all areas of the city, and a small proportion (approximately 5%) of our participants lived outside New York City. The January 1, 1995, cutoff date for pre-exchange and post-exchange participants therefore does not accurately classify all individual participants as having either no access or full access to syringe exchange services. Nevertheless, we believe that use of this date does adequately capture the dramatic change in the risk environment that occurred as a result of the large-scale expansion of syringe exchange programs in New York City. We also repeated the data analyses using January 1, 1994, and January 1, 1996, as cutoff points; the results for these analyses were very similar to the results we present in this report, with no differences in statistical significance or conclusions. (Data are available from the D.C.D.J. upon request.)

Racial/ethnic disparities were assessed through comparisons of ethnic minority group members (African Americans and Hispanics) with ethnic majority group members (Whites). Simple differences in prevalence and odds ratios were used to quantify the disparities.

RESULTS

Table 1 presents demographic characteristics of the 1203 participants recruited from 1990 to 1994 (pre-exchange IDUs) and 1109 participants who began injecting in 1995 or later and were recruited in 1995 through 2008 (post-exchange IDUs). The pre-exchange participants were more likely to be male, African American, and older (all $P<.001$, by the χ^2 test) and had been injecting for longer times ($P<.001$, by the t test). (These demographic changes reflect changes in IDUs entering the detoxification program. Data available from the D.C.D.J. upon request.)

Table 2 shows HIV prevalence by race/ethnicity and by gender and MSM behavior (i.e., whether or not male participants had sex with other men) among the pre- and post-exchange participants. There were large changes in HIV prevalence between the pre- and post-exchange participants: prevalence dropped by 24% among Whites, 42% among African Americans, and 48% among Hispanics, with only modest variation by gender and MSM behavior subgroups. The percentage differences (pre- minus post-exchange prevalence divided by post-exchange prevalence) were generally similar across the racial/ethnic, gender, and MSM behavior subgroups, although the very large percentage differences for White and for Hispanic non-MSM males should be noted (98% reduction and 92% reduction, respectively).

The odds ratios (ORs) for the comparisons of pre- vs post-exchange prevalence were generally similar across the racial/ethnic, gender, and MSM behavior subgroups. The adjusted ORs were controlled for age, gender, and MSM behavior in the comparisons of racial/ethnic groups as a whole, and for age within the gender and MSM subgroups. (Because age and years injecting were highly correlated, it was not possible to control for both of these in the

TABLE 1—Demographic Characteristics of Injection Drug Users (IDUs) Before (Pre-Exchange) and After (Post-Exchange) Implementation of Large-Scale Syringe Exchange Programs: New York City, 1990–2008

	Pre-Exchange IDUs (n = 1203)	Post-Exchange IDUs (n = 1109)
Male gender,[a] no. (%)	982 (82)	839 (76)
Race/ethnicity,[a] no. (%)		
White	226 (19)	333 (30)
African American	396 (33)	137 (12)
Hispanic	581 (48)	639 (58)
Age,[a] no. (%)		
< 40 y	800 (66)	949 (86)
≥ 40 y	403 (34)	160 (14)
Injection years, mean (IQR)	18 (10-14)	4 (1-5)

Note. IQR = interquartile range. Pre-exchange participants were interviewed in 1990 through 1994; post-exchange participants began injecting in 1995 or later and were interviewed in 1995 through 2008.
[a]Significant difference by χ^2 test ($P < .001$). The comparison is for each demographic characteristic across pre-exchange and post-exchange periods.

same models, and age was more consistently related to HIV status across the pre- and post-exchange periods.) Adjustment led to only very minor changes in the ORs. There was a relatively narrow range (0.08–0.13) in the adjusted ORs for the 3 racial/ethnic groups and overlaps in the 95% confidence intervals (CIs) for these adjusted ORs, suggesting that—at least as measured by odds ratios—the pre- vs post-exchange differences were generally similar across the 3 racial/ethnic groups.

Table 3 shows comparisons of HIV prevalence by race/ethnicity, and by gender and MSM behavior within racial/ethnic groups, for the pre- and post-exchange IDUs. White IDUs were used as the reference group, and there was a strong pattern of African American IDUs having the highest ORs and Hispanics having intermediate ORs. This pattern was consistent for both pre- and post-exchange participants and within gender and MSM subgroups. The unadjusted and adjusted ORs were again quite similar across pre- and post-exchange participants.

Two differences in the patterns of HIV prevalence in the pre- and post-exchange participants should be noted. First, African Americans and Hispanics had a very similar HIV prevalence among the pre-exchange participants (57% and 53%, respectively) but had a quite different HIV prevalence among the post-exchange participants (15% and 5%, respectively). The difference among the post-exchange participants was highly significant (OR=3.04; 95% CI=1.69, 5.46; $P<.001$; adjusted OR [AOR]=2.29; 95% CI=1.24, 4.24, $P<.001$).

Second, there were more pronounced differences in HIV prevalence by gender and MSM behavior among the post-exchange participants. Table 4 presents HIV prevalence by gender and MSM behavior, with comparisons of MSM IDUs and female IDUs with non-MSM male IDUs as the reference group. The AORs

TABLE 2—HIV Prevalence Among Injection Drug Users (IDUs) Before (Pre-Exchange) and After (Post-Exchange) Implementation of Large-Scale Syringe Exchange Programs: New York City, 1990–2008

	HIV Prevalence Among Pre-Exchange IDUs, No./Total (%)	HIV Prevalence Among Post-Exchange IDUs, No./Total (%)	Prevalence Difference, % (as % of Pre-Exchange Prevalence)[a]	Post-Exchange vs Pre-Exchange IDUs, OR (95% CI)	Post-Exchange vs Pre-Exchange IDUs, AOR (95% CI)[b]
Total	595/1203 (49)	64/1109 (6)	43 (88)	0.06 (0.05, 0.08)	0.08 (0.06, 0.10)
Whites	62/226 (27)	9/333 (3)	24 (89)	0.07 (0.04, 0.15)	0.09 (0.35, 0.15)
Male MSM IDUs	4/15 (27)	1/10 (10)	17 (63)	0.31 (0.03, 3.24)	0.51 (0.04, 6.48)
Female IDUs	17/48 (35)	7/103 (7)	28 (81)	0.13 (0.05, 0.35)	0.14 (0.05, 0.37)
Non-MSM male IDUs	41/163 (25)	1/220 (0.5)	25 (98)	0.01 (0.002, 0.10)	0.02 (0.002, 0.11)
African Americans	225/396 (57)	20/137 (15)	42 (74)	0.13 (0.08, 0.22)	0.12 (0.07, 0.21)
MSM IDUs	17/27 (63)	6/15 (40)	23 (37)	0.39 (0.11, 1.43)	0.37 (0.10, 1.42)
Female IDUs	39/69 (57)	7/42 (17)	40 (70)	0.15 (0.06, 0.39)	0.15 (0.06, 0.40)
Non-MSM male IDUs	169/300 (56)	7/80 (9)	47 (84)	0.07 (0.03, 0.17)	0.08 (0.03, 0.17)
Hispanic	308/581 (53)	35/639 (5)	48 (91)	0.05 (0.04, 0.08)	0.05 (0.04, 0.08)
MSM IDUs	23/32 (72)	3/30 (10)	62 (86)	0.04 (0.01, 0.18)	0.05 (0.01, 0.20)
Female IDUs	54/104 (52)	11/125 (9)	43 (83)	0.09 (0.04, 0.18)	0.08 (0.04, 0.18)
Non-MSM male IDUs	231/445 (52)	21/484 (4)	48 (92)	0.04 (0.03, 0.07)	0.05 (0.03, 0.08)

Note. MSM = men who have sex with men; OR = odds ratio; AOR = adjusted odds ratio; CI = confidence interval.
[a]The first number represents the absolute percentage difference in HIV prevalence between post-exchange IDUs and pre-exchange IDUs. The second number expresses that difference as a percentage of HIV prevalence among pre-exchange IDUs.
[b]Adjusted for gender, MSM behavior (i.e., whether or not male participants had sex with other men), and age within race/ethnic groups and for age within gender and MSM behavior subgroups.

TABLE 3—HIV Prevalence Among Injection Drug Users (IDUs) Before (Pre-Exchange) and After (Post-Exchange) Implementation of Large-Scale Syringe Exchange Programs, by Subgroup: New York City, 1990–2008

	HIV Prevalence Among Pre-Exchange IDUs, No./Total (%)	Pre-Exchange IDUs,[a] OR (95% CI)	Pre-Exchange IDUs,[b] AOR (95% CI)	HIV Prevalence Among Post-Exchange IDUs, No./Total (%)	Post-Exchange IDUs,[a] OR (95% CI)	Post-Exchange IDUs,[b] AOR (95% CI)
Total sample	595/1203 (49)			64/1109 (6)		
African American	225/396 (57)	3.48 (2.44, 4.96)	3.46 (2.41, 4.96)	20/137 (15)	6.15 (2.72, 13.90)	4.02 (1.67, 9.69)
Hispanics	308/581 (53)	2.98 (2.14, 4.17)	1.76 (1.49, 2.09)	35/639 (5)	2.09 (0.99, 4.39)	1.49 (1.02, 2.17)
Whites (Ref)	62/226 (27)	1.00	1.00	9/333 (3)	1.00	1.00
MSM IDUs						
African American	17/27 (63)	4.68 (1.17, 18.69)	4.78 (1.18, 19.35)	6/15 (40)	6.00 (0.60, 60.44)	6.91 (0.61, 78.01)
Hispanic	23/32 (72)	2.65 (1.33, 5.28)	2.87 (1.36, 6.05)	3/30 (10)	1.00 (0.30, 3.30)	n/a
White (Ref)	4/15 (27)	1.00	1.00	1/10 (10)	1.00	1.00
Female IDUs						
African American	39/69 (57)	2.37 (1.11, 5.07)	2.70 (1.23, 5.96)	7/42 (17)	2.74 (0.90, 8.38)	1.32 (0.36, 4.87)
Hispanic	54/104 (52)	1.40 (0.99, 2.00)	1.42 (0.99, 2.02)	11/125 (9)	1.15 (0.70, 1.88)	1.10 (0.66, 1.82)
White (Ref)	17/48 (35)	1.00	1.00	7/103 (7)	1.00	1.00
Non-MSM male IDUs						
African American	169/300 (56)	3.84 (2.52, 5.85)	3.63 (2.36, 5.59)	7/80 (9)	21.00 (2.54, 173.55)	14.27 (1.55, 131.60)
Hispanic	231/445 (52)	1.79 (1.47, 2.19)	1.80 (1.47, 2.20)	21/484 (4)	3.15 (1.15, 8.62)	3.16 (1.16, 8.65)
White (Ref)	41/163 (25)	1.00	1.00	1/220 (1)	1.00	1.00

Note. MSM = men who have sex with men; OR = odds ratio; AOR = adjusted odds ratio; CI = confidence interval.
[a]ORs are for HIV prevalence for each racial/ethnic group relative to the corresponding White group.
[b]AORs are adjusted for age.

were controlled for race/ethnicity and age. To test whether the associations of HIV prevalence with gender and MSM behavior varied by pre-exchange vs post-exchange period, we used multivariate logistic models that included the interaction of the independent variables (i.e., female gender or MSM and pre- vs post-exchange period) and adjusted for age and race/ethnicity. The interactions with period were significant both for MSM vs non-MSM males and for females vs non-MSM males (Wald $\chi^2 = 7.90$ and 7.70, respectively; both $P < .01$).

We assessed whether the differences in HIV prevalence among racial/ethnic groups in the pre- and post-exchange periods might be explained by differences in risk behaviors among racial/ethnic groups in the 2 periods. Table 5 presents rates of self-reported risk behaviors (for the 6 months prior to the interview) by race/ethnicity for the pre- and post-exchange participants. In a comparison of the pre- vs post-exchange participants, for all racial/ethnic groups, there were significantly

TABLE 4—HIV Prevalence Among Injection Drug Users (IDUs) Before (Pre-Exchange) and After (Post-Exchange) Implementation of Large-Scale Syringe Exchange Programs, by Gender and MSM Behavior: New York City, 1990–2008

	HIV Prevalence Among Pre-Exchange IDUs, No./Total (%)	Pre-Exchange IDUs,[a] OR (95% CI)	Pre-Exchange IDUs,[b] AOR (95% CI)	HIV Prevalence Among Post-Exchange IDUs, No./Total (%)	Post-Exchange IDUs, OR (95% CI)	Post-Exchange IDUs,[b] AOR (95%
MSM IDUs	44/74 (59)	1.55 (0.96, 2.52)	1.73 (1.06, 2.83)	10/55 (18)	5.79 (2.65, 12.61)	6.90 (3.11, 15.32)
Female IDUs	110/221 (50)	1.05 (0.78, 1.41)	1.18 (0.87, 1.60)	25/270 (9)	2.66 (1.53, 4.62)	2.71 (1.54, 4.76)
Non-MSM male IDUs[c] (Ref)	441/908 (49)	1.00	1.00	29/784 (4)	1.00	1.00

Note. MSM = men who have sex with men; OR = odds ratio; AOR = adjusted odds ratio; CI = confidence interval.
[a]ORs are for HIV prevalence for each gender or MSM behavior group relative to non-MSM male IDUs.
[b]AORs are adjusted for age and race/ethnicity.
[c]Whether or not male participants had sex with other men.

TABLE 5—Self-Reported Sexual and Injection Risk Behaviors Among Injection Drug Users (IDUs) Before (Pre-Exchange) and After (Post-Exchange) Implementation of Large-Scale Syringe Exchange Programs: New York City, 1990–2008

	Pre-Exchange IDUs, No. (%)	Post-Exchange IDUs No. (%)	Pre-Exchange vs Post-Exchange, OR (95%CI)
Whites			
Unprotected sex with primary partner	85 (38)	168 (50)[a]	1.69 (1.20, 2.38)
Unprotected sex with casual partner	37 (16)	54 (16)	0.99 (0.68, 1.57)
Unprotected sex with commercial partner	3 (1)	18 (5)	4.25 (1.24, 14.59)
Receptive sharing of used needles and syringes	100 (44)	132 (40)[a]	0.83 (0.59, 1.17)
Distributive sharing of used needles and syringes	113 (50)	130 (39)[a]	0.64 (0.46, 0.90)
African Americans			
Unprotected sex with primary partner	145 (37)	53 (39)[a]	1.09 (0.73, 1.63)
Unprotected sex with casual partner	72 (18)	20 (15)	0.77 (0.45, 1.32)
Unprotected sex with commercial partner	14 (4)	9 (7)	1.92 (0.81, 4.54)
Receptive sharing of used needles and syringes	137 (35)	31 (23)[a]	0.55 (0.35, 0.87)
Distributive sharing of used needles and syringes	179 (45)	29 (21)[a]	0.33 (0.21, 0.51)
Hispanics			
Unprotected sex with primary partner	214 (37)	324 (51)[a]	1.77 (1.14, 2.22)
Unprotected sex with casual partner	77 (13)	87 (14)	1.03 (0.74, 1.44)
Unprotected sex with commercial partner	9 (2)	30 (5)	3.13 (1.47, 6.65)
Receptive sharing of used needles and syringes	220 (38)	223 (35)[a]	0.88 (0.70, 1.11)
Distributive sharing of used needles and syringes	277 (48)	194 (30)[a]	0.48 (0.38, 0.60)

Note. OR = odds ratio; CI = confidence interval.
[a]Significant difference by χ^2 test ($P < .05$) for comparisons by race/ethnicity among the post-exchange participants.

lower rates of injection risk behavior among post-exchange participants and essentially no differences in sexual risk behaviors.

Among the pre-exchange participants, the reported rates of sexual and injecting risk behavior were quite similar across racial/ethnic groups, and the χ^2 test showed no significant difference by race/ethnicity in any of the risk behaviors. Among the post-exchange participants, the χ^2 test showed statistically significant differences by race/ethnicity for unprotected sex with a primary partner, receptive syringe sharing (injecting with a needle or syringe that had been used by someone else), and distributive syringe sharing (passing on a used needle or syringe to someone else; all $P < .05$). African American participants reported the lowest rates of these risk behaviors among the post-exchange participants. ORs for comparisons of post-exchange African Americans to post-exchange Whites were 0.62 (95% CI=0.41, 0.93) for unprotected sex with a primary partner, 0.44 (95% CI=0.28, 0.70) for receptive syringe sharing, and 0.42 (95% CI=0.26, 0.66) for distributive syringe sharing. Thus, in neither the pre- nor the post-exchange periods could the higher rates of HIV prevalence among African American or Hispanic participants be explained by higher rates of individual-level risk behaviors.

DISCUSSION

Large racial/ethnic disparities in HIV infection among IDUs have been frequently observed in the United States and in many other countries. To our knowledge, our report is the first to examine whether community-level implementation of syringe exchange is temporally associated with changes in racial/ethnic disparities among IDUs. The comparison of participants interviewed in 1990 through 1994 to participants who began injecting in 1995 or later (and were interviewed in 1995 through 2008) provides a strong contrast with respect to legal access to drug injection equipment. Participants interviewed in 1990 through 1994 would have spent their injecting careers in an environment with highly restricted access to sterile injection equipment, whereas participants who began injecting in 1995 or later would have spent their injection careers in an environment with relatively good and legal access to sterile injection equipment. If the expansion of syringe exchange programs was associated with changes in racial/ethnic disparities in HIV infection among IDUs in New York, this comparison would be the most likely to detect such changes.

The large-scale expansion of syringe exchange programs was associated with much lower HIV prevalence among the post-exchange participants than among the pre-exchange participants, after we controlled for age, gender, and MSM behavior (AOR=0.08; 95% CI=0.06, 0.10), which is consistent with what was found in an earlier study.[26] The simple differences in HIV prevalence did show a reduction in racial/ethnic disparities; for example, the difference in HIV prevalence between African American and White IDUs was 30% among the pre-exchange participants and 12% among the post-exchange participants. The ORs, however, showed that for each racial/ethnic group, the change in HIV prevalence from the pre-exchange to the post-exchange period was approximately the same. These ORs thus suggest relatively similar effects of the syringe exchange expansion on the 3 major racial/ethnic groups, without notably increasing or decreasing the pre-exchange minority–majority group disparities.

There were very dramatic pre- vs post-exchange differences in HIV prevalence for the Hispanic non-MSM IDUs (52% vs 4%) and for White non-MSM IDUs (25% vs 0.5%). These differences suggest that HIV infection could be eliminated in these subgroups, but further research is needed to determine both whether this is possible and how these dramatic differences in HIV prevalence might be replicated among IDUS who are African American, female, or MSM.

The post-exchange data show increases in disparities by gender and MSM behavior. Studies in Baltimore, Maryland,[29] and San Francisco, California,[30] found that female-to-male and MSM sexual transmission of HIV among IDUs was an increasingly important

factor after implementation of syringe exchange in those cities. Among our post-exchange participants, the increased ORs for MSM compared with non-MSM males, and for females compared with non-MSM males would also be consistent with the fact that sexual transmission became a more important factor in the spread of HIV after the large-scale implementation of syringe exchange in New York.

Herpes simplex virus 2 (HSV-2) increases susceptibility to HIV by a factor of 2 to 3.[31,32] In a 2005 to 2007 New York study in which we conducted HSV-2 testing among IDUs, HSV-2 prevalence was 67% among African Americans, 47% among Hispanics, 35% among Whites, 84% among females, and 41% among males.[33] Among the post-exchange IDUs in that study, there was a very strong association between HSV-2 seroprevalence and HIV seroprevalence (OR=15.68; 95% CI=1.94, 126.68). Thus, genital herpes-facilitated sexual transmission of HIV may be a critical factor in the racial/ethnic and gender disparities in HIV infection among the post-exchange IDUs.

African American IDUs had the highest HIV prevalence among both the pre- and post-exchange participants, but they did not have higher rates of injecting or sexual risk behavior in either period. Indeed, they had lower rates of risk behavior among the post-exchange participants. This pattern of higher HIV prevalence and equal or lower rates of risk behavior among African Americans has been noted in other studies.[6,34–37] There are several factors that might lead to higher HIV prevalence among African American drug users, including social structure and social network factors and the presence of sexually transmitted infections (such as HSV-2) that facilitate HIV acquisition (see discussions in Aral et al.[34] and Barrow et al.[36]). How these factors might generate disparities in HIV infection among post-exchange IDUs in New York remains to be determined. Among the post-exchange participants, the increase in the disparities between African American and Hispanic IDUs and between female and non-MSM IDUs suggests that the factors generating racial/ethnic majority–racial/ethnic minority disparities may change over time.

One factor that should be considered in the analysis of risk behavior and prevalent HIV infection is the possibility of reverse causation. In an environment with readily available HIV testing, HIV-seropositive individuals may know their serostatus and reduce risk behavior to avoid transmitting the virus to others.[38] Thus, rather than high rates of risk behavior causing high rates of HIV infection, we may observe high rates of HIV infection causing lower rates of risk behavior.

Several limitations of this study should be noted. The data were collected through serial cross-sectional surveys, so we do not have measures of risk behavior just prior to HIV infection for the participants. We were also not able to assess how deaths from AIDS or other causes or treatment of HIV infection might have affected the disparities in HIV infection among either the pre- or post-exchange participants. The study is also from a single site, although data from this site have historically been consistent with those of other IDU samples in New York.[39–41]

New York City has experienced the world's largest HIV epidemic among IDUs; that racial/ethnic disparities persisted in New York after large-scale implementation of syringe exchange programs is of itself of epidemiological importance. Additional research is needed to determine whether racial/ethnic disparities persist after implementation of effective HIV prevention programs in other locations.

The post-exchange IDUs in this report were, by definition, persons who began injecting after January 1, 1995, and thus were relatively new injectors who had been injecting no more than 13 years. They may also be considered the likely future of the HIV epidemic among IDUs in New York City in that they will eventually replace the pre-exchange IDUs. We do not have sufficient numbers of post-exchange IDUs to monitor trends over time in HIV infection by race/ethnicity, gender, and MSM behavior, but we consider this to be an important priority for future research.

The persistence of the racial/ethnic disparities clearly indicates a need for new HIV prevention programming for IDUs in New York (as well as continuation of current interventions such as syringe exchange). The differences in HIV prevalence by gender and MSM behavior (Table 4), as well as the patterns of HSV-2 infection among IDUs in New York,[33] suggest that sexual transmission is an increasingly important factor in the spread of HIV, one that any new interventions should focus on.

Our data on self-reported risk behaviors, however, suggest difficulties in evaluating these new interventions. Racial/ethnic group differences in risk behavior did not explain the ethnic group–level differences in HIV prevalence in that the group with the highest prevalence (African Americans) also had the highest rates of risk behavior. In fact, African Americans had the lowest rates of risk behavior among the post-exchange IDUs. Thus, if a new intervention reduced self-reported injecting and sexual risk behavior still further among African American post-exchange IDUs, we would not have confidence that the disparities in HIV infection between African Americans and the other racial/ethnic groups were actually being reduced. Evaluating new interventions through measuring actual HIV incidence, however, is too difficult and costly to be a practical method for evaluating a large number of new HIV prevention interventions. Fundamental advances in understanding racial/ethnic disparities in HIV infection may be needed for both the development and evaluation of new interventions.

Finally, the persistence of racial/ethnic disparities in HIV infection after large-scale implementation of syringe exchange programs should not be used as an argument against implementation of syringe exchange or other evidence-based interventions to reduce HIV transmission among IDUs. Although new interventions are clearly needed to reduce continuing disparities in HIV infection, implementation of large-scale syringe exchange programs was associated with dramatically lower HIV infection in all major racial/ethnic groups of IDUs in New York. ■

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Contributors

D.C. Des Jarlais conceptualized the study and supervised all aspects of its implementation. K. Arasteh assisted with

the study and completed the analyses. H. Hagan, C. McKnight, D.C. Perlman, and S.R. Friedman assisted with the study and writing. All authors helped to conceptualize ideas, interpret findings, and review drafts of the article.

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References

1. Allen D, Onorato I, Green T. HIV infection in intravenous drug users entering drug treatment, United States, 1988 to 1989. The Field Services Branch of the Centers for Disease Control. *Am J Public Health.* 1992; 82(4):541–546.

2. Altice F, Mostashari F, Selwyn P, et al. Predictors of HIV infection among newly sentenced male prisoners. *J Acquir Immune Defic Syndr.* 1998;18(5):444–453.

3. Caussy D, Weiss SH, Blattner WA, et al. Exposure factors for HIV-1 infection among heterosexual drug abusers in New Jersey treatment programs. *AIDS Res Hum Retroviruses.* 1990;6(12):1459–1467.

4. Chaisson R, Bacchetti P, Osmond D, Brodie B, Sande M, Moss A. Cocaine use and HIV infection in intravenous drug users in San Francisco. *JAMA.* 1989;261: 561–565.

5. D'Aquila R, Peterson L, Williams A, William A. Race/ethnicity as a risk factor for HIV-1 infection among Connecticut intravenous drug users. *J Acquir Immune Defic Syndr.* 1989;2:503–513.

6. Friedman SR, Chapman TF, Perlis TE, et al. Similarities and differences by race/ethnicity in changes of HIV seroprevalence and related behaviors among drug injectors in New York City, 1991–1996. *J Acquir Immune Defic Syndr.* 1999;22(1):83–91.

7. Koblin B, McCusker J, Lewis B, Sullivan J. Racial/ethnic differences in HIV-1 seroprevalence and risky behaviors among intravenous drug users in a multisite study. *Am J Epidemiol.* 1990;132(5):837–846.

8. Novick DM, Trigg HL, Des Jarlais DC, Friedman SR, Vlahov D, Kreek MJ. Cocaine injection and ethnicity in parenteral drug users during the early years of the human immunodeficiency virus (HIV) epidemic in New York City. *J Med Virol.* 1989;29(3):181–185.

9. Schoenbaum EE, Hartel D, Selwyn PA, et al. Risk factors for human immunodeficiency virus infection in intravenous drug users. *N Engl J Med.* 1989;321(13): 874–879.

10. Watters J, Estilo M, Kral A, Lorvick J. HIV infection among female injection-drug users recruited in community settings. *Sex Transm Dis.* 1994;21(6):321–328.

11. Williams ML. HIV seroprevalence among male IVDUs in Houston, Texas. *Am J Public Health.* 1990; 80(12):1507–1509.

12. Friedman SR, Sotheran JL, Abdul-Quader A, et al. The AIDS epidemic among blacks and Hispanics. *Milbank Q.* 1987;65:455–499.

13. Friedman SR, Quimby E, Sufian M, Abdul-Quader A, Des Jarlais DC. Racial aspects of the AIDS epidemic. *Calif Sociol.* 1988;(Winter–Summer):55–68.

14. Craib K, Spittal P, Wood E, et al. Risk factors for elevated HIV incidence among Aboriginal injection drug users in Vancouver. *CMAJ.* 2003;168(1):19–24.

15. Hogg R, Strathdee S, Kerr T, Wood E, Remis R. HIV prevalence among Aboriginal British Columbians. *Harm Reduct J.* 2005;2:26–31.

16. van Ameijden E, Coutinho RA. Large decline in injecting drug use in Amsterdam, 1986–1998: explanatory mechanisms and determinants of injecting transitions. *J Epidemiol Community Health.* 2001;55(5):356–363.

17. Ryan C, Elliott J, Middleton T, et al. The molecular epidemiology of HIV type 1 among Vietnamese Australian injecting drug users in Melbourne, Australia. *AIDS Res Hum Retroviruses.* 2004;20(12):1364–1367.

18. Kabakchieva E, Vassileva S, Kelly J, et al. HIV risk behavior patterns, predictors, and sexually transmitted disease prevalence in the social networks of young Roma (Gypsy) men in Sofia, Bulgaria. *Sex Transm Dis.* 2006; 33(8):485–490.

19. Uuskula A, McNutt L, Dehovitz J, Fischer K, Heimer R. High prevalence of blood-borne virus infections and high-risk behaviour among injecting drug users in Tallinn, Estonia. *Int J STD AIDS.* 2007;18(1):41–46.

20. Beyrer C, Celentano D, Suprasert S, et al. Widely varying HIV prevalence and risk behaviours among the ethnic minority peoples of northern Thailand. *AIDS Care.* 1997;9(4):427–439.

21. Omori K. Knowledge about AIDS and risk behaviors among hill tribes in northern Thailand. *Nippon Koshu Eisei Zasshi.* 1999;46(6):466–475.

22. Zhang Y, Shan H, Trizzino J, et al. Demographic characteristics and risk behavior associated with HIV positive injecting drug users in Xinjiang, China. *J Infect.* 2007;54(3):285–290.

23. Des Jarlais D, Hagan H, Arasteh K, et al. Higher HIV prevalence among ethnic minority IDUs: North America, Asia, Europe. Paper presented at: XVI International AIDS Conference; August 13–18, 2006; Toronto, Ontario.

24. *Colorectal Cancer Facts & Figures 2008–2010.* Atlanta, GA: American Cancer Society; 2008.

25. Committee on the Prevention of HIV Infection Among Injecting Drug Users in High Risk Countries. *Preventing HIV Infection Among Injecting Drug Users in High Risk Countries: An Assessment of the Evidence.* Washington, DC: Institute of Medicine; 2006.

26. Des Jarlais DC, Perlis T, Arasteh K, et al. HIV incidence among injection drug users in New York City, 1990 to 2002: use of serologic test algorithm to assess expansion of HIV prevention services. *Am J Public Health.* 2005;95(8):1439–1444.

27. Des Jarlais DC, Friedman SR, Novick DM, et al. HIV-1 infection among intravenous drug users in Manhattan, New York City, from 1977 through 1987. *JAMA.* 1989;261:1008–1012.

28. Maslow CB, Friedman SR, Perlis TE, Rockwell R, Des Jarlais DC. Changes in HIV seroprevalence and related behaviors among male injection drug users who do and do not have sex with men: New York City, 1990–1999. *Am J Public Health.* 2002;92(3):382–384.

29. Strathdee SA, Sherman SG. The role of sexual transmission of HIV infection among injection and non-injection drug users. *J Urban Health.* 2003;80(4): iii7–iii14.

30. Kral AH, Bluthenthal RN, Lorvick J, Gee L, Bacchetti P, Edlin BR. Sexual transmission of HIV-1 among injection drug users in San Francisco, USA: risk-factor analysis. *Lancet.* 2001;357(9266):1397–1401.

31. Freeman E, Weiss H, Glynn J, Cross P, Whitworth J, Hayes R. Herpes simplex virus 2 infection increases HIV acquisition in men and women: systematic review and meta-analysis of longitudinal studies. *AIDS.* 2006; 20(1):73–83.

32. Wald A, Link K. Risk of human immunodeficiency virus infection in herpes simplex virus type 2-seropositive persons: a meta-analysis. *J Infect Dis.* 2002;185:45–52.

33. Des Jarlais D, Arasteh K, McKnight C, Hagan H, Perlman D, Friedman S. Using hepatitis C virus and herpes simplex virus-2 to track HIV among injecting drug users in New York City. *Drug Alcohol Depend.* 2009; 101(1–2):88–91.

34. Aral S, Adimora A, Fenton K. Understanding and responding to disparities in HIV and other sexually transmitted infections in African Americans. *Lancet.* 2008;372(9635):337–340.

35. Battjes RJ, Pickens RW, Haverkos HW, Sloboda Z. HIV risk factors among injecting drug users in five US cities. *AIDS.* 1994;8(5):681–687.

36. Barrow R, Berkel C, Brooks L, Groseclose S, Johnson D, Valentine J. Traditional sexually transmitted disease prevention and control strategies: tailoring for African American communities. *Sex Transm Dis.* 2008;35(12): S30–S39.

37. Bluthenthal R, Watters J. Multimethod research from targeted sampling to HIV risk environments. *NIDA Res Monogr.* 1995;157:212–230.

38. Des Jarlais DC, Perlis T, Arasteh K, et al. "Informed altruism" and "partner restriction" in the reduction of HIV infection in injecting drug users entering detoxification treatment in New York City, 1990–2001. *J Acquir Immune Defic Syndr.* 2004;35(2):158–166.

39. Des Jarlais DC, Marmor M, Friedmann P, et al. HIV incidence among injecting drug users in New York City, 1992–1997: evidence for a declining epidemic. *Am J Public Health.* 2000;90(3):352–359.

40. Des Jarlais DC, Perlis T, Friedman SR, et al. Behavioral risk reduction in a declining HIV epidemic: injection drug users in New York City, 1990–1997. *Am J Public Health.* 2000;90(7):1112–1116.

41. Des Jarlais DC, Perlis T, Friedman SR, et al. Declining seroprevalence in a very large HIV epidemic: injecting drug users in New York City, 1991 to 1996. *Am J Public Health.* 1998;88(12):1801–1806.