Sexually transmitted disease and HIV prevalence and risk factors in concentrated and generalized HIV epidemic settings

NIMH Collaborative HIV/STD Prevention Trial Group*

Background: In many developing countries, the threat of nascent HIV epidemics expanding rapidly requires immediate and appropriate HIV prevention activities. Inexpensive and sustainable interventions are especially relevant in resource-constrained environments. In 2001, we assessed the prevalence and behavioral risk of sexually transmitted disease (STD) and HIV among at-risk populations in five developing countries in preparation for a community-randomized controlled trial, the NIMH Collaborative HIV/STD Prevention Trial.

Methods: Using a standardized protocol, more than 1000 participants in each country (China, India, Peru, Russia, and Zimbabwe) were selected by random sampling methods, completed a behavioral risk assessment, and provided biological specimens using a common laboratory protocol. Sample characteristics were studied within each country, and risk factors for HIV/STD acquisition were evaluated using logistic regression models.

Results: HIV rates were low (< 1%) in China, India, Peru, and Russia but were high (26%) in rural Zimbabwe. STDs were generally twice as common in women as men, and serological evidence of herpes simplex virus type 2 infection was the most frequently detected STD. Behavioral data showed high rates of multiple partners in the Russian sample, and very low condom use rates in India and China. Among participants who reported ever having sex, female sex and having two or more sex partners were the factors most frequently associated with an increased risk of prevalent STD.

Conclusion: Behavioral or biological risks were of sufficient magnitude in the locations selected in China, Russia, and Zimbabwe to implement the community-based randomized trial. Higher-risk subsets of community residents in India and Peru were identified before beginning the Trial.

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Introduction

The HIV epidemic has continued to unfold in developing countries more than two decades after HIV was first detected. Global estimates indicate that nearly 25 million deaths over the past 20 years can be attributed to HIV/AIDS and that 42 million individuals are currently infected [1]. Although some successes have been noted in the control of the HIV pandemic, particularly in Thailand, Uganda, Senegal, and Brazil, epidemics continue unabated in many resource-poor countries [1].

Countries at different stages in the HIV epidemic require different types of preventive interventions [2]. Those in the concentrated (or nascent) stage, where the epidemic still affects less than 1% of the general population, are often characterized as having HIV confined to limited, high-risk (often mobile) populations. With sufficient mixing between high-risk individuals and the general population, referred to as epidemiological 'bridging', the epidemic may become more generalized and expand rapidly [3]. In concentrated epidemics, HIV prevention is most efficient when it addresses so-called 'core groups' [4]. In generalized epidemics, prevention focused on the general population is more efficient, given the widespread prevalence of the local HIV epidemic. Depending on the local situation, prevention efforts might thus entail making HIV voluntary counseling and testing easily accessible to core groups or to the general population, providing or promoting sexually transmitted disease

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(STD) diagnosis and treatment to core or general target populations, and promoting condom use and peer intervention to appropriate populations [5].

An HIV prevention strategy using a popular opinion leader approach initiated by Kelly and colleagues [6] demonstrated efficacy in multiple settings with multiple populations in the United States [6–8]. Adapting this intervention using community popular opinion leaders is an ideal HIV/STD prevention programme for international low-resource settings because procedures for conducting such a programme already exist, it may be cost effective [9,10] depending on the local context, and because it relies on word-of-mouth and social influence the intervention can be easily implemented in low-literacy settings.

One of the principal approaches to HIV prevention in developing-country settings has been the control of sexually transmitted infections through interventions aimed at treatment as well as those aimed at prevention through behavior change (risk reduction) and condom promotion. To date, the effects of community randomized trials aimed at reducing HIV incidence through the treatment of STDs in these settings have been inconclusive [11,12], as have behavioral interventions [13]. There is widespread agreement, however, that effective behavior change can lead to a reduction in disease acquisition [14].

The NIMH Collaborative HIV/STD Prevention Trial ('the Trial') seeks to determine the effectiveness of a community popular opinion leader intervention approach to stimulating HIV risk reduction in developing countries. Before implementing this large, community-randomized controlled trial for HIV/STD prevention in China, India, Peru, Russia, and Zimbabwe, an epidemiological study was conducted in these countries to assist with planning of the Trial. The objectives of the epidemiological study were to assess STD and HIV prevalence and behavioral risk in each country and to field test HIV/STD sampling procedures, laboratory assays, and reference laboratory procedures. Findings from this study are the subject of this article.

Methods

Study design

During the study period, February–September 2001, approximately 20–30 locations for study implementation (venues) were identified in each country using standardized criteria, although different types of places were selected in the individual countries, described briefly under Study sites below and more completely in 'Selection of populations represented in the NIMH Collaborative HIV/STD Prevention Trial' [15]. In each country, simple probability sampling after enumeration was used to select 50 or more participants in each venue to ensure that the final sample provided behavioral risk data and biological specimens for at least 50 participants. Because behavioral risk factors and the epidemiology of STDs were expected to vary by site, the age range of participants varied, but all countries sampled a core group of 18–30 year-olds. All participants verified that they lived or worked in the selected venue, planned to remain in their neighborhood for the next year, were able to give informed consent, and did not have any condition (deafness, serious mental illness, or mental retardation) that would preclude obtaining informed consent and thus participating in the study.

Identification of venues

Venues and at-risk populations were identified in each country. Extensive ethnographic studies [16,17] were used to assess sexual behavior and HIV/STD risk factors to help ensure that appropriate venues and populations were selected. These studies also identified characteristics of natural leaders in the venues, provided the formative data necessary to design the final intervention strategy, and identified high-risk behaviors.

Study sites

China

Thirty food markets were selected, based on size and geographical location, from among 95 commercial food markets in five districts in Fuzhou city in the Fujian Province in southern China. Each market was an identifiable venue located in a separate physical structure. Most markets had 50–150 independent stores or stalls, with a total of approximately 150–300 employees. A sample of workers, aged 18–40 years, was drawn at each of the 30 markets by first selecting a random sample of stalls and then selecting one person at random among those aged 18–40 years in each selected stall. Participants were accompanied to a local community health center where they provided biological samples and were interviewed.

India

Participants were selected from low-income neighborhoods called 'slums' (government-designated low-income housing communities scheduled for the construction of subsidized housing blocks), in Chennai, the capital of Tamil Nadu State in southern India. The selection of slums was based on ethnographic evidence of low condom use and anticipated high HIV prevalence. The 28 geographically separated slums used for the study, with 100–300 families each, were enumerated. A simple random sample of households, and then a random sample of adults aged 18–40 years within households, was drawn in each slum. The residents selected in each slum were asked to participate in the confidential interview and to give biological specimens when they attended a 1-day 'health camp'. All slum residents were invited to the camps, where physical examinations were conducted, health education provided, medications given free of

charge, and appropriate referrals made. Over 90% of eligible participants invited to the health camps attended.

Peru

Residential areas (barrios, or neighborhoods) were selected in the capital city of Lima, and in Chiclayo and Trujillo, coastal cities north of Lima. Geographically separate communities were selected to reflect the sociodemographic structure of low to low middle-income populations and to be homogeneous with regard to values of an indicator of poverty widely used in the country (the score of unmet basic needs). Within the barrios, core clusters of between eight and 16 contiguous blocks with resident populations of between 800 and 1600 were selected as study venues. A random sample of residents aged 18–30 years was drawn from each of 30 venues, and all selected residents were invited to a storefront location in the community, where study procedures were conducted.

Russia

Participants were selected from among young adults aged 18–30 years living in vocational, technical, or trade school dormitories in St Petersburg. Earlier studies with similar populations in Russia suggested high rates of sexual risk behavior, substance use, and STDs. Approximately equal numbers of men and women lived in the dormitories, with an average of 400 residents per dormitory. From residential rosters, residents were randomly selected in each of the 20 dormitories with at least 200 residents. At a health station nearby, participating residents responded to interviews and provided biological samples.

Zimbabwe

Thirty-two rural villages across eight rural districts were purposely selected as venues from communities designated by the government in 1985 as 'growth points' to receive aid for the development of local area rural economies. With populations ranging from 2500 to 15 000, these villages have small commercial areas, usually consisting of a few stores and markets, other services, and bottle stores, beer halls, or nightclubs. Primary, and occasionally secondary, schools and a health clinic were sometimes part of these communities. Participants, aged 16–30 years, were randomly selected from among inhabitants in randomly selected households in each of the 32 villages. All data collection took place in households where privacy was assured.

Data collection

A behavioral risk assessment instrument was used to collect data systematically on the participants' demographics, residential stability, health status, drug and alcohol use, sexual behavior, and condom use. Participants in Peru, Russia, and Zimbabwe entered their responses themselves directly into computers using audio computer-assisted self-interviewing (ACASI). In China and India, interviewers used computer-assisted personal interviewing (CAPI) to administer the questionnaire to participants in privacy and enter their responses into computers. ACASI was not used in these countries because preliminary studies showed that it took considerably longer to administer, and it appeared that participants in China and India may have been more forthright when CAPI was used [18]. All assessments were conducted in the languages of the country: Mandarin and Fuzhou dialect in China, Tamil in India, Spanish in Peru, Russian in Russia, and Shona and Ndebele in Zimbabwe. All translations were independently back-translated into English to assess meaning and fidelity to the original questions. The interviews took 15–35 min to complete, depending on reported sexual and drug use behaviors. After completing the interview, participants received HIV pretest counseling and provided blood and urine specimens and self or clinician-collected vaginal swabs to test for the following STDs: HIV, herpes simplex virus type 2 (HSV-2), syphilis, trichomonas (women only), gonorrhea, and chlamydia.

Specimens were tested in study laboratories in each country, following standardized laboratory protocols developed by a team of STD and laboratory experts. HIV testing was performed using HIV enzyme-linked immunosorbent assay (ELISA), and it was repeated using a second approved ELISA kit. Positives and discordants were confirmed using Western blot, except in Zimbabwe, where a positive result on duplicate ELISA tests was considered confirmatory, and a third ELISA test or a Western blot was used to confirm HIV status in the case of discordant results on the previous two. As a result of the anticipated high prevalence of HIV in Zimbabwe, triplicate ELISA testing was allowed to minimize study costs. HSV-2 testing was performed using Herpeselect 2 enzyme immunoassay (MRL, Focus Technologies, Los Angeles, California, USA). Those with index values of 1.1 or greater were considered positive for HSV-2. The Trial's biological workgroup is evaluating the HSV-2 index value cutoff values for the study populations in light of recent scientific data regarding the variability in confirmed HSV-2 seropositive results using the US Food and Drug Administration-cleared manufacturer's instructions for the Focus Technologies Herpeselect enzyme immunoassay. This workgroup will make recommendations regarding cutoff values for the main Trial. Syphilis testing was performed by rapid plasma reagin and confirmed using the *Treponema pallidum* particle agglutination test. Vaginal swabs were cultured for *Trichomonas vaginalis* using the InPouch TV 20 test kit (Biomed, San Jose, California, USA). Urine from men and vaginal swabs from women were tested for chlamydia and gonorrhea DNA using Amplicor CT/NG polymerase chain reaction (Roche, Branchburg, New Jersey, USA). Individuals with non-viral STDs were treated according to US Centers for Disease Control and Prevention STD treatment guidelines [19] or World Health Organization

STD treatment guidelines [20], or were referred to local centers for treatment based on national best practices guidelines. People testing positive for HIV were referred to existing local treatment centers. All participants were offered their HIV and STD test results and post-test counseling within 4 weeks of the initial visit. Over 85% of participants either received on-site treatment or referrals.

Quality assessment

Interviewers were trained centrally, and site visits were conducted by the data coordinating center to ensure that the ACASI and CAPI programmes were functioning correctly and that data were recorded accurately. Procedures for drawing samples of participants in each venue were developed centrally and overseen locally.

The quality assurance process for biological specimen testing was extensive. Senior laboratory staff from each site were trained at the Johns Hopkins University international STD reference laboratory. Protocols were developed to specify standard biological specimen collection, storage, and analysis procedures. The reference laboratory prepared panels of approximately 200 known samples and sent them to site laboratories for analysis by appropriate assay, and site visits were conducted to review laboratory procedures. The five site laboratories shipped to the reference laboratory for retesting a 20% sample of specimens collected in each site, including all positive samples (if less than 10%) or a random sample of positives (up to 10%) and a random sample of negatives. All discordant results were initially checked for data entry or interpretation errors, and study data were corrected as needed.

Statistical analysis

Data were analysed using SAS software [21]. The percentage of participants who tested positive for HIV and each STD (chlamydia, gonorrhea, syphilis, trichomonas, HSV-2) was determined separately for men and women. A binary variable (Any STD) was created to indicate participants who tested positive for any of these STDs including HIV, but was not calculated for individuals with three or more missing results (3% of those with at least one test). A second composite binary variable (Any non-viral STD) was created to indicate participants who tested positive for chlamydia, gonorrhea, syphilis, or trichomonas, STDs treatable with simple pharmacological regimens. This variable was not calculated for people with two or more missing results (9% of participants tested).

Unadjusted comparisons of demographic characteristics between men and women were made using Fisher's exact or Wilcoxon tests. The risk of prevalent STD was studied among the subset of participants who reported ever having sex. Possible risk factors were evaluated for each country separately using logistic regression models fit to the Any STD outcome with statistical significance of covariates determined by Wald chi-square tests. We also considered risk factors for Any Viral STD and Any non-viral STD, but as the results were similar, we report here only the results for Any STD (results for the previous two outcomes are available from the authors). First, a stepwise procedure was used to select, from the following, the behavioral variable with the strongest association with the outcome after adjusting for sex: number of sexual partners in the past year (two or more, one, or none), the number of sexual partners in the past 3 months (two or more, one, or none), and the frequency of condom use in the past 3 months ($<$ 100% of the time, 100%, no sex in the past 3 months). The number of sexual partners in the past year or in the past 3 months was selected for all countries.

Models that were fit included the behavioral variable as well as venue, sex, marital status, age ($\leq$ 24, 25–30, 31–40 years), education (high school or not), the frequency of alcohol use (weekly or more, less than weekly, no use), any illegal drug use in the past 3 months, ever exchanged sex for money or goods, attempted to obtain condoms in the past 3 months, and perceived likelihood of HIV infection (somewhat or very likely or already infected versus unlikely). All two-way interactions with sex were first included to test for differences by sex. No significant interactions were detected except in Zimbabwe. Therefore, models were refit with main effects only, as well as with non-significant interactions removed for Zimbabwe. Adjusted odds ratios (OR) and 95% confidence intervals from these models are reported.

Results

Population

Between 1000 and 1600 people participated in each country. Slightly less than half of the participants in each country were men (Table 1). Participation response rates varied from 77 to 89% of those selected, depending on site. No information was available from Russia on the number of people selected who refused to participate. Participants in Peru, Russia, and Zimbabwe were younger than those in China and India (by design), and were more likely to be unmarried and to have at least a high school degree. Female participants in all countries were more likely than men to be married. Significantly more men than women had high school degrees in China, India, and Zimbabwe but not in Peru. All Russian participants had completed high school. In China, India, and Zimbabwe, more female than male participants reported ever having had sex. In Russia more male participants reported having had sex, and no difference was found among participants in Peru.

Prevalence of HIV and sexually transmitted diseases

Refusal rates for STD testing were extremely low, and virtually all participants were tested for at least one

Table 1. Demographic characteristics of participants by study site.

Participant characteristic	China	India	Peru	Russia	Zimbabwe
Sample size	1542	1540	1462	1000	1606
Response rate (%)	85.5	88.6	81.0	NA[a]	76.9
Male (%)	48.3	47.3	41.2	49.4	43.4
Age, years (%)					
≤24	20.4	31.3	64.2	94.6	65.1
25–30	28.9	32.8	35.8	5.4	34.9
31–40	50.7	35.9	–	–	–
Median, years	31	28	23	20	22
Men	30*	28	22*	20*	21*
Women	31	28	24	19	23
Married[b] (%)	78.1	71.7	35.5	9.9	40.4
Men	75*	64*	19*	7*	19*
Women	81	78	47	12	57
Education[c] (%)					
None	11.5	24.6	0.5	–	0.9
Primary	28.7	19.5	7.7	–	44.5
Junior high	48.0	23.1	15.2	–	–
Secondary	10.8	30.0	35.4	58.4	52.2
College or higher	1.0	2.9	41.3	41.6	2.4
High school or more					
Men	14*	38*	79	100	61*
Women	10	28	75	100	50
Ever had sex (%)	85.7	83.5	85.3	91.3	81.6
Men	83*	77*	86	96*	75*
Women	88	89	85	87	87

[a]No information is available on the number of individuals selected who did not participate in the study.
[b]Marital status was missing for three participants; one each from Peru, Russia, and Zimbabwe.
[c]Education level was missing for three participants from Peru and one from Zimbabwe.
*$P \leq 0.05$ for a difference between men and women by Fisher's exact tests or the Wilcoxon test (age).

STD: in China, 1537 (99.7%); in India, 1513 (98.2%); in Peru, 1446 (98.9%); in Russia, 998 (99.8%); and in Zimbabwe, 1596 (99.4%). With few exceptions, more women than men in all countries tested positive for each STD (Table 2). STD prevalence rates varied widely by specific pathogen and by sex. Overall, serological evidence revealed that HSV-2 infection was the most prevalent STD, with rates in women generally two to three times as high as rates in men. HSV-2 antibody prevalence was lowest in Russia (3.2% in men and 9.1% in women), intermediate in China (5.8% in men and 11.3% in women), India (10.3% in men and 16.4% in women), and Peru (7.1% in men and 20.2% in women); and highest in Zimbabwe, where 27% of men and 59% of women tested positive. HIV prevalence was generally under or very close to 1% in all countries except Zimbabwe, where 15% of men and 34% of women in this sample of young adults tested positive for HIV. More than 30% of Zimbabwe men and 66% of Zimbabwe women were positive for at least one of the six STDs.

Chlamydia prevalence ranged from 0.1% among women in India to a high of 12% among women China. In all countries except India, women had somewhat higher rates of chlamydia than men. Gonorrhea and syphilis were infrequent in all countries, with small differences between men and women. Finally, the prevalence of trichomonas ranged from 0.5% among women in Russia to 15% among those in Zimbabwe.

Behavioral risks

More than 80% of participants in each country reported ever having had sex (Table 3). Most participants reported having one sexual partner in the year preceding the interview, except in Russia, where 47% reported having two or more sexual partners. Between 49 and 79% of participants reported having had sex at least once during the 3 months before the interview. Among those who reported having sex in the past 3 months, most participants in China (87%), India (93%), and Peru (60%) reported never using condoms, whereas approximately half (53%) in Zimbabwe and a minority (37%) in Russia reported never using condoms. The percentage of participants who said they had ever exchanged money, goods, shelter, or anything else for sex ranged from 4% in India to 15% in Zimbabwe. Attempts to seek condoms correlated strongly with reports of the frequency of condom use: less than 10% of participants in China and India had attempted to obtain condoms, compared with 17% in Peru, 30% in Zimbabwe, and 51% in Russia.

Reported alcohol use was highest among Russian participants and lowest among those in India and Zimbabwe. In Zimbabwe, however, among those who drank alcohol (mostly men), 48% reported getting drunk at least once per week; less than 10% of those reporting alcohol use in all other sites reported frequent drunkenness. Illegal drug use was reported by 6% or less of participants in China, India, and Peru but by 17% in Russia and Zimbabwe.

Table 2. Prevalence of selected sexually transmitted diseases by sex and study site.

	China		India		Peru		Russia		Zimbabwe	
STD	*N*	*n* (%)	*N*	*n* (%)	*N*	*n* (%)	*N*	*n* (%)	*N*	*n* (%)
Chlamydia										
Men	732	33 (4.5)	709	3 (0.4)	533	26 (4.9)	485	27 (5.6)	565	9 (1.6)
Women	746	91 (12.2)	722	1 (0.1)	812	52 (6.4)	500	52 (10.4)	719	18 (2.5)
Gonorrhea										
Men	739	5 (0.7)	699	1 (0.1)	536	2 (0.4)	486	3 (0.6)	564	5 (0.9)
Women	746	8 (1.1)	719	2 (0.3)	716	10 (1.4)	502	7 (1.4)	715	10 (1.4)
HSV-2										
Men	741	43 (5.8)	716	74 (10.3)	537	38 (7.1)	470	15 (3.2)	683	182 (26.7)
Women	788	89 (11.3)	782	128 (16.4)	769	155 (20.2)	471	43 (9.1)	891	522 (58.6)
Trichomonas										
Women	671	46 (6.9)	628	45 (7.2)	853	22 (2.6)	399	2 (0.5)	869	132 (15.2)
Syphilis										
Men	735	12 (1.6)	698	6 (1.2)	573	3 (0.5)	488	0 (0)	692	8 (1.2)
Women	785	13 (1.7)	765	6 (0.8)	824	8 (1.0)	499	6 (1.2)	904	20 (2.2)
HIV										
Men	739	0 (0)	717	8 (1.1)	584	0 (0)	491	6 (1.2)	691	102 (14.8)
Women	790	0 (0)	778	2 (0.3)	851	2 (0.2)	500	0 (0)	903	306 (33.9)
Any STD[a]										
Men	739	81 (11.0)	709	87 (12.3)	586	62 (10.6)	487	49 (10.1)	598	188 (31.4)
Women	789	194 (24.6)	766	163 (21.3)	851	220 (25.9)	499	95 (19.0)	872	579 (66.4)
Any non-viral STD[b]										
Men	721	46 (6.4)	671	11 (1.6)	538	31 (5.8)	479	30 (6.3)	564	19 (3.4)
Women	756	132 (17.5)	712	51 (7.2)	787	81 (10.3)	500	62 (12.4)	719	141 (19.6)

HSV-2, Herpes simplex virus type 2; STD, sexually transmitted disease.
[a]Any positive test for chlamydia, gonorrhea, HSV-2, trichomonas, syphilis, or HIV. Variable was calculated if at least four test results were non-missing.
[b]Any positive test for chlamydia, gonorrhea, trichomonas, or syphilis. Variable was calculated if at least three test results were non-missing.

When asked how likely they were to become HIV infected, most participants in each site thought that it was unlikely. Of note is the fact that only four people in Zimbabwe responded that they knew they were already HIV infected, whereas 408 (26%) tested positive among the 1594 tested for HIV. Because in-country antenatal clinic monitoring surveys of HIV status are conducted anonymously, many women who have been tested may not be aware of their serostatus.

In each site, some participants who indicated that they had never had sex tested positive for at least one STD. That percentage was similar for women and men in China (6% for women and 5% for men), India (3% for both), and Russia (5% for both) but higher for women in Peru (10% for women and 1% for men) and Zimbabwe (23% for women and 11% for men). The most common infection among this group was serological evidence of HSV-2 infection. In Zimbabwe, with the highest rates of HSV-2, some HSV-2 infections are likely to have been acquired perinatally. Inferences based on our results must take this into account.

Risk-factor analysis

In the subset of participants in each country that reported ever having had sex, we evaluated possible risk factors for acquiring at least one of the six STDs. Female sex was significantly associated with increased odds of STD in each country (Table 4). Adjusted OR for women compared with men ranged from 3.8 in Russia to 6.7 in Zimbabwe. Participants in China with two or more sexual partners were at increased odds of STD compared with those who reported no partners (OR 3.4), as were those in Russia (OR 2.2). In Zimbabwe, the odds were increased among women who reported two or more sexual partners (OR 5.5), but not among men who had multiple partners (OR 1.1). Other factors were less frequently associated with increased odds of STD. Drinking alcohol at least once per week was associated with increased odds in Zimbabwe (OR 1.7) and Peru (OR 1.9), whereas in India illicit drug use (OR 2.2) and having exchanged sex for money or goods (OR 2.3) were significantly associated with increased odds of an STD.

In India, Peru, and Zimbabwe, younger participants were at a significantly reduced risk of STD compared with older participants. The odds of having an STD were reduced by half for those with at least a high school education compared with those with less education in Peru (OR 0.5) and among women in Zimbabwe (OR 0.5), but no association with education was found among Zimbabwean men (OR 0.9).

Discussion

Few international comparative studies of HIV risk in defined populations have used standardized sampling approaches, common behavioral assessments, and

Table 3. Behavioral risks for sexually transmitted disease acquisition in participants by study site.

Behavioral risk	China *n* (%)	India *n* (%)	Peru *n* (%)	Russia *n* (%)	Zimbabwe *n* (%)
Ever had sex					
Yes	1322 (86)	1286 (84)	1242 (85)	908 (91)	1308 (82)
No	220 (14)	254 (16)	214 (15)	87 (9)	296 (18)
Missing	–	–	6	5	2
Married					
Ever had sex, Yes	1200 (99.7)	1101 (99.7)	513 (98.8)	99 (100)	643 (99.2)
Ever had sex, No	4 (0.3)	3 (0.3)	6 (1.2)	0	5 (0.8)
Not married					
Ever had sex, Yes	122 (36)	185 (42)	728 (78)	808 (90)	664 (70)
Ever had sex, No	216 (64)	251 (58)	208 (22)	87 (10)	291 (30)
Missing	–	–	7	6	3
No. of partners in past year					
0	254 (17)	403 (26)	399 (28)	122 (13)	440 (28)
1	1203 (78)	1053 (68)	763 (53)	399 (41)	801 (51)
2–5	42 (5)	73 (5)	245 (17)	385 (39)	288 (18)
>5	9 (<1)	10 (1)	22 (2)	71 (7)	57 (4)
Missing	4	1	33	23	20
No. of times had sex in past 3 months					
0	322 (21)	526 (35)	691 (51)	266 (31)	710 (51)
1+	1205 (79)	990 (65)	654 (49)	596 (69)	682 (49)
Missing	15	24	117	138	214
Frequency of condom use[a]					
Never	1043 (87)	914 (93)	378 (60)	209 (37)	336 (53)
1–50% of the time	32 (3)	22 (2)	83 (13)	107 (19)	84 (13)
51–99% of the time	14 (1)	2 (<1)	29 (5)	60 (11)	43 (7)
Every time	115 (10)	42 (4)	138 (22)	186 (33)	175 (27)
Missing	1	10	26	34	44
Frequency of alcohol use					
None	587 (38)	1012 (66)	429 (29)	28 (3)	1098 (68)
Less than weekly	618 (40)	222 (14)	838 (57)	516 (52)	216 (13)
Weekly	192 (13)	184 (12)	190 (13)	430 (43)	227 (14)
Daily	145 (9)	121 (8)	2 (<1)	23 (2)	65 (4)
Missing	–	1	3	3	–
Frequency of drunkenness[b]					
Weekly or more often	2 (<1)	30 (6)	95 (9)	53 (6)	244 (48)
Ever exchanged sex for material goods[c]	85 (6)	57 (4)	109 (9)	66 (7)	194 (15)
Tried to obtain condoms in past 3 months	133 (9)	97 (6)	244 (17)	512 (51)	481 (30)
Drug use in past 3 months	1 (<1)	98 (6)	54 (4)	169 (17)	269 (17)
Perceived likelihood of becoming HIV infected					
Already infected	0 (0)	3 (<1)	5 (<1)	0 (0)	4 (<1)
Somewhat/very likely	20 (1)	54 (4)	152 (12)	58 (6)	527 (33)
Unlikely	1513 (99)	1397 (96)	1160 (88)	907 (94)	1058 (67)
Missing	9	86	145	35	17

[a]Among participants who reported having sex in the past 3 months.
[b]Among participants who reported drinking alcohol.
[c]Among participants who reported ever having had sex.

standardized protocols for laboratory assays. Other comparative studies generally have not included both behavioral and biological outcomes. Combining individual self-reports of behavioral risk with biological outcomes adds strength to the findings of this study.

As anticipated, the overall HIV prevalence was very low in four of the five countries in our study. These sites were selected purposely because they have many of the factors that can fuel an HIV epidemic [22], and they offer good prospects for primary prevention. Although India had approximately 5.7 million HIV cases in 2005 [23], these results indicate that HIV had not yet unduly affected the urban general population considered to be at highest risk, inner-city slum dwellers. Nevertheless, if slum residents were to mix sexually with high-risk individuals (e.g. sex workers or drug users), the opportunity exists for the rapid expansion of an HIV epidemic. The current situation in Fujian Province, China, is more reassuring, for HIV infection does not yet appear to have reached the heterosexual working population in Fuzhou, despite recent reports of a potentially explosive HIV epidemic [24,25]. This is also true for Peru and Russia, where concentrated epidemics exist, most commonly associated with men who have sex with men in Peru and injection drug use in Russia. As was known, Zimbabwe has a very well established, generalized epidemic.

The type and level of STD burden showed some important variation across sites. Gonorrhea and syphilis were consistently low and showed little variation by sex. Chlamydia, however, was more common among women

Table 4. Participant characteristics and risk of any sexually transmitted disease among people who reported ever having had sex.

	China $N=1310$		India $N=1236$		Peru $N=1222$		Russia $N=898$		Zimbabwe $N=1192$	
Risk factor	*n* (%) with any STD	Adjusted OR (95% CI)	*n* (%) with any STD	Adjusted OR (95% CI)	*n* (%) with any STD	Adjusted OR (95% CI)	*n* (%) with any STD	Adjusted OR (95% CI)	*n* (%) with any STD	Adjusted OR (95% CI)
Sex										
Female	188 (27)	3.9 (2.6–5.9)*	161 (23)	4.2 (2.1–8.1)*	206 (29)	4.6 (2.9–7.2)*	92 (21)	3.8 (2.3–6.3)*	552 (73)	6.7 (4.4–10.1)*
Male	75 (12)	1.0	82 (15)	1.0	61 (12)	1.0	48 (10)	1.0	169 (39)	1.0
Marital status										
Married	239 (20)	0.7 (0.3–1.3)	203 (19)	0.7 (0.4–1.1)	135 (27)	1.0 (0.7–1.5)	13 (14)	0.8 (0.4–1.7)	421 (70)	1.2 (0.8–1.6)
Unmarried	24 (20)	1.0	40 (23)	1.0	132 (19)	1.0	127 (16)	1.0	300 (51)	1.0
Age (years)										
≤24	16 (13)	0.5 (0.3–1.3)	31 (12)	0.3 (0.2–0.5)*	132 (18)	0.7 (0.5–1.0)‡	132 (16)	0.6 (0.2–1.5)	335 (49)	0.3 (0.2–0.4)*
25–30	85 (20)	1.0 (0.7–1.4)	70 (15)	0.4 (0.3–0.6)*	135 (28)	1.0	8 (15)	1.0	386 (76)	1.0
31–40	162 (21)	1.0	142 (27)	1.0						
Education									Women[b]	
High school plus	25 (17)	0.8 (0.5–1.3)	40 (12)	0.7 (0.5–1.1)	175 (19)	0.5 (0.4–0.8)*	NA[a]		219 (64)	0.5 (0.3–0.7)*
Less than high school	238 (21)	1.0	203 (23)	1.0	92 (30)	1.0			333 (82)	1.0
Number of partners[c]									Women[d]	
2+	23 (28)	3.4 (1.0–11.7)‡	12 (36)	2.6 (1.0–6.8)	65 (25)	1.5 (0.8–2.6)	38 (19)	2.2 (1.1–4.5)‡	83 (88)	5.5 (2.3–13.1)*
1	233 (20)	1.2 (0.4–3.5)	185 (19)	1.1 (0.7–1.7)	164 (22)	1.0 (0.6–1.7)	85 (17)	1.8 (0.9–3.3)	419 (72)	2.2 (1.2–3.9)†
0	6 (19)	1.0	46 (19)	1.0	31 (17)	1.0	15 (10)	1.0	43 (60)	1.0
Alcohol use										
Weekly plus	42 (14)	1.2 (0.7–2.1)	47 (17)	1.6 (0.8–3.2)	37 (22)	1.9 (1.1–3.5)‡	69 (16)	1.8 (0.4–9.0)	123 (55)	1.7 (1.1–2.8)‡
Less than weekly	101 (21)	1.3 (0.9–1.8)	25 (15)	2.0 (0.9–4.2)	150 (21)	1.1 (0.7–1.5)	66 (15)	1.2 (0.3–6.1)	84 (54)	1.6 (1.0–2.5)
Don't drink	120 (23)	1.0	171 (21)	1.0	80 (24)	1.0	3 (16)	1.0	514 (63)	1.0
Illegal drug use										
Yes	NA[e]		32 (35)	2.2 (1.3–4.0)†	13 (25)	2.1 (0.9–4.7)	19 (12)	0.8 (0.4–1.4)	94 (49)	0.9 (0.6–1.4)
No			211 (18)	1.0	250 (22)	1.0	120 (17)	1.0	627 (63)	1.0
Exchanged sex										
Yes	21 (25)	1.5 (0.7–3.1)	16 (29)	2.3 (1.0–4.9)‡	25 (24)	1.3 (0.7–2.4)	15 (23)	2.0 (0.9–4.4)	104 (59)	0.9 (0.6–1.4)
No	242 (20)	1.0	227 (19)	1.0	242 (22)	1.0	125 (15)	1.0	614 (61)	1.0
Tried to obtain condoms										
Yes	24 (18)	0.9 (0.5–1.4)	14 (15)	0.8 (0.4–1.6)	40 (18)	1.1 (0.7–1.7)	67 (14)	1.0 (0.7–1.6)	214 (54)	1.0 (0.7–1.4)
No	239 (20)	1.0	229 (20)	1.0	226 (23)	1.0	72 (18)	1.0	505 (64)	1.0
Likelihood of HIV infection										
Some/very likely/already	4 (24)	0.8 (0.2–2.9)	13 (27)	1.9 (0.9–4.0)	37 (27)	1.4 (0.9–2.2)	9 (18)	1.3 (0.6–3.0)	285 (66)	1.1 (0.8–1.5)
Unlikely	256 (20)	1.0	211 (19)	1.0	212 (22)	1.0	125 (15)	1.0	428 (57)	1.0

CI, Confidence interval; OR, odds ratio; STD, sexually transmitted disease. Any STD means a positive result for chlamydia, gonorrhea, herpes simplex virus type 2, trichomonas, syphilis, or HIV. This outcome was calculated if at least four test results were non-missing. People for whom any STD could not be calculated were excluded: 12 in China, 50 in India, 20 in Peru, 10 in Russia, and 116 in Zimbabwe. The numbers shown for each country thus differ by these amounts from the number of people who reported ever having had sex in Table 4. Odds ratios for any STD (with 95% CI) from logistic regression models that included all variables shown as well as venue are reported. Separate models were fit for each country.

[a]All participants from Russia had completed high school.

[b]Among men, 104 out of 277 (38%) with and 65 out of 162 (40%) without a high school degree had an STD; adjusted OR 0.9 (0.5–1.4), $P=0.6$.

[c]Number of sexual partners in the past year for China, Peru, and Zimbabwe; number of partners in the past 3 months for India and Russia.

[d]Among men, 97 out of 215 (45%) with two or more sexual partners in the past year, 50 out of 157 (32%) with one, and 18 out of 60 (30%) who reported no sexual partners in the past year had an STD; adjusted OR for two or more compared with no partners 1.1 (0.6–2.3), $P=0.7$; adjusted OR for one compared with no partners 0.8 (0.4–1.6), $P=0.4$.

[e]Only one person from China reported illegal drug use.

*$P \leq 0.001$;

†$P \leq 0.01$;

‡$P \leq 0.05$.

than men, except in India, and was most prevalent in China and Russia, where virtually no HIV was detected. India and Zimbabwe showed very low rates of chlamydia among women. However, HSV-2 antibody prevalence was much more common and positive test results occurred approximately twice as often among women as men, ranging from 9 to 20% among women in all countries except Zimbabwe, where the prevalence among women was 59%. This has important implications for the future prominence of HIV epidemics, because herpes virus has been implicated as an important STD risk factor for HIV seroconversion in several recent epidemiological studies [26,27]. When the six STDs were combined, all sites showed prevalence above 10% for both sexes, and women consistently had an STD burden double that of their male counterparts. When restricted to the four non-viral STDs evaluated, the male rates were all below 10%, although the female prevalence continued to be 10% or above for all sites but India.

Our study found important differences by site in the behavioral risks evaluated. In Russia, there were very high rates of multiple sexual partnerships compared with the other four countries. Almost half of the Russian participants reported a history of multiple partners in the past year, and 7% reported having more than five. This reflects the young age and single status of these students compared with participants in the other countries. In the two Asian sites, unmarried participants reported lower rates of sexual experience than in the other three sites. This finding may be partly the result of socially desirable responses among participants in these countries; discussions about sex in public settings are considered taboo, and premarital sex, at least for women, is considered culturally unacceptable. Behavioral risk, whether measured by the number of partners [28], partner selection practices [29], or condom use [30], may be independent of STD prevalence [28]. Therefore, to be effective, prevention efforts for HIV acquisition must focus on both risk reduction and STD control, along with appropriate AIDS care [31,32], using established and cost-effective measures [33].

The feasibility of obtaining biological specimens in these settings outside of a medical encounter was initially of some concern, because few previous studies had obtained blood and urine specimens and vaginal swabs as part of random population STD/HIV assessments in developing countries. Although the sites used different strategies to select and approach potential participants, overall response rates to requests for biological specimens were equally high across sites. In particular, our ability to obtain self or clinician collected vaginal swabs for trichomonas testing was quite high, as has been demonstrated in other studies [34–38].

In conclusion, on the basis of these results, the data safety and monitoring board of the Trial determined that there was sufficient behavioral and biological risk in three of the sites (China, Russia, and Zimbabwe) to warrant moving ahead with the community-randomized controlled trial. Study personnel in India and Peru conducted a second survey of approximately equal size to identify higher-risk populations. In India, the focus shifted to the recruitment of men who were frequent patrons of 'wine shops', establishments selling beer and distilled spirits by the drink or bottle. These venues were the principal locations for non-brothel female sex workers in Chennai, and the behavioral and STD risks there were significantly higher than in the general population sample originally tested. In Peru, the focus shifted to higher-risk young adults, particularly men who had sex with men, young unemployed men, and women with multiple partners. The risks in these second cross-sectional surveys approximated those seen in China, Russia, and Zimbabwe during the initial surveys.

Baseline data collection for the Trial began in September–October 2002 in China and Russia and in May–October 2003 in India, Peru, and Zimbabwe. Behavioral interviews and biological specimen collection will be repeated at 12 and 24 months after baseline. The incidence of STD and behavioral outcomes (principally unprotected sex with non-spousal partners) will be compared between intervention venues, which will receive a community popular opinion leader intervention along with STD/HIV educational materials and easy access to condoms, and comparison venues that will receive only the STD/HIV educational materials and easy access to condoms. Results of the intervention Trial are expected to be available in 2008.

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