The Potential for Bridging of HIV Transmission in the Russian Federation: Sex Risk Behaviors and HIV Prevalence among Drug Users (DUs) and their Non-DU Sex Partners

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ABSTRACT *The HIV epidemic that began in Russia in the mid-1990s has been concentrated mostly among drug users (DUs). Recent evidence of increasing HIV cases among non-DUs attributed to sexual behavior raises potential concern about a more generalized epidemic. The purpose of this analysis is to examine the potential for HIV transmission from DUs to their non-DU sex partners. Analyses are conducted using data collected during 2005–2008 in St. Petersburg, Russia. A total of 631 DUs were recruited into the sample with an HIV prevalence of 45%. A majority (84%) of DUs reported being sexually active in the past 6 months, and the DU status of their sex partners was reported as follows: 54% DU, 40% non-DU, and 6% unknown DU status. In 41% of partnerships with an HIV-negative or unknown status partner not known to be DU (potential bridging partnerships), the last reported intercourse was unprotected. Female DUs with potential bridging partnerships were more likely than male DUs to be younger and report homelessness and to have multiple or new sex partners. Many non-DU sex partners of DUs enrolled in the study reported new sex partners in the past 6 months (66%), unprotected intercourse at last sex (60%), and multiple sex partners in the past 6 months (48%). HIV prevalence in this group was 15% (eight out of 53). The high prevalence of HIV among DUs, their sexual contact with non-DUs, and the high-risk sexual behaviors of this potential bridging population together indicate the real potential for an increasingly generalized epidemic. The degree to which there will be further transmission from non-DU sex partners of DUs who exhibit high levels of sex risk behaviors to other non-DU sex partners deserves further study.*

KEYWORDS *HIV, Russia, Drug users, Sex behavior*

INTRODUCTION

Russia has experienced rapid growth in its HIV epidemic since the mid-1990s. According to the Russian Federal AIDS Center, the cumulative number of officially registered people with HIV/AIDS increased from $\approx 2,000$ to $>438,000$ between 1996 and 2008, making the epidemic in Russia one of the fastest-growing epidemics observed anywhere in the world.^{1,2} An estimated 560,000–1,600,000 individuals

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are currently living with HIV/AIDS, and the adult prevalence is estimated to be approximately 1%.² The epidemic has been concentrated largely among drug users (DUs), a vast majority of whom inject drugs.³ Prevalence estimates among injection DUs in large cities range from 14% in Moscow to 50% or greater in St. Petersburg and Togliatti City.⁴⁻⁶

Bridging refers to HIV transmission from high-risk core groups to noncore group members through unprotected sex between and across groups. Core groups include individuals with high potential for disease transmission due to high prevalence of infection and frequency of transmission-related behaviors. In the context of the Russian Federation, DUs are considered an important core group. In this setting where HIV may spread from core DUs to non-DUs through sexual activity, the non-DU sex partners of DUs constitute members of a "bridge population" that may serve as a pathway for transmission beyond the core group into the general population. Therefore, a generalized epidemic may occur when members of this potential bridge population, the non-DUs who have sex with DUs, also have other sex partners who are non-DUs. Recent evidence from Russia suggesting spread beyond the core group of DUs is indicated by increases from 4.7% in 2001 to 13.4% in 2002 and to 19.4% in 2003 in the percentage of cases due to sexual transmission.⁷ This trend has been observed in both urban provinces such as St. Petersburg and in more rural provinces such as Orel.^{8,9}

The high prevalence of HIV among DUs in Russia, in combination with a growing HIV prevalence among non-DUs and a high rate of sex with non-DU partners and suboptimal condom use, suggests that transmission beyond the core group is likely.¹⁰ Further transmission from non-DU sex partners of DUs to other non-DUs is also likely, although little empirical evidence on this is available. To the best of our knowledge, a single study that includes information relevant to all aspects of bridging (e.g., HIV prevalence among DUs, sex behaviors with non-DU partners, and characteristics of these partners) has not been conducted. In this paper, we assess the frequency of bridging and nonbridging sex partnerships in a large sample of DUs, determine the characteristics of the potential bridging partnerships including analysis of male-female differences, and characterize the non-DU sex partners of DU participants enrolled in the study.

METHODS

From November 2005 to August 2008, data were collected in St. Petersburg, Russia as part of a multisite study called Sexual Acquisition and Transmission of HIV-Cooperative Agreement Program (SATH-CAP), funded by the National Institute on Drug Abuse at the National Institutes of Health. The overall goal of SATH-CAP is to better understand how patterns of sexual and drug use behaviors along with other social and environmental factors influence the spread of HIV/AIDS from groups at high risk for HIV/AIDS (DUs and men who have sex with men) to the general population. Data were gathered using a common protocol in St. Petersburg, Los Angeles, Chicago, and several sites in North Carolina (details provided in the paper by Iguchi et al. in this issue).

Participants

This analysis included two subgroups of participants from the sample: individuals who reported drug use ($n=631$) and individuals who were recruited into the study as a sex partner of a DU and who did not report being a DU ($n=53$). Drug use was

defined as use of heroin, powder or crack cocaine, or methamphetamines in the past 30 days or injection of any illicit drug ever. Participants were recruited into the SATH-CAP study using a dual-component form of respondent-driven sampling (RDS). RDS is a chain referral sampling methodology that uses dual incentives and structured coupon disbursement procedures for peer referrals in order to reduce biases that are typically inherent in samples of hidden populations. Traditional RDS methods were modified in this study to recruit both additional members of the target population (DUs) as well as sex partners of participants. Briefly, a number of “seeds” ($n=48$) eligible to participate in the study as DUs were enrolled and given coupons with study location information to give to their DU peers and their sex partners. Initial seeds included participants from previous studies at the research site or referrals from agencies providing services to DU. DU peers and sex partners then called the site to schedule an appointment for eligibility screening and enrollment. For sex partner recruitment, DU participants were given two sex partner coupons with which males could recruit female sex partners they had in the past 6 months and females could recruit male sex partners they had sex with in the past 6 months. Sex partners were eligible for participation if they reported having had anal or vaginal sex with the recruiter in the past 6 months. Participants were reimbursed with gifts containing cell phone cards or personal care items and they were also given subway tokens, condoms, and HIV prevention information. Participation was confidential, and all study procedures were approved by institutional review boards at The Biomedical Center, Yale University, and RAND Corporation.

Data Collection, Measures, and Laboratory Procedures

Participants completed a 60- to 120-min structured interview using computer-assisted survey interviewing technology on laptop computers. Survey data used in the present analyses included demographic, drug and sex behaviors, and sex partner information. Demographic variables included sex, age, education, employment status, method of transportation, and reporting homelessness in the past year. Participants were asked to report their HIV status if known. Drug use behaviors (reported by DUs only) included method of use (injection or not), duration of use, use in the past 30 days, frequency of use in past 30 days, and unsafe injections in past 30 days as assessed by receptive syringe sharing, distributive syringe sharing, and use of a single syringe to mix/divide drugs or sharing cookers/cotton/water. Sex behaviors included age at first sex, number of sex partners in past 6 months, new sex partners in past 6 months, and unprotected intercourse at last sex. Participants could report on their last sexual intercourse with up to three sex partners in the past 6 months, and partner-specific data were obtained by asking an iterative set of questions about each sex partner. Questions about sex partners included type of partner (main vs. other), duration of sex partnership (dichotomized at the median of 6 months for multivariate modeling), knowledge of partner drug use, and knowledge of partner HIV status.

Pretest HIV counseling was provided, and serum specimens were tested for HIV antibodies by enzyme-linked immunosorbent assay (ELISA) using commercially licensed reagents including Genscreen HIV 1/2 (BioRad, France) and/or Vironostika HIV Uni-Form II plus 0 (Biomerieux, The Netherlands). Nonreactive specimens were considered to be HIV-negative. Specimens that were reactive were further tested with Western blot analysis using New Lav Blot HIV-1 (BioRad, France). Participants were considered HIV-positive if their ELISA reactive specimens were confirmed by Western blot. All participants were invited to return to the site for

post-test counseling to get HIV test results, and referrals for additional medical and social services were provided as needed. The HIV status variable in these analyses was based on both self-report and biological testing.

Statistical Analysis

To describe the potential magnitude of bridging, analyses were restricted to the sample of DU who had nonmissing sex partner data ($n=577$, 91% of all drug users [54 had missing sex partner data]). Potential bridging partnerships were defined as sex partnership between a DU and someone not known to be DU, as reported by the DU participant. The primary analysis included all DUs regardless of HIV status; secondary analyses were conducted restricting this sample to HIV-positive DUs. First, we estimated the number of DUs who reported being sexually active and who reported partner-specific data for at least one sex partner in the past 6 months. Among the total number of partners reported, we estimated the proportions reported to be non-DU or, unknown DU status, to be HIV-negative or, of unknown status, and with whom the respondent had unprotected sex at last intercourse.

To identify factors associated with potential bridging partnerships, analyses included all sex partnerships reported by DUs ($n=709$ partnerships). Partnerships were described with respect to the individual demographic, sexual behavior, and HIV variables in addition to the partner-specific variables. Bridging and nonbridging partnerships were compared using generalized estimating equations to account for correlated observations (multiple partnerships reported by same individual). Covariates that were associated in the bivariate analysis using the critical value of $p<0.20$ were included in the initial multivariate model. A manual backward selection procedure eliminated covariates that did not remain significant using the critical value of $p<0.05$ to arrive at the final multivariate model.

Our experience with the population of DUs in Russia, anecdotal evidence that male DUs may be more likely to have non-DU female sex partners than female DUs are to have non-DU male sex partners, and our preliminary finding that the majority of DUs are male led us to hypothesize the existence of important sex differences. Therefore, a stratified analysis was conducted for male DUs and female DUs with potential bridging sex partners on the variables described above to investigate possible differences.

To gain a better understanding of the characteristics of non-DU sex partners of DU participants who were recruited into the sample, analyses including all sex partners recruited by DUs into the study who did not report being DUs themselves was conducted ($n=53$). This sample was described with respect to demographic, sex behavior, and HIV variables.

Using a weighting procedure that took into account our modified RDS methodology, we found that the weighted and unweighted estimates for sex, age, and HIV status proportions in this sample did not differ substantially: unweighted estimates for proportions male, <25 years of age, and HIV-infected were 74%, 33%, and 50%, respectively, compared to weighted estimates of 75%, 32%, and 49% respectively. Therefore, we used unweighted estimates for all subsequent analyses.

RESULTS

A total of 631 DUs was recruited into this study. This group was predominantly male (72%) and mean age was 29 years (standard deviation [SD]=6.5, median=28; Table 1). Eighty-three percent reported completing high school or some university

TABLE 1 Characteristics of drug users recruited in St. Petersburg, Russia, 2005–2008 (*n*=631 individuals unless otherwise noted)

Characteristic	Number (percent)
Sex	
Male	457 (72)
Female	174 (28)
Age (<i>n</i> =630)	
≤26 years	249 (40)
>26 years	381 (60)
Mean=29, SD=6.5, median=28	
Education (<i>n</i> =630)	
No/incomplete high school	109 (17)
Completed high school	459 (73)
Some university education	62 (10)
Currently employed for pay (<i>n</i> =622)	
Yes	204 (33)
No	418 (67)
Owns car (<i>n</i> =627)	
Yes	84 (13)
No	543 (87)
Homeless at any time during past year (<i>n</i> =630)	
Yes	141 (22)
No	489 (78)
Ever IDU	
Yes	606 (96)
No	25 (4)
Duration of IDU among IDU (<i>n</i> =597)	
≤5 years	157 (26)
>5 years	440 (74)
Mean=9, SD=6.0, median=8	
IDU past 30 days (<i>n</i> =578)	
Yes	532 (92)
No	46 (8)
Frequency of IDU in past 30 days (<i>n</i> =578)	
<30	370 (64)
≥30	208 (36)
Mean=22, SD=20.3, median=20	
Receptive syringe sharing in past 30 days (<i>n</i> =578)	
Yes	193 (33)
No	385 (67)
Distributive syringe sharing in past 30 days (<i>n</i> =578)	
Yes	186 (32)
No	392 (68)
Sharing of cooker/cotton/water or use of a single syringe to mix or divide drug in past 30 days (<i>n</i> =578)	
Yes	387 (67)
No	191 (33)
Age at first sex (<i>n</i> =565)	
≤15	311 (55)
>15	254 (45)
Mean=15, SD=3.3, median=15	

TABLE 1 (continued)

Characteristic	Number (percent)
Number of sex partners in past 6 months (<i>n</i> =574)	
0	94 (16)
1	282 (49)
>1	198 (35)
Mean=2, SD=2.2, median=1,	
New sex partner in past 6 month (<i>n</i> =522)	
Yes	264 (51)
No	258 (49)
Unprotected intercourse at last sex (<i>n</i> =449)	
Yes	258 (57)
No	191 (43)
HIV status (<i>n</i> =628)	
Positive serology and self-report	102 (16)
Positive serology, negative self-report	179 (29)
Negative serology and self-report	347 (55)

education, but 67% were currently unemployed and 22% reported being homeless during the past year. A majority of the sample reported injection as mode of drug use (96%), and among injection drug users (IDU), the median duration was 8 years and 92% were active IDU (injected in past 30 days). For sexual activity among DUs, 35% reported multiple partners in past 6 months, 51% reported having a new partner in the past 6 months, and 57% reported unprotected intercourse at last sex; 13% reported all three sexual risk factors. Forty-five percent (*n*=281) of the sample was HIV-positive by serology at the study visit, of whom 102 reported that they were aware of their HIV-positive serostatus and 179 were unaware of their HIV-positive serostatus.

Among the 631 DUs in the sample, 91% had nonmissing information on sexual activity in past 6 months (Figure 1). Among those 577 participants, 84% reported being sexually active in past 6 months; of these, 93% reported partner-specific data about at least one sex partner. A total of 709 sex partnership relationships were described by these 449 DUs. Of these partnerships, 54% were with another DU, 40% were with individuals reported not to be DUs, and 6% were with individuals of unknown drug use status. A majority of sex partners who were not known to be drug users were thought be HIV-negative by the respondent (97%), and in 126 (41%) of these partnerships, condoms were not used at last intercourse. Thus, the potential for bridging, when defined as unprotected sex between a DU and a sex partner not known to be a DU or HIV-positive occurred in 18% of all sex partnerships of drug users (126 out of 709). When these analyses were restricted to DUs known to be HIV-positive, the potential for bridging occurred in 12% of sex partnerships (out of 281 sex partners reported by HIV-positive DUs, unprotected intercourse with a partner not known to be DU or HIV-positive occurred in 35; see Figure 1, italics).

Generalized estimating equations were used to examine correlates (demographic, sex risk behaviors, and sex partnership characteristics) of potential bridging partnerships defined as sex partners of DUs not known to use drugs (Table 2). Covariates that were associated with potential bridging sex partnerships at *p*<0.20 and thus candidates for inclusion in the final multivariate model were male sex, higher education levels, currently employed for pay, owning a car, being a new sex partner, protected intercourse at last sex, being HIV-negative, and partner type

FIGURE 1. Estimate of the potential magnitude of bridging (total sample of DU presented in regular font, sample of HIV-positive DU presented in *italics*).

main. Covariates that remained significantly associated with potential bridging partnerships in the final multivariate model included male sex (adjusted odds ratio [aOR]=4.56, 95% confidence intervals [95%CI]=2.90–7.17), some university education compared to incomplete high school (aOR=2.39, 95%CI=1.13–5.05), protected intercourse at last sex (aOR=2.35, 95%CI=1.67–3.30), and main partner (aOR=2.09, 95%CI=1.50–2.91).

The analysis of male–female differences among those who had potential bridging partnerships showed that females with non-DU male sex partners were more likely than males with non-DU female sex partners to be younger ($p<0.001$), homeless during the past year ($p<0.001$), have multiple partners in the past 6 months ($p=0.05$), and have a new sex partner in the past 6 months ($p=0.04$; Table 3). Females were also marginally more likely to be unemployed ($p=0.09$).

The 53 non-DU sex partners of DUs recruited into this sample are described according to their demographics, sex behaviors, and HIV status in Table 4. Nearly half (48%) had more than one sex partner in the past 6 months, over half (66%) had a new sex partner in the past 6 months, and 60% reported unprotected

TABLE 2 Correlates of potential bridging partnerships (*n*=709 partnerships unless otherwise noted)

Characteristic	Sex partners not known to be DU, <i>n</i> =330, 47%; <i>n</i> (%)	Sex partners known to be DU, <i>n</i> =379, 53%; <i>n</i> (%)	Unadjusted OR (95%CI)	Adjusted OR (95%CI)
Sex				
Male	282 (55)	227 (45)	4.34** (2.83, 6.66)	4.56** (2.90, 7.17)
Female	48 (24)	152 (76)	1.0	1.0
Age (<i>n</i> =708)				
≤26 years	138 (44)	175 (56)	0.85 (0.61, 1.19)	
>26 years	192 (49)	203 (51)	1.0	
Education (<i>n</i> =708)				
No/incomplete high school	38 (38)	62 (62)	1.0	1.0
Completed high school	243 (47)	278 (53)	1.38 (0.84, 2.27)	1.58* (0.92, 2.73)
Some university education	49 (56)	38 (44)	1.93* (1.00, 3.74)	2.39** (1.13, 5.05)
Currently employed for pay (<i>n</i> =708)				
Yes	140 (56)	110 (44)	1.75** (1.24, 2.45)	
No	190 (41)	268 (59)	1.0	
Owns car (<i>n</i> =706)				
Yes	56 (57)	42 (43)	1.47* (0.90, 2.39)	
No	273 (44)	335 (55)	1.0	
Homeless at any time during past year				
Yes	70 (47)	78 (53)	1.08 (0.72, 1.60)	
No	260 (46)	301 (54)	1.0	
Sex risk behaviors of DU				
Age at first sex				
≤15	196 (46)	228 (55)	0.97 (0.70, 1.36)	
>15	134 (47)	151 (53)	1.0	
Number of sex partners in past 6 months (<i>n</i> =705)				
≤1	120 (44)	151 (56)	0.86 (0.61, 1.19)	
>1	208 (48)	226 (52)	1.0	
New sex partner in past 6 months (<i>n</i> =687)				
Yes	210 (51)	205 (49)	1.50** (1.06, 2.12)	
No	113 (42)	159 (58)	1.0	

TABLE 2 (continued)

Characteristic	Sex partners not known to be DU, <i>n</i> =330, 47%; <i>n</i> (%)	Sex partners known to be DU, <i>n</i> =379, 53%; <i>n</i> (%)	Unadjusted OR (95%CI)	Adjusted OR (95%CI)
Unprotected intercourse at last sex				
Yes	128 (37)	215 (63)	1.0	1.0
No	202 (55)	164 (45)	2.19** (1.59, 3.00)	2.35** (1.67, 3.30)
HIV status (<i>n</i> =707)				
Positive serology and self-report	41 (37)	71 (63)	1.0	
Positive serology, negative self-report	70 (41)	99 (59)	1.15 (0.67, 1.98)	
Negative serology and self-report	219 (51)	207 (49)	1.72** (1.08, 2.72)	
Characteristics of sex partnership				
Type				
Main	149 (58)	110 (42)	1.84** (1.36, 2.47)	2.09** (1.50, 2.91)
Casual	181 (40)	269 (60)	1.0	1.0
Duration of sexual relationship (<i>n</i> =672)				
≤6 months	150 (44)	190 (56)	0.84 (0.62, 1.14)	
>6 months	159 (48)	173 (52)	1.0	

***p*<0.05, **p*<0.20

intercourse at last sex. Ninety-one percent had at least one of these sexual risk factors (multiple partners, a new partner, or unprotected intercourse). Over two thirds (68%) reported also having non-DU sex partners in the past 6 months in addition to the DU sex partner that recruited them into the study. Eight (15%) non-DU sex partners of DUs were HIV-positive, though only two of them self-reported knowledge of their HIV-positive serostatus.

DISCUSSION

These findings suggest that St. Petersburg faces an expanding HIV epidemic due to transmission from the core group of higher-risk DUs to their lower-risk non-DU sex partners and possibly further into the general population. The prevalence of HIV among DUs was high (45%), as was their level of sexual activity in the past 6 months. The vast majority (84%) of DUs was sexually active, and many reported a new sex partner (51%) or multiple sex partners (35%) in the past 6 months. Sexual risk behaviors of the non-DU sex partners of DUs were also found to be high with near majorities or greater reporting a new sex partner (66%), multiple partners (48%) in the past 6 months, or unprotected intercourse at last sex (60%). Furthermore, a small but not insignificant HIV prevalence among non-DU sex partners of DU (15%) indicated that some transmission to or within this noncore

TABLE 3 Comparison of male and female DU with potential bridging sex partnerships (*n*=330 partnerships unless otherwise noted)

Characteristic	Male DU with non-DU sex partners, <i>n</i> =282; <i>n</i> (%)	Female DU with non-DU sex partners, <i>n</i> =48; <i>n</i> (%)	<i>p</i> value
Age			<0.001
≤26 years	107 (38)	31 (65)	
>26 years	175 (62)	17 (35)	
Education			0.67
No/incomplete high school	32 (11)	6 (12)	
Completed high school	210 (75)	33 (69)	
Some university education	40 (14)	9 (19)	
Currently employed for pay			0.09
Yes	125 (44)	15 (31)	
No	157 (56)	33 (69)	
Owns car (<i>n</i> =329)			0.94
Yes	48 (17)	8 (17)	
No	233 (83)	40 (83)	
Homeless at any time during past year			<0.001
Yes	50 (18)	20 (42)	
No	232 (82)	28 (58)	
Sex risk behaviors of DU			
Age at first sex			0.88
≤15	167 (59)	29 (60)	
>15	115 (41)	19 (40)	
Number of sex partners in past 6 months (<i>n</i> =328)			0.05
≤1	109 (39)	11 (24)	
>1	173 (61)	35 (76)	
New sex partner in past 6 months (<i>n</i> =323)			0.04
Yes	174 (63)	36 (78)	
No	103 (37)	10 (22)	
Unprotected intercourse at last sex			0.84
Yes	110 (39)	18 (38)	
No	172 (61)	30 (62)	
HIV status (<i>n</i> =327)			0.28
Positive serology and self-report	32 (12)	9 (20)	
Positive serology, negative self-report	61 (22)	9 (20)	
Negative serology and self-report	189 (66)	27 (60)	
Characteristics of sex partnership			
Type			0.92
Main	127 (45)	22 (46)	
Casual	155 (55)	26 (54)	
Duration of sexual relationship (<i>n</i> =309)			0.18
≤6 months	124 (47)	26 (58)	
>6 months	140 (55)	19 (42)	

TABLE 4 Characteristics of non-DU sex partners of DU enrolled in study (*n*=53 unless otherwise noted)

Characteristic	Number (percent)
Sex	
Male	23 (43)
Female	30 (57)
Age	
≤26 years	23 (43)
>26 years	30 (57)
Mean=30, SD=8.8, median=29	
Education	
No/incomplete high school	4 (8)
Completed high school	13 (24)
Some university education	36 (68)
Currently employed for pay	
Yes	31 (58)
No	22 (42)
Owns car	
Yes	8 (15)
No	45 (85)
Homeless at any time during past year	
Yes	5 (9)
No	48 (91)
Age at first sex (<i>n</i> =50)	
≤15	19 (38)
>15	31 (62)
Mean=16, SD=2.3, median=16	
Number of sex partners in past 6 months (<i>n</i> =46)	
0	2 (4)
≤1	23 (52)
>1	21 (48)
Mean=2, SD=1.7, median=1	
New sex partner in past 6 months (<i>n</i> =41)	
Yes	27 (66)
No	14 (34)
Number of non-IDU sex partners in past 6 months (<i>n</i> =41)	
0	13 (32)
1	18 (44)
>1	10 (24)
Mean=1, SD=1.0, median=1	
Unprotected intercourse at last sex	
Yes	32 (60)
No	21 (40)
HIV status	
Positive serology and self-report	2 (4)
Positive serology and negative self-report	6 (11)
Negative serology and self-report	45 (85)

group is occurring, although precise modes, timing, and direction of transmission cannot be known from this study. These findings complement those provided in the companion paper in this issue by Toussova et al. that, among newly diagnosed HIV-positive non-DUs, a high proportion reported unsafe heterosexual sex with DU sex partners.

The potential for HIV bridging was observed in the 18% of all sex partnerships reported by DUs that involved unprotected intercourse with a person not known to be DU and not known to be HIV-positive. More direct evidence of potential bridging involving HIV-positive DUs occurred in 12% partnerships, suggesting that transmission events will likely continue as long as the prevalence of HIV among DUs remains high or increases and unprotected sex remains so widespread. Despite this concern, several factors may limit the extent of HIV spread to the general population. Unprotected intercourse at last sex was significantly lower in bridging partnerships compared to nonbridging partnerships (37% vs. 55%, $p < 0.001$), suggesting that some risk reduction may be occurring in these partnerships. In addition, though not statistically significant in our multivariate model, HIV-positive DUs who were aware of their serostatus were less likely to have bridging partnerships compared to HIV-negative DUs (37% vs. 51%). The extent to which this knowledge influences risk behaviors in this population is not fully understood and remains an empirical question for future research, especially given that HIV testing among IDUs in Russia is low and knowledge of positive serostatus is poor.⁵ At a minimum, these findings point to the need for more HIV prevention efforts focusing on positives.

Some male–female differences in the potential for bridging are noteworthy. First, male DUs were significantly and substantially more likely to report non-DU sex partners than female DUs (aOR > 4); this suggests that female non-DUs may be at greater risk for acquiring HIV via sexual transmission from male partners who are DUs. Regarding those with potential bridging partnerships, there is some evidence that females have greater HIV risk due to certain vulnerabilities; they were of lower socioeconomic status and exhibited higher-risk sexual behaviors. Understanding the sexual risk dynamics of female DUs in this setting requires future study.

Similar to their DU partners, the non-DU sex partners of DUs exhibited high levels of sex risk behavior, raising concern for their risk of acquiring HIV and resulting in next waves of transmission into the general population. Nearly half reported multiple sex partners in the past 6 months, and approximately two thirds reported a new sex partner in the past 6 months. Among last sexual encounters, intercourse was unprotected in a majority (60%). In this setting of high prevalence of HIV among DUs, it appears that the possibility of continuing spread to and beyond the bridging population will become a major public health problem in St. Petersburg. Many (68%) of these individuals reported also having non-DU sex partners, further indicating the potential for greater penetration of HIV into the general population. The HIV prevalence of 15% in this population of non-DUs should be confirmed with larger sample size. There are few data about bridging populations in Russia, but our findings support a recent study conducted during 2003–2004 in four Russian *oblasts* that recruited non-IDU individuals whose newly diagnosed HIV infection was attributed to unprotected heterosexual sex, many of whom (43%) reported a regular IDU sex partner.¹¹ Unprotected sex in this sample of 86 individuals was widespread; 36% reported never using condoms and 78% reported some unprotected sex.

These data are cross-sectional and do not provide information about how transmission dynamics may be changing over time, either at the individual or population level. In addition, our measure of condom use was for last intercourse only (not an aggregate measure over a period of time), but use of this measure provides a conservative estimate for potential magnitude of bridging (e.g., partnerships where condom use was reported at last intercourse may include other episodes

of unprotected intercourse). The potential for bias in recruitment of participants' sex partners may have occurred because individuals may be more willing to recruit steady sex partners compared to casual partners. Furthermore, our sample size of sex partners was insufficient to conduct stratified or multivariate analyses to examine male–female or other potentially important differences.

With an estimated 70,000–75,000 IDUs in St. Petersburg, an HIV prevalence approaching 50% in this population, and the finding that 18% of all DU and 12% of HIV-positive DU report unsafe sex partnerships with non-DU, the possibility for epidemic expansion exists. In so far as the non-DU sex partners of DU have high-risk behaviors including multiple partners, some of whom are not DUs themselves (as demonstrated by our findings), the potential for a generalized epidemic remains. More extensive sampling of the bridge population, coupled with careful monitoring of prevalence and incidence, will be needed to detect spread outside the current high-risk core groups.

ACKNOWLEDGMENTS

This work was supported by NIH grants 5U01DA017387 (National Institute of Drug Abuse, PI), 5P30NIMH62294 (National Institute Mental Health), and 5D43TW001028 (Fogarty International Center) to Yale University.

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