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Prevalence of HIV, Sexually Transmitted Infections, and Risk Behaviours Among Female Sex Workers in Nairobi, Kenya: Results of a Respondent Driven Sampling Study

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Abstract

We conducted a respondent driven sampling survey to estimate HIV prevalence and risk behavior among female sex workers (FSWs) in Nairobi, Kenya. Women aged 18 years and older who reported selling sex to a man at least once in the past 3 months were eligible to participate.

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Disclaimer The findings and conclusions in this paper are those of the authors and do not necessarily represent those of the US Centers for Disease Control and Prevention or the Government of Kenya.

Consenting FSWs completed a behavioral questionnaire and were tested for HIV and sexually transmitted infections (STIs). Adjusted population-based prevalence and 95 % confidence intervals (CI) were estimated using RDS analysis tool. Factors significantly associated with HIV infection were assessed using log-binomial regression analysis. A total of 596 eligible participants were included in the analysis. Overall HIV prevalence was 29.5 % (95 % CI 24.7–34.9). Median age was 30 years (IQR 25–38 years); median duration of sex work was 12 years (IQR 8–17 years). The most frequent client-seeking venues were bars (76.6 %) and roadsides (29.3 %). The median number of clients per week was seven (IQR 4–18 clients). HIV testing was high with 86.6 % reported ever been tested for HIV and, of these, 63.1 % testing within the past 12 months. Of all women, 59.7 % perceived themselves at ‘great risk’ for HIV infection. Of HIV-positive women, 51.0 % were aware of their infection. In multivariable analysis, increasing age, inconsistent condom use with paying clients, and use of a male condom as a method of contraception were independently associated with unrecognized HIV infection. Prevalence among STIs was low, ranging from 0.9 % for syphilis, 1.1 % for gonorrhea, and 3.1 % for Chlamydia. The data suggest high prevalence of HIV among FSWs in Nairobi. Targeted and routine HIV and STI combination prevention strategies need to be scaled up or established to meet the needs of this population.

Keywords

Female sex worker; Kenya; HIV; Sexually transmitted infection; Respondent driven; Sampling

Introduction

Female sex workers (FSWs) continue to bear a high burden of HIV infection in many countries and are an important target population for a public health response to HIV/AIDS [1–5]. However, because behaviors associated with FSWs are considered to be illegal and highly stigmatized in many countries, it is often difficult to conduct probability-based surveys designed to provide representative estimates of biologic and behavioral factors among FSWs [6].

Despite these challenges, numerous studies among FSWs have been conducted in Kenya to estimate the level of HIV risk and to ascertain accurate levels of HIV infection, both prevalent and incident, among cohorts of FSWs [7–10]. These studies which have primarily utilized targeted or selective recruitment methods have provided useful information over the years. To date, however, methods used in previous studies in Nairobi have not measured HIV and STI prevalence among a representative sample of FSW in Nairobi. Sex work is illegal in Kenya, and surveillance of HIV and STI’s of FSW populations requires sampling methods suitable for recruiting hard-to-reach populations. Globally, national HIV surveillance activities have adopted respondent driven sampling (RDS) methods to provide population-based estimates of HIV prevalence and associated risk behaviors for populations at highest risk for HIV infection, such as FSWs [11, 12]. RDS is a probability-based, chain-referral sampling method to reach hidden populations that takes into account the social network size and degree of similarity between participants and other members they recruit into the study that provides population estimates of HIV prevalence and risk behaviors. Despite widespread use of RDS globally, important limitations of the method exists,

including high variance of estimates and inflated design effects, making it difficult to identify changes in behavior and disease prevalence in the surveyed populations over time [13]. In 2010, the Government of Kenya established a surveillance system to monitor biologic and behavioral trends among key population groups at highest risk for HIV infection using RDS. In this analysis we present estimates of baseline HIV, sexually transmitted infections (STIs), and behavioral risk among FSWs using data collected from an RDS survey conducted in Nairobi, the capital city of Kenya. This is the first RDS survey to approximate a population-based survey on HIV and STI among FSWs in Nairobi, Kenya.

Methods

Study Design and Eligibility

Between November through December 2010, an RDS survey was conducted among FSWs in Nairobi, Kenya. Details of RDS methodology are described elsewhere [14, 15]. A target sample size of 600 was calculated. This sample size took into consideration the expected RDS-related design effect of 2.0 [16], an estimated HIV prevalence of 33.5 %, and an expected precision of 6 %. Women, 18 years of age or older, who reported selling sex for money, drugs, or goods to a man at least once in the past 3 months, and who lived in Nairobi or adjacent urban areas were eligible for the survey. Women who were mentally impaired due to alcohol or drug use, previously participated in the survey or presented with an invalid study coupon were excluded from participation. Participants were assessed for eligibility and interviewed at a single, centrally located facility in Nairobi close to Kenyatta National Hospital which was easily accessible by public transportation.

Sampling Method

Six initial FSW participants, also known as “seeds,” were selected to initiate coupon-based recruitment. Seeds were selected purposively to represent the geographical, occupational (e.g., brothel vs. street based), social economic and educational diversity of the target populations. Seeds were identified through formative assessments (e.g., focus group discussions, key informant interviews and in-depth interviews) with key study stakeholders and representatives of different key population groups. Eligible FSWs who provided informed consent to participate were administered an interview and asked to provide blood, urine, vaginal, and anal specimens for HIV and STI testing. Participants were provided up to three coupons and instructed to recruit their FSW peers into the study, who in turn were provided up to three coupons to recruit their FSW peers into the study. FSWs were provided a primary incentive of 200 KSH (i.e., $2USD) to participate and a secondary incentive of 200 KSH (i.e., $2USD) for each eligible peer recruited and enrolled into the study. A coupon manager system was used during the study to track coupons and monitor recruitment. The number of coupons distributed to participants was reduced at times when the number of recruits visiting the study site was too large for study staff capacity. Coupon reduction was also employed in order to balance recruitment when the number of participants was skewed towards certain contingencies of Nairobi. Fingerprint recognition software was used to create a unique study identification number for each participant to assist in preventing the same participant from enrolling more than once. Following informed consent participants were interviewed by a nurse counselor with a structured questionnaire

in a private room. The questionnaire included questions on participant socio-demographic characteristics, sex work habits, sexual behaviors, condom use with paying clients and nonpaying partners, history of STI symptoms, alcohol consumption, history of drug use, knowledge of HIV transmission risk, self-perceived risk for HIV infection, HIV testing history, and self-reported HIV status. Correct knowledge of HIV status was assessed by comparing the participant's self-reported HIV status with the survey HIV test result. Participants who were aware of their status were asked if they were currently taking antiretroviral therapy to treat their infection. Participants were requested to provide blood, vaginal, urine, and anal specimens for HIV and STI testing. Anal specimens were collected only for participants that reported anal sex or had anal symptoms.

Laboratory Methods

Rapid HIV testing was conducted on-site on blood samples using a parallel HIV testing algorithm. All specimens were screened with Determine (Inverness Medical, Massachusetts, USA) and Unigold (Biotech PLC, Ireland) rapid test kits. Specimens that were non-reactive by both rapid tests were classified as HIV-negative. Dually reactive specimens were classified as HIV-positive. All discordant specimens were resolved using Bioline rapid test kit (Standard Diagnostics, INC, South Korea). Specimens that were positive on Bioline were classified as HIV-positive. Specimens that were negative on Bioline were classified as HIV-negative. Participants with HIV-positive results were referred to government clinics for confirmatory testing and further HIV management.

STI testing was conducted at the University of Nairobi Institute of Tropical and Infectious Diseases Laboratory. Testing for syphilis was performed using rapid plasma reagent (RPR) assays (Roche Amplicor CT/NG test) and Treponema palladium hemagglutination assay (TPHA) for confirmatory testing. Detection of *T. vaginalis* was performed using the In Pouch™ system. Vaginal cultures were evaluated for Bacterial Vaginosis using Nugent's scoring criteria and for candidiasis the KOH test. Vaginal and rectal swab specimens and urine were tested for using the Polymerase chain reaction (PCR) (Roche Amplicor, Switzerland) assay for detection of *C. trachomatis* and *N. gonorrhea* antigens. Detection of the HSV-2 antibody was conducted using an enzyme-linked immunosorbent assay (Kalon Biological Ltd, United Kingdom). At the end of the visit, participants were provided an appointment card and asked to return to the study site after 2 weeks to receive their STI test results with post-test counseling and secondary incentives for those who recruited a FSW that was later enrolled in the study. Participants with positive STIs and/or STI symptoms were provided free treatment in accordance with the Kenya National STI Treatment Guidelines.

Data Management and Analysis

All interview data were entered into handheld Personal Digital Assistant (PDAs) using customized data entry applications with programmed data entry checks to ensure data quality. Data were analyzed using SAS 9.0 and RDS Analysis Tool (RDSAT) version 6.0.1, an analysis package designed to provide population estimates and their 95 % confidence intervals (CI) accounting for differences in participant recruitment patterns, network size, and homophily [15]. Estimates generated through RDSAT were weighted to compensate for

bias due to personal network size or any differential sampling of participants. Personal network size was estimated by asking each participant the question: “Approximately, how many other female sex workers do you know by name, who live in or around Nairobi, and you know how to contact them.” The dual-component estimator within RDSAT was used to measure average network size [17]. Ninety-five percent CIs were determined by bootstrap methods using 15,000 re-samples. The RDS dataset was analyzed using the enhanced data smoothing option. To assess associations with the outcome of unrecognized HIV infection, multivariable analyses were conducted using the relative risk (RR) measure. HIV-positive women who were aware of their infection were excluded from the analysis because reported risk behaviors may have differed among participant’s based on knowledge of HIV-infection. Unrecognized infection was defined as a participant who was HIV-positive based on test results from the study but was unaware of her infection (i.e., either reported her status as HIV-negative or never had been tested before). Relative risk and its corresponding 95 % CIs was estimated using log-binomial regression using the GENMOD procedure in SAS. The REPEATED option was used to calculate robust standard errors for parameter estimates. All analyses were weighted using individual HIV weights exported from RDSAT. Variables (or individual categories within variables) that were found to be significant at $p = .20$ or lower were included in the multivariable analysis. Prevalence and corresponding 95 % CIs of specific STIs and STI symptoms were also generated by RDSAT. Comparison of STI prevalence and STI symptoms by HIV status was assessed using a z-test.

Ethical Considerations

This study protocol was submitted for review and approved by the Kenyatta National Hospital Ethics and Research Committee (KNH-ERC), the Population Council Institutional Review Board (IRB), and to the Associate Director for Science, Division of Global HIV/AIDS of the US Centers for Disease Control and Prevention.

Results

During the 10 waves of recruitment, a total of 1,219 coupons were issued to peers with 632 returned resulting in a coupon return rate of 52 %. Of the six initial seeds, only one did not recruit additional participants. This seed was HIV-negative, aged 25–29 years, married, reported to be at “great risk” for HIV infection, and was recruited from Makadara constituency—a neighborhood that recruited only 3.4 % of the sample (Fig. 1). Of these 632 women who arrived at the facility with coupons, 596 (94 %) FSWs (non-seeds) were eligible for the survey and consented to participate. Of the 36 women excluded, the reasons for exclusion included eligible but did not provide consent (n = 9), not from the study coverage area (n = 7), under 18 years of age (n = 5), under the influence of substances (n = 4), determined to be disruptive during the screening process (n = 3), did not have a coupon (n = 3), previous participation (n = 2), not a sex worker within the study criteria (n = 2), and mentally impaired (n = 1). The median personal network size of participants was 8 (IQR 4–20). Equilibrium was reached on age-group, marital status, education-level, and duration of sex work before the 10 recruitment waves attained in the sample. Although FSW were recruited from all the eight constituencies of Nairobi (i.e., sub-counties of Nairobi which serve as administrative units for local governance: Makadara, Kamukunji, Starehe, Lang’ata,

Dagoretti, Westlands, Kasarani, and Embakasi), recruitment was concentrated in the Kamkunji and Kasarani constituencies of Nairobi. Figure 1 illustrates the recruitment pattern of participants by constituency.

RDS adjusted population estimates of socio-demographic, behavioral characteristics, and HIV prevalence are shown in Table 1. Ages ranged from 18 to 62 years with the median age of 30 years (unweighted IQR 25–38 years). Almost all women were currently unmarried, and 44.3 % had no formal education or attained only an incomplete primary education. Duration of sex work ranged from 4 to 45 years with a median duration of 12 years (IQR 8–17 years). The majority of women (82.2 %) stated that sex work was their main source of income. The most frequent client-seeking venues were bars (76.6 %) and roadsides (29.3 %), and situations where clients called them (20.1 %). The median number of paying clients in the last 7 days was seven (IQR 4–18 clients). Almost two-thirds (62.6 %) used a condom consistently (“always used”) with their paying clients in the past 30 days, and 86.9 % reported using a condom with their last paying client. Most women (59.8 %) did not have a non-paying partner in the past 30 days. Among those who did, 38.6 % consistently used a condom (always used) within the last 30 days with their non-paying partner(s), and 47.5 % reported using a condom at last sex with their non-paying partner. Less than 20 % reported never consuming alcohol; however, 33.4 % reported consuming alcohol 4 or more times per week. Bhang (marijuana) (36.0 %) and Khat/miraa (40.1 %) were the most frequently used drugs in the past. Very few women (*1 %) ever used heroin or injected drugs. Almost three-quarters (73.9 %) of women used at least one contraception method within the past 30 days, with the most common method being injectable contraception (e.g., depot medroxyprogesterone acetate or DMPA) (27.1 %) followed by male condoms (26.6 %), implants (e.g., Norplant) (12.2 %), oral contraception (the pill) (8.2 %), and female condoms (6.7 %). Just over half (51.6 %) of women stated that they practiced vaginal douching. HIV testing was high with 86.6 % of women who had been tested in the past; 63.1 % of these had been tested within the past 12 months. Of participants who tested HIV-positive during the survey, 51.0 % were aware of their infection before the survey, 25.4 % incorrectly reported they were HIV-negative, and 23.0 % were unaware because they had never tested for HIV. The majority of women (59.7 %) had high self-perceived risk for HIV while 14.9% already knew they were infected.

Table 1 also shows HIV prevalence by selected demographic and behavioral characteristics. Overall, the HIV prevalence among FSWs in this study was 29.5 % (95 % CI 24.7, 34.9). HIV prevalence increased with age and duration of time as a sex worker and was highest among women with no or incomplete primary education. Prevalence also varied by client-seeking locations. The highest HIV prevalence was observed among women who received clients in their home [43.6 % (95 % CI 28.3, 63.2)] whereas the lowest prevalence was among women seeking clients at ‘other’ locations such as brothels, hotels, massage parlors [17.9 % (95 % CI 6.0, 35.6)]. Prevalence was similar with overlapping confidence intervals across categories of number of paying clients in past 7 days, consistent condom use with paying clients, and condom use with last paying client. Prevalence was slightly higher for women who consistently used condoms with nonpaying partners (if any) and who used a condom with their last nonpaying partner (if any). Women who used a barrier method (male and/or female condom) as a form of contraception in the past 30 days had high HIV

prevalence [male condom: 44.6 % (95 % CI 32.7, 54.8), female condom: 41.8 % (95 % CI 22.4, 65.5)]. Conversely, women who used an oral contraception ("Pill") as a method of contraception had lower HIV prevalence [10.7 % (95 % CI 3.5, 19.5)].

Table 2 shows prevalence of possible STI symptoms and STI biomarkers, and a comparison of STI biomarkers by HIV test results. The most frequent symptom was abnormal vaginal discharge (23.9 %), followed by burning pain during urination (22.7 %), vaginal ulcer or sore (7.8 %), and anal ulcer or sore (1.0 %). Significantly higher prevalence of abnormal vaginal discharge and vaginal ulcer or sore was observed among HIV-infected women (abnormal vaginal discharge: z-score = 3.02, p = .0025; vaginal ulcer or sore: z-score = 2.39, p = .0167). The prevalence of biomarkers for syphilis, gonorrhea, and chlamydia infection was low (<5 %) among the population as a whole, as well as HIV-infected women. Prevalence of trichomaniasis, bacterial vaginosis, and candidiasis ranged from 10 to 28 % with slightly higher STI rates for HIV-infected women than HIV-uninfected women. Only trichomaniasis was significantly higher among HIV-infected women compared with HIV-uninfected women (z-score: 2.18, p = .0293).

Table 3 shows results of bivariate and multivariable analysis identifying candidate variables and significant predictors of unrecognized HIV infection. In bivariate analysis, increasing age, receiving clients at home, inconsistent condom use with paying clients, and use of a male condom as a method of contraception were positively associated with unrecognized HIV infection. Conversely, completing primary education, inconsistent condom use with nonpaying clients and use of the 'implant' as a method of contraception were negatively associated with unrecognized infection. Multivariable analysis revealed that increasing age, inconsistent condom use with a paying client [adjusted RR = 2.1 (95 % CI 1.4, 3.0), p = .0001], and male condom use as a method of contraception [adjusted RR = 2.5 (95 % CI 1.7, 3.5), p < .0001] were associated with unrecognized HIV infection.

Discussion

We confirm high HIV prevalence among FSWs in Nairobi where approximately one-third are infected with HIV. This level of HIV infection is nearly three times that of Nairobi women aged 15–49 years from two national population-based HIV serologic surveys conducted in Kenya in 2007 and 2008/09 [18, 19]. HIV prevalence among FSWs aged 18–24 years was also high at 14 %, highlighting the vulnerability of acquisition and transmission of HIV infection even among young FSWs. The high prevalence among young FSWs requires immediate interventions to encourage young girls and women to adopt early risk reduction strategies to prevent HIV infection and remain uninfected. We found that increasing age was associated with HIV infection, confirming that age increases the cumulative risk for HIV infection in this population. Moreover, inconsistent condom use with paying partners and reported use of male condoms as a contraceptive in the past 30 days were associated with HIV infection. Though condom use is a practical approach for minimizing transmission and acquisition of HIV infection among FSWs, prevention messages around correct and consistent use of condoms during sexual intercourse are critical for ensuring effectiveness of this tool for HIV prevention.

A second finding from this study is that HIV testing among FSWs is high, with testing rates more than two times that of persons in the general population [18]. After excluding women with known HIV-positive status, 84 % had a previous HIV test, and more than 50 % of those tested had been tested in the past 12 months. The high level of self-perceived risk among FSWs, together with the expansion of targeted HIV testing services for FSWs in Nairobi, may account for high testing rates in this population. As a direct benefit of HIV testing, over half of HIV-positive FSW were aware of their HIV infection compared with 18 % of HIV-infected women in the general population [19]. Still, despite high awareness of HIV status, a large percentage of HIV-infected FSW remained unaware of their HIV infection, and almost half incorrectly believed they were HIV-negative based on their last HIV test. As a result, FSWs continue to pose high risk of transmission to both their paying and non-paying partners and experience delays in accessing important treatment and care interventions. Some FSWs may have known their HIV-positive status at the time of the survey, but did not feel comfortable in reporting this during the interview. In Kenya, there is an extensive network of service delivery points that target FSWs which provide HIV testing and counseling services [20]. These services include innovative HIV testing and counseling strategies such as mobile testing, door-to-door testing, moonlight testing (i.e., where services are provided during times and in locations convenient to key populations), and provider-initiated testing and counseling services. These programs, while beneficial, should also undergo routine evaluation to assess reach and impact.

A third finding observed in this study is differential condom use patterns among participants. Measures of consistent condom use (“always used”) and condom use at last sex were higher with paying partners (62.3 and 86.8 %, respectively) than with non-paying partners (37.4 and 46.4 %, respectively). Differences in condom use by partner type have been noted in other studies of FSWs and other female populations [8, 10, 21–23]. Of concern is that unprotected sex is likely to occur with non-paying partners, increasing the risk of secondary infection (and other STIs) to themselves if uninfected, or to their sexual partners if infected. More information is needed to determine factors associated with condom use that may explain differences in condom utilization by partner type. It has been noted that behavioral changes that include increased condom use with partners, can be successful among FSWs in Kenya [22, 23], and in general, other low- and middle income countries [24, 25]. Besides increased condom use by partners, other approaches that place more emphasis on female-controlled prevention strategies, such as the use of female condoms, intravaginal products such as microbicides, or oral pre-exposure prophylaxis should be explored [10].

Finally, this study found low prevalence of syphilis %), gonorrhea (1.1 %), and chlamydia (3.1 %) infections, but higher levels of trichomaniasis (10.3 %), bacterial vaginosis (15.1 %), and candidiasis (28.4 %). Our population-based estimate of syphilis prevalence is similar to findings from another study of Nairobi FSWs which found that FSWs had higher syphilis prevalence than the general female population in Kenya (2.5 vs. 1.7 %, respectively) [10, 18]. However, our study found lower prevalence of other STIs than other studies conducted in Kenya and elsewhere [8–10, 25–28]. Low rates of STI among FSWs in Nairobi may highlight the availability and successful access of services through targeted programs for FSWs in the city, including drop-in centers, outreach services, and peed education

programs. Programs that target FSWs should continue to be supported and provide a package of prevention interventions, including HIV testing, condom promotion, syndromic management of STIs and education on how to prevent HIV transmission and acquisition.

There were several limitations of this study. Selfreported behaviors may have been misreported because of recall or social desirability bias. Although FSWs from all constituencies were eligible to participate, over 50 % of the sample came from only two constituencies: Kamkunji and Kasarani. In addition, we observed high degree of homophily for constituency (i.e. high preference for recruiting in one's own constituency), suggesting that the sample may not have formed an unbiased social network. Therefore, the sample drawn for this survey may not be generalizable to the broader population of FSWs in Nairobi. In addition, RDS is not a simple random sample, but subject to assumptions, such as quantifying the size of participant networks, which may be difficult to verify. As such, there may be limitations of the RDS method to approximate representative samples of hidden populations.

In spite of these limitations, this study demonstrated that surveillance for FSWs using RDS methodology is feasible in Nairobi, Kenya. Given the high prevalence of HIV infection in this population and the public health concern of potential for HIV transmission among FSWs and their partners, we recommend continued periodic surveillance among FSW in Nairobi, and expansion to other areas in Kenya, to monitor trends of HIV and behavioral risk factors for HIV to appropriately respond to the HIV epidemic in this vulnerable group.

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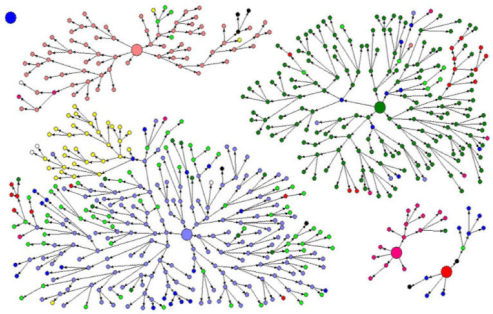

Recruitment by Constituency	
Dagoreti	1.7% (3)
Embakasi	12.4% (53)
Kamkunji	28.1% (166)
Kasarani	27.6% (160)
Langata	6.0 (4)
Starehe	6.0% (28)
Makadara	3.4% (14)
Westlands	11.7% (32)
Other	3.5% (20)

Fig. 1.

Respondent driven sampling recruitment profile of female sex workers by Constituency Nairobi, Kenya, 2010

Table 1

Characteristics and estimates of HIV prevalence among female sex workers, Nairobi, Kenya, 2010 (N = 596)

Characteristic	n[a]	Unadjusted % (95 % CI)	Adjusted % (95 % CI)	No. HIV+	Unadjusted HIV prevalence (95 % CI)	Adjusted HIV Prevalence (95 % CI)
HIV prevalence (N = 596)	–	–	–	183	30.7 (27.0, 34.4)	29.5 (24.7, 34.9)[f]
Age group (years)						
18–24	149	25.0 (21.5, 28.5)	30.8 (25.0, 36.7)	20	13.4 (7.9, 18.9)	14.3 (8.1, 24.7)
25–29	133	22.3 (19.0, 25.7)	22.5 (18.2, 27.4)	30	22.6 (15.4, 29.7)	24.3 (15.0, 32.7)
30–34	105	17.6 (14.6, 20.7)	18.9 (14.3, 23.6)	42	40.0 (30.6, 49.4)	42.0 (30.7, 55.9)
35–62	209	35.1 (31.2, 38.9)	27.9 (22.3, 33.6)	91	43.5 (36.8, 50.3)	39.0 (29.4, 50.2)
Median (IQR)[b]	30	(25–38)				
Marital status						
Never married	225	37.8 (33.8, 41.7)	41.7 (35.9, 46.5)	55	24.4 (18.8, 30.1)	26.5 (18.7, 35.4)
Previously married	365	61.2 (57.3, 65.2)	57.4 (52.6, 63.2)	125	34.2 (29.4, 39.1)	31.0 (24.7, 37.6)
Currently married	6	1.0 (0.20, 1.8)	1.0 (0.2, 2.0)	3	50.0 (9.9, 90.1)	43.6 (0.0, 1.0)
Education						
None/incomplete primary	278	46.6 (42.6, 50.7)	44.3 (38.5, 50.1)	105	37.8 (32.0, 43.5)	37.1 (29.9, 45.8)
Completed primary	169	28.4 (24.7, 32.0)	30.5 (25.4, 36.0)	40	23.7 (17.2, 30.1)	19.6 (13.0, 27.0)
Incomplete secondary	85	14.3 (11.4, 17.1)	12.8 (9.2, 16.3)	27	31.8 (21.8, 41.7)	30.9 (16.3, 47.4)
Completed secondary+	64	10.7 (8.2, 13.2)	12.4 (8.5, 17.3)	11	17.2 (7.9, 26.5)	21.1 (7.0, 38.9)
Duration of sex work (years)						
4–9	205	34.4 (30.6, 38.2)	39.1 (33.6, 45.1)	47	22.9 (17.2, 28.7)	23.5 (16.6, 33.0)
10–14	170	28.5 (24.9, 32.2)	27.8 (22.8, 33.0)	50	29.4 (22.5, 36.3)	28.2 (20.7, 38.9)
15–45	221	37.1 (33.2, 41.0)	33.1 (27.4, 38.5)	86	38.9 (32.5, 45.4)	37.2 (28.1, 47.3)
Median (IQR)[b]	12	(8–17)				
Sex work as main source of income						
Yes	485	81.4 (78.2, 84.5)	82.2 (77.6, 86.3)	147	30.3 (23.7, 41.2)	28.7 (17.9, 46.7)
No	111	18.6 (15.5, 21.8)	17.8 (13.7, 22.4)	36	32.4 (26.2, 34.4)	32.9 (24.0, 34.7)
Client seeking locations[c]						
Bar	441	74.0 (70.5, 77.5)	76.6 (70.7, 82.1)	116	26.3 (22.2, 30.4)	28.7 (23.9, 34.8)
Roadside	174	29.2 (25.5, 32.9)	29.3 (24.6, 34.7)	47	27.0 (20.4, 33.6)	22.9 (15.5, 31.1)

Characteristic	n[a]	Unadjusted % (95 % CI)	Adjusted % (95 % CI)	No. HIV+	Unadjusted HIV prevalence (95 % CI)	Adjusted HIV Prevalence (95 % CI)
At home	82	13.8 (11.0, 16.5)	8.8 (5.6, 12.4)	40	48.8 (37.9, 59.6)	43.6 (28.3, 63.2)
Rented stall or shed	43	7.2 (5.1, 9.3)	4.1 (2.3, 5.9)	16	37.2 (22.7, 51.7)	35.6 (16.9, 57.7)
Clients called participant	132	22.1 (18.8, 25.5)	20.1 (15.6, 24.7)	37	28.0 (20.3, 35.7)	33.2 (19.9, 44.8)
Other locations	47	7.9 (5.7, 10.1)	6.2 (3.5, 9.3)	10	21.3 (9.5, 33.0)	17.9 (6.0, 35.6)
Number of paying partners (past 7 days)						
0–10	359	60.6 (56.7, 64.6)	67.7 (62.1, 72.4)	103	28.7 (24.0, 33.4)	28.9 (22.7, 36.1)
11–20	105	17.7 (14.7, 20.8)	14.5 (11.1, 18.0)	30	28.6 (19.9, 37.2)	27.6 (18.0, 41.8)
21–30	78	13.2 (10.4, 15.9)	12.3 (8.9, 16.5)	26	33.3 (22.8, 43.8)	23.2 (13.1, 36.8)
31+	50	8.4 (6.2, 10.7)	5.6 (3.5, 8.2)	22	44.0 (30.2, 57.8)	31.5 (16.4, 48.9)
Median number of paying partners past 7 days (IQR)[b]	7	(4–18)				
Consistent condom use with paying partners (past 30 days)						
Always	383	64.6 (60.7, 68.4)	62.6 (55.9, 68.3)	115	30.0 (25.4, 34.6)	26.9 (20.9, 33.9)
Sometimes/never	210	35.4 (31.6, 39.3)	37.4 (31.7, 44.2)	67	31.9 (25.6, 38.2)	33.0 (25.4, 42.6)
Condom use with last paying partner						
Yes	513	86.2 (83.4, 90.0)	86.9 (82.8, 90.2)	161	31.4 (27.4, 35.4)	30.6 (25.2, 36.7)
No	82	13.8 (11.0, 16.6)	13.1 (9.7, 17.3)	22	26.8 (17.2, 36.4)	24.1 (13.0, 36.6)
Number of non-paying sex partner(s) (past 30 days)						
None	336	56.4 (52.4, 60.4)	59.8 (54.6, 65.6)	112	33.3 (28.3, 38.4)	30.4 (24.0, 37.0)
1	181	30.4 (26.7, 34.1)	27.4 (22.1, 32.2)	48	26.5 (20.1, 33.0)	28.2 (18.0, 39.3)
2+	79	13.3 (10.5, 16.0)	12.9 (9.4, 16.6)	23	29.1 (19.1, 39.2)	27.0 (15.5, 40.6)
Consistent condom use with nonpaying partner(s) (past 30 days) (N = 260)						
Always	94	36.2 (30.3, 42.0)	38.6 (21.6, 44.4)	35	37.2 (27.4, 47.1)	33.6 (22.0, 70.0)
Sometimes/never	166	63.8 (58.0, 69.7)	61.4 (55.6, 78.4)	36	21.7 (15.3, 28.0)	22.4 (7.8, 27.7)
Condom use with last nonpaying partner (N = 260)						
Yes	125	48.1 (42.0, 54.2)	47.5 (29.3, 53.1)	41	32.8 (24.5, 41.1)	34.0 (25.4, 37.5)
No	135	51.9 (45.8, 58.0)	52.5 (46.9, 70.7)	30	22.2 (15.2, 29.3)	17.7 (6.1, 27.1)
Alcohol consumption						
Never	111	18.6 (15.5, 21.8)	19.4 (14.6, 24.5)	40	36.0 (27.1, 45.0)	33.1 (24.6, 47.2)
Once a month or less	62	10.4 (7.9, 12.9)	8.0 (6.0, 12.8)	28	45.2 (32.7, 57.6)	37.2 (20.7, 55.9)
2–4 times a month	56	9.4 (7.0, 11.7)	10.9 (7.4, 14.3)	18	32.1 (19.9, 44.4)	34.7 (16.8, 50.8)

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Characteristic	n[a]	Unadjusted % (95 % CI)	Adjusted % (95 % CI)	No. HIV+	Unadjusted HIV prevalence (95 % CI)	Adjusted HIV Prevalence (95 % CI)
2–3 times a week	144	24.2 (20.7, 27.6)	27.4 (22.6, 33.8)	36	25.0 (17.9, 32.1)	24.0 (17.4, 36.1)
4 or more times a week	223	37.4 (33.5, 41.3)	33.4 (27.3, 38.4)	61	27.4 (21.4, 33.2)	28.6 (19.4, 36.9)
Drug use (past 12-months)[c,d]						
Marijuana/bhang	246	41.3 (37.3, 45.2)	36.0 (31.1, 42.1)	68	27.6 (22.0, 33.2)	24.3 (18.9, 32.2)
Khat/miraa	263	44.1 (40.1, 48.1)	40.1 (34.1, 45.7)	74	28.1 (22.7, 33.6)	28.7 (21.1, 37.3)
Heroin	9	1.5 (0.52, 2.5)	1.1 (0.4, 2.0)	3	33.3 (2.4, 64.2)	50.8 (0.0, 81.3)
Injection drug use	9	1.5 (0.53, 2.5	1.0 (0.3, 1.9)	1	11.1 (0.0, 31.7)	22.6 (0.0, 54.6)
Contraception method (past 30 days)[c]						
Any contraception used	434	72.8 (69.2, 76.4)	73.9 (69.0, 78.3)	135	31.0 (22.6, 36.7)	30.2 (24.2, 36.4)
Injection	152	25.5 (22.0, 29.0)	27.1 (21.9, 32.3)	36	23.7 (16.9, 30.5)	26.6 (18.6, 36.8)
Male condom	167	28.0 (24.4, 31.6)	26.6 (20.1, 31.0)	68	40.7 (33.3, 48.2)	44.6 (32.7, 54.8)
Implant	63	10.6 (8.1, 13.0)	12.2 (8.1, 16.7)	19	30.2 (18.8, 41.5)	17.0 (9.1, 29.4)
Pill	57	9.6 (7.2, 11.9)	8.2 (5.9, 11.0)	10	17.5 (7.6, 27.4)	10.7 (3.5, 19.5)
Female condom	39	6.5 (4.6, 8.5)	6.7 (4.1, 9.6)	15	38.5 (26.3, 34.0)	41.8 (22.4, 65.5)
Practice douching						
Yes	305	51.2 (47.1, 55.2)	51.6 (46.1, 57.1)	98	32.1 (26.9, 37.4)	31.6 (24.8, 39.2)
No	291	48.8 (44.9, 52.9)	48.4 (42.9, 53.9)	85	29.2 (24.0, 34.4)	27.4 (20.4, 34.3)
Tested for HIV						
Yes, tested before	532	89.3 (86.8, 91.8)	86.6 (81.9, 90.2)	154	28.9 (25.1, 32.8)	25.9 (20.4, 31.3)
Never tested	64	10.7 (8.2, 13.2)	13.4 (9.8, 18.1)	29	45.3 (33.1, 57.6)	47.3 (33.1, 65.2)
Time since last HIV test (among those tested) (N = 532)						
<12 months	341	64.1 (60.0, 68.2)	63.1 (56.1, 68.4)	66	19.4 (15.1, 23.6)	17.1 (13.0, 23.6)
12+ months	181	34.0 (30.0, 38.1)	34.8 (29.7, 41.9)	84	46.4 (39.1, 53.7)	45.3 (34.5, 58.4)
Unknown	10	1.9 (0.72, 3.0)	2.1 (0.6, 3.6)	4	40.0 (9.5, 70.5)	32.1 (2.4, 85.9)
Correct knowledge of HIV status[d]						
HIV-positive (N = 181)						
Aware, reported HIV-positive	116	64.1 (57.0, 71.1)	51.0 (40.6, 63.1)	–		–
Unaware of infection, reported negative	32	17.7 (12.1, 23.3)	25.4 (14.8, 35.3)	–		–
Unaware of infection, never tested	33	18.2 (12.6, 23.9)	23.0 (14.4, 34.2)	–		–
HIV-negative (N = 409)						

Characteristic	n[a]	Unadjusted % (95 % CI)	Adjusted % (95 % CI)	No. HIV+	Unadjusted HIV prevalence (95 % CI)	Adjusted HIV Prevalence (95 % CI)
Reported HIV-negative	362	88.5 (85.4, 91.6)	88.1 (84.0, 92.2)	–		–
Unaware of status, never tested	47	11.5 (8.4, 14.6)	11.9 (7.8, 16.0)	–		–
ARV use by knowledge of HIV-positive status (N = 178)[e]						
Aware, Taking ARVs	59	33.1 (26.2, 40.1)	30.9 (15.2, 54.5)	–		–
Aware, Not taking ARVs	54	30.3 (23.5, 37.2)	31.0 (8.4, 41.4)	–		–
Unaware	65	36.5 (29.4, 43.7)	38.0 (21.8, 66.6)	–		–
Perception of HIV risk						
No risk	26	4.4 (2.7, 6.0)	3.7 (2.2, 5.7)	3	11.5 (0.0, 23.9)	7.6 (0.0, 17.4)
Small or moderate risk	105	17.6 (14.6, 20.7)	18.1 (13.6, 22.6)	7	6.7 (1.9, 11.5)	6.5 (1.4, 13.3)
Great risk	333	55.9 (51.9, 59.9)	59.7 (53.8, 62.2)	53	15.9 (12.0, 20.0)	20.7 (14.1, 27.5)
Don’t know risk	16	2.7 (1.4, 4.0)	3.7 (1.6, 5.6)	4	25.0 (3.7, 46.3)	27.2 (0.0, 56.7)
Already knew HIV infected	116	19.5(16.2, 22.7)	14.9 (11.3, 19.3)	116	100 (–)	100 (–)

[a] The denominator for unadjusted percentages is 596 unless otherwise noted

[b] Median and IQR are unadjusted

[c] Respondents could have selected several client seeking locations

[d] Six observations were excluded because the participant refused to disclose their HIV status and therefore correct knowledge of HIV status could not be classified

[e] Five observations were excluded: three because the participant refused to disclose their HIV status and therefore knowledge of HIV status. could not be classified, and two refused to disclose ARV usage

[f] The design effect (DEFF) for HIV prevalence was 1.94

Table 2

Prevalence of STI symptoms and diagnoses among female sex workers, Nairobi, Kenya, 2010 (N = 596)

Variable	All participants (N = 596)			HIV-negative participants (N = 413)			HIV-positive participants (N = 183)			*p* value
	n	Unadjusted % (95 % CI)	Adjusted % (95 % CI)	n	Unadjusted % (95 % CI)	Adjusted % (95 % CI)	n	Unadjusted % (95 % CI)	Adjusted % (95 % CI)	
STI symptoms										
Abnormal vaginal discharge	171	28.7 (25.0, 32.3)	23.9 (19.5, 28.8)	98	23.7 (19.6, 27.8)	18.9 (14.7, 24.1)	73	39.9 (32.8, 47.0)	36.2 (27.2, 47.6)	.0025
Vaginal ulcer or sore	52	8.7 (6.5, 11.0)	7.8 (5.1, 10.7)	27	6.5 (4.1, 8.9)	5.2 (2.9, 8.4)	25	13.7 (8.7, 18.7)	14.1 (7.4, 20.9)	.0167
Anal ulcer or sore	7	1.2 (0.3, 2.0)	1.0 (0.2, 2.1)	4	1.0 (0.0, 1.9)	0.4 (0.0, 10.0)	3	1.6 (0.0, 3.5)	2.3 (0.0, 5.6)	.5158
Burning pain on urination	152	25.5 (22.0, 29.0)	22.7 (18.5, 27.3)	92	23.3(0.0, 3.5)	20.0 (15.3, 25.6)	60	32.8 (26.0, 39.6)	29.6 (21.5, 40.8)	.0854
Prevalence of STI										
Syphilis	5	0.8 (0.1, 1.6)	0.9 (0.2, 1.9)	2	0.5 (0.0, 1.2)	0.8 (0.0, 2.1)	3	1.6 (0.0, 3.5)	1.3 (0.1, 3.5)	.5483
Gonorrhea[a]	13	2.3 (1.0, 3.5)	1.1 (0.4, 2.1)	6	1.5 (0.31, 2.7)	0.5 (0.1, 1.0)	7	4.0 (1.1, 6.8)	2.9 (0.7, 6.0)	.0811
Chlamydia[a]	16	2.8 (1.4, 4.1)	3.1 (1.5, 5.3)	13	3.3 (1.5, 5.0)	3.9 (1.6, 6.6)	3	1.7 (0.0, 3.6)	1.1 (0.0, 4.0)	.0851
Trichomaniasis[b]	49	8.5 (6.2, 10.8)	10.3 (6.9, 14.5)	26	6.5 (4.1, 9.0)	7.9 (4.6, 12.8)	23	12.9 (8.0, 17.9)	17.8 (8.8, 24.6)	.0293
Bacterial vaginosis[c]	95	16.4 (13.4, 19.5)	15.1 (11.5, 19.3)	57	14.3 (10.8, 17.7)	12.3 (8.7, 16.4)	38	21.4 (15.3, 27.4)	21.4 (13.4, 32.0)	.0764
Candidiasis[c]	147	25.4 (21.9, 29.0)	28.4 (23.3, 33.5)	103	25.8 (21.5, 30.0)	28.2 (22.0, 34.5)	44	24.7 (18.4, 31.1)	28.5 (19.1, 38.0)	.9586
Positive/reactive for any STI biomarker (except HIV)[d]	205	34.4 (30.6, 38.2)	38.0 (33.0, 43.6)	135	32.7 (28.2, 37.2)	36.4 (29.8, 42.9)	70	38.3 (31.2, 45.3)	42.9 (32.9, 53.5)	.2966

[a] 21 participants excluded because of missing STI results

[b] 20 participants excluded because of missing STI results

[c] 18 participants excluded because of missing STI results

[d] 22 respondents excluded because missing one or more STI test results

Table 3

Bivariate and multivariable log-binomial analysis of predictors of unrecognized HIV infection among female sex workers, Nairobi, Kenya, 2010 (N = 480)

Variable	Unadjusted RR (95 % CI)	*p* value	Adjusted RR (95 % CI)[a]	*p* value
Age group (years)				
18–24	Referent	–	Referent	–
25–29	1.6 (0.9, 3.1)	**.1287**	1.5 (0.8, 2.9)	.1808
30–34	2.9 (1.6, 5.2)	**.0005**	2.4 (1.3, 4.3)	**.0030**
35–62	2.3 (1.3, 4.1)	**.0045**	2.1 (1.2, 3.7)	**.0124**
Marital status				
Never married	Referent	–		
Previously married	0.9 (0.6, 1.3)	.4210		
Currently married	1.3 (0.3, 6.4)	.7720		
Education				
None/incomplete primary	Referent	–		
Completed primary	0.5 (0.3, 0.8)	**.0088**		
Incomplete secondary	0.8 (0.5, 1.5)	.5638		
Completed secondary+	0.7 (0.4, 1.3)	.2301		
Duration of sex work (years)				
4–9	Referent	–		
10–14	1.0 (0.6, 1.7)	.9705		
15–45	1.3 (0.9, 2.1)	**.1997**		
Sex as a main source of income				
No	Referent	–		
Yes	0.8 (0.5, 1.4)	.4880		
Client-seeking locations[b,d]				
Bar	1.0 (0.6, 1.5)	.8992		
Roadside	0.7 (0.4, 1.1)	**.1448**		
At home	1.8 (1.0, 2.9)	**.0299**		
Rented stall or shed	1.2 (0.67, 2.1)	.5430		
Clients called participant	1.3 (0.8, 2.0)	.3165		
Other locations	0.8 (0.4, 1.9)	.6605		
Number of paying partners (past 7 days)				
0–10	Referent	–		
11–20	0.9 (0.5, 1.6)	**.7278**		
21–30	0.6 (0.3, 1.2)	**.1514**		
31+	0.2 (0.02, 1.5)	**.1119**		
Consistent condom use with paying partners (past 30 days)				
Always	Referent	–	Referent	–
Sometimes/never	1.9 (1.3, 2.8)	**.0015**	2.1 (1.4, 3.0)	**.0001**
Condom use with last paying partner				
Yes	Referent	–		

Variable	Unadjusted RR (95 % CI)	*p* value	Adjusted RR (95 % CI)[a]	*p* value
No	0.8 (0.4, 1.4)	.3788		
Number of non-paying sex partner(s) (past 30 days)				
None	Referent	–		
1	0.6 (0.4, 1.0)	.0613		
2+	1.0 (0.6, 1.8)	.9442		
Consistent condom use with nonpaying partner(s) (past 30 days)				
Always	Referent	–		
Sometimes/Never	0.7 (0.4, 1.1)	**.1380**		
Condom use with last nonpaying partner				
Yes	Referent	–		
No	0.5 (0.2, 0.9)	**.0287**		
Drug use (past 12 months)[c,d]				
Marijuana/bhang	0.8 (0.5, 1.2)	**.1981**		
Khat/miraa	0.8 (0.6, 1.3)	.3871		
Heroin	1.3 (0.2, 6.8)	.7721		
Injection drug use	1.2 (0.2, 5.9)	.8899		
Alcohol consumption				
Never	Referent	–		
Once a month or less	1.9 (0.9, 3.9)	**.0973**		
2–4 times a month	1.1 (0.4, 2.5)	.8879		
2–3 times a week	1.3 (0.7, 2.4)	.4658		
4 or more times a week	1.3 (0.7, 2.4)	.4037		
Contraception method (past 30 days)[c]				
Any contraception used	1.2 (0.8, 1.9)	.4328		
Injection	0.8 (0.5, 1.3)	.3901		
Male condom	2.3 (1.6, 3.3)	**<.0001**	2.5 (1.7, 3.5)	**<.0001**
Implant	0.5 (0.1, 0.9)	**.0322**		
Pill	0.3 (0.1, 1.0)	**.0510**		
Female condom	0.5 (0.1, 1.8)	.2686		
Practice douching				
No	Referent	–		
Yes	1.1 (0.9, 1.2)	**.1315**		

[a] Adjusted for all variables or individual categories within variables that were found to be significant at $p \leq .20$ or lower in bivariate analysis. Variables found to be significant at the $p \leq .05$ are displayed

[b] Respondents could have selected several client-seeking locations

[c] Respondents could have used selected several drugs in the past 12 months

[d] Referent group for multi-response variables were women who did not report the response