

Dyspareunia, signs of epithelial disruption, and HIV status in female sex workers and men who have sex with men in Nairobi: a cross-sectional study

Bastian Fischer (✉ bastian.fischer@kh-hubertusburg.de)

Hubertusburg Hospital Wermisdorf

Walter Jaoko

University of Nairobi

Elvis Kirui

Bernard Muture

Isaac Madegwa

University of Nairobi, Centre for HIV Prevention and Research

Lisbeth Kageni

University of Nairobi, Centre for HIV Prevention and Research

Research Article

Keywords: Sexual dysfunction, coital bleeding, dyspareunia, anodyspareunia, HIV infection risk, HIV key populations, female sex workers (FSWs), men who have sex with men (MSM)

Posted Date: March 8th, 2022

DOI: <https://doi.org/10.21203/rs.3.rs-1315364/v2>

License:  This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Abstract

Background: There is need to focus on HIV prevention as the global number of people acquiring HIV has not declined enough to meet set targets. Painful sexual intercourse may be indicative of minor epithelial injury. Epithelial trauma signs are potential risk factors of HIV infection in men who have sex with men (MSM) and female sex workers (FSWs). The objective of the study was to establish whether there is a relationship between HIV serostatus and signs of epithelial disruption in two HIV key population samples.

Methods: Participants were randomly selected from registers of two health facilities in Nairobi, namely Bar Hostess and Hoymas, which serve FSWs and MSM respectively. A questionnaire was administered to 322 FSWs and 231 MSM, who provided data on HIV infection status, sexual dysfunction, intercourse frequency and previous abstinence behaviour. Sexual dysfunction scores were created from items of the Female Sexual Function Index (FSFI-19). Additional questions addressed visual and sensory signs of epithelial trauma. Sexual dysfunction scores for MSM used an anal adaptation of questions from the FSFI-19 and additional trauma sign questions. Statistical tests included two-sample t-tests for abstinence gaps and intercourse frequencies, the number of sex partners, vaginal births, and age of sexual debut. Mann-Whitney U tests were used to compare HIV status and the ordinal variables of sexual behaviour, individual factors, dyspareunia and signs of trauma scores. Bivariate logistic regression was used to estimate the magnitude of difference for significant associations. Potential factors influencing the occurrence of sexual dysfunction were evaluated by FSWs, yielding percentages of the assessment options selected by FSWs out of the total sample.

Results: Complaint levels for pain and discomfort from sexual intercourse in the previous four weeks were at least moderate for 60% of MSM and 74% of FSWs. Bleeding related to intercourse was reported at least sometimes by 57% of MSM and 51% of FSWs. For FSWs, living with HIV was 0.874 (0.814-0.939) (odds ratio (95% confidence interval)) times less likely with increased intervals (one day) between any instance of vaginal intercourse or comparable object insertion in the previous month. As the level of satisfaction with emotional closeness during sex decreased, the odds of living with HIV increased 1.479 (1.220-1.792) times. The odds of living without HIV decreased 0.807 (0.656-0.994) times with increasing satisfaction with overall sexual life. As the frequency level of pain and discomfort during or following vaginal penetration in the past four weeks increased, risk of living with HIV increased 1.757 (1.379-2.239) or 1.441 (1.125-1.845) times, respectively, while incrementing intensity of discomfort and pain increased the odds of living with HIV 1.398 (1.119-1.747) times. As the frequency level of bleeding signs during or after vaginal intercourse increased, the relative risk of living with HIV increased 1.737 (1.285-2.348) times, and noticing more vaginal itching, burning, or soreness increased the odds of living with HIV 2.145 (1.429-3.220) times. No significant association between self-reported HIV status and sexual dysfunction or sex frequency variables were found in the MSM sample. A majority of FSWs agreed that steady partnerships (81% agreement), regularity of intercourse (74%), foreplay (73%) and lubrication or artificial lubricants (65%) alleviate discomfort and painful vaginal intercourse.

Conclusions: Dyspareunia and epithelial trauma signs were highly prevalent in FSWs and MSM. Complaint levels for pain and discomfort as well as bleeding and tenderness signs were associated with living with HIV, providing some evidence that reducing epithelial disruption may be a novel HIV prevention approach. Subjective factor assessments by FSWs may imply prevention methods for further study.

Background

The World Health Organization emphasizes the need to focus on HIV prevention as the global number of people acquiring HIV has not declined enough to reach the set targets [1]. Sex workers and men who have sex with men (MSM) are among the key populations considered particularly vulnerable to HIV with regard to a high risk of infection, discrimination, and stigma [2]. While the presence of other sexually transmitted infections (STIs) is a crucial co-factor of HIV transmission [3], attempts to reduce HIV infections by effectively treating other STIs have failed [4, 5]. Moderately significant associations between intimate partner violence and HIV infection among women were found but showed significant heterogeneity depending on the study region or country [6]. Furthermore, a systematic review of studies on intravaginal practices found no conclusive evidence as to their causal role in the African HIV pandemic [7]. Given the limitations of these infection risk factors regarding their preventive potential and given the absence of an effective preventive HIV vaccine, innovative methods against HIV transmission seem all the more expedient.

Sexual dysfunctions, especially dyspareunia, are understudied in HIV key populations. Psychological contributing factors notwithstanding, painful intercourse for the recipient partner may be indicative of epithelial tissue being pressured, possibly causing traumatic breaches in the tissue. Disruptions in the epithelial barrier facilitate viral penetration and increase the efficiency of HIV infection vaginally and anorectally [8]. Indicators of epithelial trauma have been studied in HIV key populations:

Three studies in South Africa examined the prevalence of genital bleeding: In the first, 36% of men and 28% of women experienced sexual contact involving blood in the previous three months [9]. According to the second, more than 30% of both men and women reported engaging in sexual intercourse involving genital bleeding in the previous three months [10]. The third found that 31% of men and 26% of women had a lifetime history of engaging in sexual intercourse involving bleeding [11]. A prospective study found a statistically significant association between coital genital bleeding and HIV seroconversion [12].

A multivariate analysis of behavioural, psychological, and medical risk factors showed that anal bleeding during sex affected a third of Mexican MSM at least sometimes, and that it was significantly associated with living with HIV [13]. Associations between anorectal trauma, or indications of it, and HIV seropositivity had been previously found in one other cross-sectional study [14] and in two prospective studies [15, 16]. In a more recent study, 42% of MSM subjects in Senegal reported experiencing bleeding and discharge from the anus, and 22% having anal sores or tags [17]. In South Africa, 60% of MSM subjects surveyed reported experiencing some form of rectal trauma [18]. Using conditional logistic regression models, rectal trauma with bleeding in the last 6 months was found to be a risk factor for HIV

infection among MSM in Yunnan [19]. An eminent role of the biological transmission risk inherent in anal intercourse for the spread of HIV among MSM has been established using powerful agent-based network simulation models: they showed that a hypothetical reduction of the transmission risk of anal sex to that of vaginal sex could lead to an 80–98% reduction of HIV spread among MSM sexual networks even when MSM's actual behavioural factors within main and casual partnerships, circumcision, HIV testing and treatment levels are maintained [20].

Early "anodyspareunia" studies in MSM found a lack of lubrication, relaxation, or anal stimulation as well as anxiety as contributing to pain and discomfort [21, 22]. Vansintejan et al. studied ten risk factors [23]: age, the number of previous sex partners, the number of partners at a time, age of sexual debut, the frequency of sex with a partner, having a steady relationship, inhaled nitrite use, condom use, lubricant use, and foreplay. Statistical analysis using multivariate logistic regression showed that only age and the frequency of sex with a partner were correlated significantly with anodyspareunia. Higher frequency of anal sex was associated with less pain.

The almost unique role of intercourse frequency among the ten factors paralleled previous research on a cohort of 424 initially HIV-1 seronegative female sex workers (FSWs) in Nairobi, who paradoxically showed a decrease in HIV seroconversion with increasing exposure to HIV through sex work [24]. The sex workers' age, their sexual behaviour or the presence of other STIs were not associated with persisting HIV-1-seronegativity. This and other subsequent observations [25] led researchers to suggest the possibility of the women being resistant to HIV infection, and to link the resistance to HIV-specific cytotoxic T lymphocytes (CTL). At the end of the observation, 114 FSWs of the cohort had met criteria for HIV-1 resistance by remaining HIV-seronegative and PCR-negative for at least three years while continuing sex work. Eleven of them, however, seroconverted between 1996 and 2000 [26]. Their late seroconversion was significantly associated with "having stopped sex work entirely for at least two months during the preceding year" and with a relative reduction of sex work by two or more clients per day [26]. Since this reduction or interruption of sex work was the only significant association of their late seroconversion according to a case-control analysis considering various HIV risk factors, HIV acquisition was explained by "loss or diminution of HIV-1-specific CTL in the absence of ongoing antigenic stimulation" by HIV, and maintaining resistance was considered to be due to boosting of memory CTLs through continued antigen exposure [26].

Nevertheless, any lagged continuity of viral exposure in the initial phases of Kenyan HIV spread might have led to a diminution of HIV-1-specific CTL comparable to that hypothesized for the late seroconverters who had taken a break from sex work. Limited antigenic stimulation in the beginning of HIV spread in Kenya may not sufficiently explain the very large cumulative protection against HIV infection in the cohort (up to 100-fold) associated with starting sex work in 1985 as against 1994 [24]. At a later time point, continued antigenic exposure would have been more likely than in 1985 as the HIV pandemic in Kenya had an incidence peak in 1992–1993 and a prevalence peak in 1995 whereas HIV prevalence was low in 1985, and continually rising until 1995 [27]. Given this incongruity, the negative relationship between sexual intercourse frequency and painful intercourse in MSM [23], and given a

possible mechanism of increased HIV infectivity through epithelial injury, which dyspareunia may indicate, we formulated an alternative hypothesis for explaining the previous results in the sex worker cohort: Continued regularity of sexual intercourse may have been a principle of avoiding HIV infection due to the recurring vaginal epithelial dilation, which may have reduced the likelihood or extent of epithelial disruption in FSWs. After periods of sexual abstinence, however, the probability of epithelial disruption and minor injury may have increased.

On this account, the seeming protection against HIV acquisition by longer experience in sex work and the late HIV seroconversions after FSWs had reduced sexual encounters seemed compatible with one another, without the incongruity from rising general HIV prevalence over time that the explanation of immunity by HIV-specific CTL activity created. Rising HIV prevalence in the general population between 1985 and 1994 seemed consistent with this alternative explanation of how some FSWs in the cohort may have avoided infection. Based on the empirical links of HIV acquisition with both epithelial trauma signs and reduced sexual encounters, we studied the relationship of HIV status in key populations, (i) with epithelial disruption signs, including painful intercourse, and (ii) with intercourse frequency in order to evaluate these variables for HIV prevention.

Current study

Participants reported the degrees of dyspareunia and physical symptoms such as bleeding as indicators of epithelial disruption. The study examined the association of the frequency of sexual intercourse and abstinence gaps with HIV status and that of dyspareunia and epithelial disruption signs with HIV status. The biological role of dyspareunia as potentially increasing HIV infection risk was its possible indication of epithelial anogenital trauma, an accepted HIV transmission risk [8]. Various additional behavioural and individual HIV infection risks in the sex worker sample were considered. Sex workers were asked to assess factors contributing to and protecting against dyspareunia.

Methods

Study design

The study design was cross-sectional. Two key population facilities, namely Bar Hostess for FSWs and Hoymas health facility for MSM in Nairobi, were purposively selected. The two facilities provide comprehensive health services and offer biomedical and structural prevention. Services include HIV testing and counselling, condom and lubricant distribution, HIV care and treatment. Random sampling was done at the specific sites to obtain the sample size required. Using the Cochran formula, this was estimated as 324 FSWs and 230 MSM based on an HIV prevalence of 29.6% [28] and 18.2% [29], respectively, at a 95% confidence level and level of precision 0.05. Participants were randomly selected from the facility registers. The inclusion criteria were being 18 years of age and above, identifying as MSM or FSW, and having either had receptive sexual intercourse within the previous month or with prior sexual abstinence breaks not exceeding three months.

Ethical consideration

The study participants were assured of confidentiality of the information they gave. Unique identifiers were used for anonymity. Written informed consent was obtained from each study participant prior to conducting the interviews. Ethics approval was granted by the Kenyatta National Hospital–University of Nairobi Ethics and Research Committee (KNH-UoN ERC) prior to initiation of the study.

Data collection

A structured questionnaire was administered to all eligible participants who consented. The interviews were done in English, the written version of them was passed by the review committee. Some respondents who were not fully literate were spontaneously helped by other FSWs while answering certain questions and five pairs of participants had given identical answers for all items, including age, number of births, and abstinence intervals. These ten FSWs were excluded from the

analysis. Apart from that, there was no exclusion from final data analysis and there was no loss to follow-up as all respondents completed the interviews in one sitting. One mature and emancipated FSW, who reported to be 17 years of age, was included and one FSW reporting secondary school education level and having given birth twice was included but had refused to specify her age.

Measures

Demographic information included gender, age, and education level. HIV serostatus was self-reported while the participants had previously been assessed, examined, or treated at the health facilities.

Dyspareunia and signs of epithelial disruption score

Questionnaires for FSWs included the last six questions of the Female Sexual Function Index (FSFI-19) [30]. The first three addressed satisfaction with (i) emotional closeness, (ii) with the sexual relationship(s), and (iii) with overall sexual life in five grades ("very satisfied" to "very dissatisfied"). The specific questions on arousal or desire, lubrication, and climax from the FSFI-19 were dropped for the sake of simplicity and since they were not directly related to signs of trauma or of epithelial tissue being directly pressured. The last three questions of the FSFI-19 directly addressed the frequency ("always or almost always" to "almost never or never") of discomfort and pain both (iv) during and (v) after vaginal penetration as well as (vi) the degree of discomfort or pain ("very high" to "very low or none at all"). We added two questions directly aiming at physical symptoms of epithelial disruption asking about (vii) the frequency (always to never) of any notice of blood on the genitals of the sexual partners not related to menstruation and about (viii) the frequency level of vaginal itching or sensitivity during or after receptive intercourse.

Due to prior extensive research on anodyspareunia factors involving general relationship and relaxation factors [23] as well as to reduce complexity of the questionnaire, we dropped questions about foreplay and general relationship factors for MSM. MSM were asked three questions about the frequency of discomfort and pain both (i) during and (ii) after anal penetration as well as (iii) the degree of discomfort

or pain. We added three questions asking about (iv) the frequency of itching and anal sensitivity, (v) the frequency of noticing blood that the participant believed came from his anus during or after receptive intercourse, and (vi) the frequency of the presence of blood on toilet paper in order to evaluate indicators of epithelial disruption more direct than pain and discomfort.

Intercourse frequency and gaps of abstinence

Frequencies of intercourse and intervals of abstinence were asked in an identical fashion in the FSW and MSM samples: Participants selected the number of receptive sexual intercourse events in the previous month. Use of sex-intended objects or sex toys the size of a penis were also counted as a receptive contact. Participants were additionally asked what the longest time gaps (in days) were between any instances of receptive vaginal (FSWs) or anal (MSM) intercourse (or comparable object insertion) in the previous month. The previous month was selected because memory of the past few weeks of sexual behaviour seemed more reliable *a priori* than a general subjective estimate of usual maximum abstinence gaps. The measure was a surrogate to roughly represent abstinence durations. To roughly gauge previous abstinence habits and phases, participants were asked to specify the longest abstinence gaps in their sexually active life from memory; both including times of illness, a lack of potential partners, or other reasons for involuntary abstinence, and excluding involuntary reasons for abstinence such as partner availability, illness or disability affecting sexual life at the time.

Sexual behaviour and individual variables

Based on the Belgian anodyspareunia study [23], questionnaires for FSWs included the age of sexual debut, relationship status and tendency of having steady partnerships, use of artificial lubricants, stimulation before intercourse, the number of different sex partners in a month, use of condoms, participation in group sex and having anonymous sex. We added some specific factors for women practising sex with men as the number of vaginal births and engaging in intravaginal practices (insertion of herbs, potions, powders or cleansing agents for dry and tight intercourse or vaginal cleansing). The questionnaire inquired about the approximate duration of sexual intercourse, the use of sex toys, the presence of other STIs, and participation in sado-masochistic practices as further potential risk factors of HIV infection or epithelial disruption. We asked FSWs about several types of drug use including stimulants, inhaled nitrites, painkillers, and alcohol consumption in relation to sex.

Subjective assessment on dyspareunia factors

In addition to behavioural and individual traits, we asked the FSWs to assess the impact of the following circumstances, habits and behaviour for increasing or decreasing discomfort and pain during sex: having a steady partner, higher number of sex partners, several partners at a time, higher age, longer duration of sex, increasing regularity or frequency of intercourse, stimulation or foreplay, lubrication or artificial lubricants, condom use, sex toy insertion before sex, and sex drugs or alcohol use. FSWs judged whether dyspareunia occurred less or more given the items, whether they made no difference, or abstained from judgement.

Statistical analyses

Data were analysed using STATA 13 statistical software. Statistical tests included two-sample t-tests for abstinence gaps and intercourse frequencies, the number of sex partners, vaginal births, and age of sexual debut. Mann-Whitney U tests were used to compare HIV status and the ordinal variables of sexual behaviour, individual factors, dyspareunia and signs of trauma scores. Bivariate logistic regression was used to estimate the magnitude of the difference for significant associations from t-tests and the non-parametric tests. Subjective assessments of the role of behavioural and other variables for sexual dysfunction were given as percentages of the four assessment options selected out of the total FSW sample ratings.

Results

Participants

A total of 322 FSWs with a mean age of 27.8 ± 6.9 (SD) years completed the questionnaire. See Table 1. Two hundred and three (63%) reported to be living without HIV, 119 (37%) living with HIV. Longest abstinence breaks in sexually active adult life for involuntary reasons were more than twice greater (68.9 ± 63.5 days) than voluntary abstinence gaps (25.5 ± 32.1 days).

A total of 231 MSM with mean age of 26.6 ± 5.5 years were interviewed, most of whom (33.8%) had a university level education. See Table 1. Self-reported HIV seropositivity was 43.7%, and the time difference was less pronounced between maximum voluntary abstinence (56.2 ± 80.4 days) and maximum involuntary abstinence (82.7 ± 97.2 days) from receptive intercourse or comparable object insertion in adult life than in the FSW sample.

Table 1
Descriptive statistics: Population characteristics

	MSM		FSW	
	n	%	n	%
HIV Status: Negative	130	56.3	203	63.0
Positive	101	43.7	119	37.0
Education Level: Primary	20	8.7	75	23.2
Secondary	67	29.0	126	39.0
Tertiary	66	28.6	86	26.6
University	76	33.8	36	11.2
Age Mean(SD)	231	26.6(5.5)	322	27.8(6.9)
Min-Max		18–45		17–50
No. of times had receptive intercourse last month:	230	5.3(5.0)	321	19.3(8.4)
Mean(SD)		0–25		0–31
Min-Max				
longest time gaps between any instance of receptive intercourse (previous month): Mean(SD)	225	9.8(7.9)	321	5.6(5.0)
Min-Max		0–31		0–30
longest time gaps between any instance of receptive intercourse (sexually active life) Mean(SD)	231	82.7(97.2)	322	68.9(63.5)
Min-Max		2-730		2-365
longest time gaps between receptive intercourse for voluntary reasons: Mean(SD)	229	56.2(80.4)	322	25.5 (32.1)
Min-Max		2-700		1-365
age at first sex: Mean(SD)	N/A	N/A	323	16.1(2.8)
Min-Max				6–28
No. of vaginal births: Mean(SD)	N/A	N/A	322	1.7(1.4)
Min-Max				0–8

Dyspareunia and signs of trauma scores, abstinence gaps, and other behavioural and medical variables

Female Sex Workers

Forty-two percent of FSWs reported discomfort or pain during vaginal penetration "sometimes" in the previous four weeks. Six percent said it had occurred always or almost always during vaginal sex. See Table 2. The greatest proportion of FSWs (43%) reported a moderate pain and discomfort level. Noticing blood on the vagina or the partner's penis not related to menstruation was common; 44% of the sex workers said it occurred about half the time during or after intercourse, and itching, burning or soreness had been experienced by 71% of FSWs about half the time during or after intercourse. Internal consistency for the total eight item dyspareunia and epithelial disruption sign score was acceptable with Cronbach's alpha = 0.72. Internal consistency was good for the three pain frequency and level questions (iv)-(vi) (Cronbach's alpha = 0.81), acceptable for the three emotional and sexual relationship satisfaction items (i)-(iii) (Cronbach's alpha = 0.73), while the two questions on direct bleeding signs and vaginal sensitivity (vii)-(viii) lacked internal consistency if separated from the total score (Spearman-Brown prophecy coefficient = 0.58).

Fifty-six percent of the FSWs were in a steady relationship at the time of the study while most of them (55%) had had "some" steady relationships; 7% "always" had a steady relationship. Artificial lubricant use was moderately common, 34% of the FSWs sometimes using it, 18% using lubricants more than half the time for sex, and 27% never using them. Foreplay with stimulation of the vagina was rather common, with 63% of the FSWs having foreplay at least half the time and only 14% never. Sex toy use and insertion before intercourse was rather rare, 225 (71%) of the FSWs reporting never using sex-intended objects before intercourse and 74% saying they never use them on themselves. Two hundred forty-six FSWs (77% of the sample) had at least one STI diagnosed previously, most of whom (41%) had had a diagnosis of exactly one STI (either syphilis, chlamydia, gonorrhoea, genital herpes, trichomoniasis, hepatitis C, genital or anal warts). Twenty-four FSWs had a diagnosis of STIs four or more times. Condoms were used at least half the time by 71% of the FSWs. Sadomasochistic sexual practices were rare: 91% of FSWs never engaged in them. Four percent of FSWs engaged in sadomasochistic practices involving blood rarely, 2% sometimes, and 1% regularly. Group sex appeared rather common as 47% of FSWs reported participating in it at least rarely. Having sex with anonymous partners was common (58% of FSWs having anonymous sex at least sometimes), as were dry sex practices involving vaginal insertion of herbs, powders or cleansing agents (69% of FSWs said they practised intravaginal substance insertion at least sometimes). Stimulant drug use (68% never) as well as inhaling nitrites (78% never) or gamma-Hydroxybutyric acid use (86% never) was rather rare. Use of sedative drugs or analgesics was more common among FSWs, 60% of whom reported never using such drugs in relation to sex while 32% admitted to taking them at least sometimes. Alcohol use was common, 43% of the FSWs reporting regular drinking in relation to sex, and only 8% reporting never consuming alcohol when having sex.

Table 2
Discomfort or pain and signs of trauma scores among FSWs

How often discomfort or pain during vaginal penetration was experienced in the past 4 weeks:	Respondents (n)	Proportion (%)
Almost always or always	19	6
Most times (more than half the time)	38	12
Sometimes (about half the time)	132	42
A few times (less than half the time)	66	21
Almost never or never	62	20
Total	317	100
How often discomfort or pain following vaginal penetration was experienced in the past 4 weeks:	Respondents (n)	Proportion (%)
Almost always or always	24	8
Most times (more than half the time)	89	28
Sometimes (about half the time)	115	36
A few times (less than half the time)	73	23
Almost never or never	17	5
Total	318	100
Rating of level (degree) of discomfort or pain during or following vaginal penetration in the past 4 weeks:	Respondents (n)	Proportion (%)
Very high	16	5
High	82	26
Moderate	136	43
Low	57	18
Very low or none at all	27	8
Total	318	100
Has noticed blood on vagina or partner's penis during vaginal intercourse or after vaginal sex that was not related to menstruation:	Respondents (n)	Proportion (%)
Never	37	12
Rarely (less than half the time)	118	37
Sometimes (about half the time)	141	44
Most times (more than half the time)	20	6

How often discomfort or pain during vaginal penetration was experienced in the past 4 weeks:	Respondents (n)	Proportion (%)
Always	2	1
Total	318	100
Has ever noticed vaginal itching, burning, or soreness during or after receptive vaginal intercourse:	Respondents (n)	Proportion (%)
Never	14	4
Rarely (less than half the time)	41	13
Sometimes (about half the time)	225	71
Most times (more than half the time)	36	11
Always	2	1
Total	318	100

Inferential statistics

An independent sample t-test established a significant relationship between HIV status and the longest time gap of sexual abstinence for vaginal intercourse or any similar vaginal insertion during the previous month ($p < 0.001$) but none with a participant's number of vaginal births, the number of times she had receptive vaginal intercourse in the past month and the longest remembered abstinence gaps in their adult life. The relationship between HIV status and age at first sex with a man was significant. See Table 3.

Significant results for the relationship between the ordinal scale behavioural and other individual variables and HIV status according to Mann-Whitney U tests were found for the traits or behaviours as shown in Table 4.

Table 3

t-test for equality of means for FSW living with HIV and without HIV for parity, sex frequency and abstinence gaps, sexual debut, and number of sex partners in a month

Independent Samples Test	t-test for Equality of Means						
	living without HIV	living with HIV	p-value	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
	Mean \pm SD	Mean \pm SD				Lower	Upper
Number of vaginal births had:	1.721 \pm 1.404	1.605 \pm 1.323	.465	-.116	.159	-.428	.196
Number of times had receptive vaginal intercourse in the last month:	18.940 \pm 8.534	20.193 \pm 8.101	.196	1.253	.967	-.650	3.156
Longest time gap (in days) between vaginal sex or any comparable insertion in the last month	6.353 \pm 5.473	4.160 \pm 3.207	.000	-2.193	.550	-3.275	-1.111
Longest time gap (in days) between vaginal sex or any comparable insertion in sexually active life in general	64.836 \pm 55.696	76.496 \pm 74.871	.112	11.660	7.325	-2.751	26.071
Longest time gap (in days) between vaginal sex or any comparable insertion in sexually active life for voluntary reasons	27.154 \pm 34.708	22.832 \pm 27.377	.246	-4.322	3.718	-11.636	2.992
Age at first sex with a man:	16.303 \pm 2.712	15.655 \pm 2.854	.043	-.648	.319	-1.276	-.020
Number of sex partners had for receptive vaginal intercourse in a month:	11.360 \pm 7.785	9.840 \pm 5.990	.068	-1.520	.829	-3.151	.0111

At either below 1% (**) or 5% (*) levels of significance, in binary logistic regression of HIV status against the ratings of significant factors identified at the bivariate level, odds ratios were established as follows:

Table 4

Mann Whitney U tests for independent behavioural, medical and individual variables for FSW living with HIV and without HIV

Independent Variables	Sample Average ± SD / Median:	Sample Average ± SD / Median:	standardized effect size	p-value
	FSW living without HIV	FSW living with HIV		
Uses a water or silicone-based lubricant for receptive vaginal intercourse: (0–4)	1.497512 ± 1.229327 / 2	1.655462 ± 1.14564 / 2	0.078	0.164
Has finger stimulation or massage of the vagina before intercourse: (0–4)	2.034826 ± 1.230358 / 2	1.672269 ± 1.157944 / 2	0.15	0.006262
Has sex toys, plugs, or dildos inserted before vaginal intercourse: (0–4)	0.432836 ± 0.828684 / 0	0.596639 ± 0.914287 / 0	0.11	0.06026
Uses sex toys, plugs, or dildos on self: (0–3)	0.383085 ± 0.739941 / 0	0.521008 ± 0.871865 / 0	0.076	0.1757
Has ever been diagnosed with Syphilis, Chlamydia, Gonorrhoea, Genital Herpes, Trichomoniasis, Hepatitis C or genital or anal warts/HPV: (0–5)	1.597015 ± 1.500597 / 1	2.092437 ± 1.567637 / 2	0.16	0.003335
Uses condoms for vaginal intercourse: (0–4)	2.910448 ± 0.939117 / 3	2.739496 ± 0.995432 / 3	0.075	0.1781
Engages in BDSM (bondage, discipline/domination, sado-masochism) practices: (0–3)	0.184080 ± 0.548585 / 0	0.10084 ± 0.419745 / 0	0.085	0.1302
Engages in BDSM practices that involve blood: (0–3)	0.109453 ± 0.433544 / 0	0.084034 ± 0.381341 / 0	0.045	0.418
Takes part in group sex: (0–3)	0.860697 ± 0.969793 / 0	0.764706 ± 0.980366 / 0	0.051	0.3601

Independent Variables	Sample Average ± SD / Median:	Sample Average ± SD / Median:	standardized effect size	p-value
	FSW living without HIV	FSW living with HIV		
Has sexual intercourse with anonymous partners: (0–3)	1.550000 ± 0.955018 / 2	1.176471 ± 0.979857 / 1	0.19	0.0007418
Engages in dry sex practices or inserts herbs, potions, powders or cleaning agents in vagina: (0–3)	1.517413 ± 1.020267 / 2	1.857143 ± 0.923201 / 2	0.16	0.003697
Usual length of receptive vaginal intercourse: (0–5)	2.736318 ± 1.115851 / 3	2.386555 ± 1.058535 / 2	0.15	0.00654
Uses stimulants in relation to sexual intercourse: (0–3)	0.532338 ± 0.888931 / 0	0.504202 ± 0.757717 / 0	0.024	0.6695
Uses inhaled nitrites (poppers) in relation to sexual intercourse (rare): (0–3)	0.500000 ± 0.879698 / 0	0.151261 ± 0.444146 / 0	0.2	0.0002892
Uses GHB (liquid G) in relation to sexual intercourse: (0–3)	0.253731 ± 0.640545 / 0	0.176471 ± 0.531181 / 0	0.054	0.3337
Uses sedative drugs or painkillers in relation to sexual intercourse: (0–3)	0.680000 ± 1.001306 / 0	1.033613 ± 1.149302 / 0	0.15	0.00594
Uses alcohol in relation to sexual intercourse: (0–3)	2.054726 ± 0.928434 / 2	2.344538 ± 0.887168 / 3	0.18	0.001708
(i) Over the past 4 weeks, how satisfied have you been with the amount of emotional closeness during sexual activity between you and your partner(s)? (0–4)	1.442786 ± 1.161017 / 1	2.02521 ± 1.278653 / 2	0.22	0.00007237

Independent Variables	Sample Average ± SD / Median:	Sample Average ± SD / Median:	standardized effect size	p-value
	FSW living without HIV	FSW living with HIV		
(ii) Over the past 4 weeks, how satisfied have you been with your sexual relationship with your partner(s)? (0–4)	1.557214 ± 1.085339 / 2	1.453782 ± 1.087275 / 1	0.048	0.3892
(iii) Over the past 4 weeks, how satisfied have you been with your overall sexual life? (0–4)	1.740000 ± 1.103853 / 2	1.478992 ± 1.118782 / 1	0.12	0.02698
(iv) Over the past 4 weeks, how often did you experience discomfort or pain during vaginal penetration? (0–4)	1.656716 ± 0.930896 / 2	2.201681 ± 1.029891 / 2	0.26	0.000003074
(v) Over the past 4 weeks, how often did you experience discomfort or pain following vaginal penetration? (0–4)	1.587065 ± 0.976541 / 2	1.907563 ± 0.853622 / 2	0.17	0.002836
(vi) Over the past 4 weeks, how would you rate your level (degree) of discomfort or pain during or following vaginal penetration? (0–4)	1.656716 ± 1.027895 / 2	2.016807 ± 1.033205 / 2	0.16	0.004051
(vii) Have you ever noticed blood on your vagina or your partner's penis during vaginal intercourse or after vaginal sex that was not related to menstruation? (0–4)	1.338308 ± 0.821569 / 1	1.680672 ± 0.735686 / 2	0.21	0.0001313
(viii) Have you ever noticed vaginal itching, burning, or soreness during or after receptive vaginal intercourse? (0–4)	1.800995 ± 0.678380 / 2	2.092437 ± 0.582100 / 2	0.20	0.0003063
(iv)-(vi) sum (Cronbach's alpha 0.81)	4.900498 ± 2.459685 / 5	6.12605 ± 2.536361 / 6	0.23	0.00003025
(iv)-(viii) sum (Cronbach's alpha 0.74)	8.039801 ± 2.952695 / 8	9.89916 ± 3.157973 / 10	0.29	0.00000026

Living with HIV was 0.874 (0.814–0.939)** (COR (95% C.I.)) times less likely with increased (1 day) intervals between any instance of vaginal intercourse or comparable object insertion in the previous month. Age at first sex with a man higher by one year reduced the risk of living with HIV 0.915 (0.840–0.996)* times. Unit increase of the rating of the frequency (five degrees: never to always) of finger stimulation or massage of the vagina before intercourse decreased the risk of living with HIV 0.787 (0.648–0.955)* times. The more often and the more STIs (incrementing up to six degrees) a participant had been diagnosed with previously, the odds of living with HIV increased 1.231 (1.062–1.427)** times. Increased frequency of sex with anonymous partners decreased the risk of living with HIV 0.674 (0.531–0.856)** times. Increased frequency of intravaginal practices increased the risk of living with HIV 1.419 (1.114–1.808)** times. Increase in the usual length of vaginal intercourse by one time range (out of six) decreased the risk of living with HIV 0.754 (0.609–0.933)** times. More use of sedative or analgesic drugs and of alcohol during or before sex increased the risk of living with HIV 1.385 (1.119–1.713)** and 1.439 (1.101–1.880)** times, respectively. As the level of satisfaction with emotional closeness during sex decreased, the odds of living with HIV increased 1.479 (1.220–1.792)** times. The odds of living without HIV decreased 0.807 (0.656–0.994)* times with increasing satisfaction with overall sexual life. As the frequency degree of pain and discomfort during or following vaginal penetration in the past four weeks increased, risk of living with HIV increased 1.757 (1.379–2.239)** or 1.441 (1.125–1.845)** times, respectively, while incrementing levels of discomfort and pain increased the odds of living with HIV 1.398 (1.119–1.747)** times. As the frequency level of bleeding signs during or after vaginal intercourse increased, the relative risk of living with HIV increased 1.737 (1.285–2.348)** times, and noticing more vaginal itching, burning, or soreness increased the odds of living with HIV 2.145 (1.429–3.220)** times. Items (iv) to (viii) were unidirectional in the association with self-reported HIV status as higher scores of complaints were linked to increased risk of living with HIV for items (iv) to (viii), with combined standardized effect size 0.29 and acceptable internal consistency of (iv) to (viii) (Cronbach's alpha = 0.74).

Subjective assessment of factors

Eighty-one percent of FSWs agreed that steady partnerships lessened dyspareunia. They were divided on whether having had more partners is contributing or protective (n = 317): Half (50%) of the FSWs judged discomfort and pain to decrease with more experience, yet more than a third of them (34%) found that it had no relevant effect on dyspareunia, and 10% believed sexual dysfunction worsened with further tries. Group sex or having several partners simultaneously seemed to increase sexual discomfort for 50% of sex workers (n = 317). Yet 17% felt that having several partners at a time reduced sexual dysfunction and another 20% said it made no difference. A slight absolute majority of 53% agreed that age did not play a role. Subjective judgements favouring a contributing (18%) and a protecting (14%) influence of maturing on dyspareunia roughly levelled each other out while 15% of participants claimed not to be in a position to compare the effect of age. More than two-thirds (69%) agreed that longer duration of vaginal intercourse led to higher discomfort. The regularity of intercourse had the second most unanimous assessment among the items: 74% of the FSWs agreed that higher regularity of intercourse alleviated sexual dysfunction. Foreplay or stimulation seemed to facilitate intercourse according to 73% of sex

workers (n = 317). Almost two-thirds (65%) agreed that lubrication or artificial lubricants eased difficulties. Participants seemed to confirm a lacking influence of condoms on dyspareunia (n = 317). Sixty-one percent agreed that they made no difference to the dysfunction, and those participants (15%) saying condoms increase trouble were levelled out by an equal number (15%) saying condoms reduce trouble. The last two factors, sex toy and sex drug use, refer to practices that were uncommon in the FSW sample although alcohol played a central role for sexual encounters. Sex-intended object insertion was rare. Half of the FSWs abstained from judgement for these two items. Eighteen percent of FSWs (n = 317) said sex toys eased trouble and 20% said they did not have a relevant effect. Almost every participant saying drugs facilitated sex (22%) had a counterpart in the sample saying drugs had no effect on pain and discomfort (20%), and eight percent of the sample agreed that drugs and alcohol worsened discomfort.

MSM

Prevalence of dyspareunia in MSM was high, with 195 (84%) experiencing at least some discomfort and pain in relation to anal intercourse. Sixty percent of them experienced pain during anal penetration at least sometimes, 17% always or almost always. Pain following anal penetration was experienced half the time by 33%, and most times by 20% of MSM. Roughly a third of participants rated the degree of pain to be non-existent or low, another third as moderate, and another as high or very high. See Table 5. Seventy-seven percent of MSM complained about anal itching, burning or soreness at least half the time when having receptive sex. Traces of blood believed to be of anal origin were seen by 45% of MSM half the time, and by 12% most times. Blood was present on the toilet paper in 43% of MSM half the time, in 13% most times. The overall internal consistency of the six item score of pain frequency, level, and of the direct epithelial disruption signs was good (Cronbach's alpha = 0.88).

Table 5
Discomfort and pain as well as sensitivity or bleeding scores among MSM

How often discomfort or pain during anal penetration by a partner was experienced in the last 4 weeks:	Respondents (n)	Proportion (%)
Did not attempt intercourse	12	5
Almost always or always	39	17
Most times (more than half the time)	39	17
Sometimes (about half the time)	59	26
A few times (less than half the time)	52	23
Almost never or never	30	13
Total	231	100
How often discomfort or pain following anal penetration by a partner was experienced in the last 4 weeks:	Respondents (n)	Proportion (%)
Did not attempt intercourse	12	5
Almost always or always	17	7
Most times (more than half the time)	47	20
Sometimes (about half the time)	77	33
A few times (less than half the time)	53	23
Almost never or never	25	11
Total	231	100
Rating level (degree) of discomfort or pain during or following anal penetration by a partner over the past 4 weeks:	Respondents (n)	Proportion (%)
Did not attempt intercourse	11	5
Very high	11	5
High	50	22
Moderate	76	33
Low	55	24
Very low or none at all	27	12
Total	230	100
Has ever noticed anal itching, burning, or soreness during or after receptive anal intercourse:	Respondents (n)	Proportion (%)
Never	12	5

How often discomfort or pain during anal penetration by a partner was experienced in the last 4 weeks:	Respondents (n)	Proportion (%)
Rarely (less than half the time)	41	18
Sometimes (about half the time)	142	61
Most times (more than half the time)	29	13
Always	7	3
Total	231	100
Has ever noticed blood believed to have come from anus during or after receptive anal intercourse:	Respondents (n)	Proportion (%)
Never	14	6
Rarely (less than half the time)	86	37
Sometimes (about half the time)	103	45
Most times (more than half the time)	28	12
Total	231	100
Noticed blood on the toilet paper:	Respondents (n)	Proportion (%)
Never	12	5
Rarely (less than half the time)	90	39
Sometimes (about half the time)	99	43
Most times (more than half the time)	30	13
Total	231	100

There were no significant differences between MSM living with and without HIV regarding anal sex frequencies during the previous month, their maximum abstinence gaps in the previous month, during adult life in general, nor for their maximum remembered voluntary abstinence interval (t-test: $p = 0.439$, $p = 0.878$, $p = 0.259$, and $p = 0.833$, respectively). There was no significant association between the frequency of pain and discomfort during or after intercourse or the degree of pain and discomfort and HIV status, nor for the ordinal scale values of signs of anal tenderness and bleeding (direct notice of blood and blood on the toilet paper) in the MSM sample (Mann-Whitney U test; $p = 0.247$, $p = 0.484$, $p = 0.621$, $p = 0.151$, $p = 0.951$ and $p = 0.731$, respectively).

Discussion

Although HIV prevalence is decreasing [1], the drivers of ongoing HIV infections are yet to be addressed in more detail. The preventative utility of co-factors (STIs, intravaginal practices, intimate partner violence)

seems unclear and biological HIV transmission risk remains crucial among MSM [3, 6, 7, 20]. In this study, dyspareunia and signs of anogenital epithelial trauma were highly prevalent in FSWs and MSM, indicating considerable limitations to sexual health and personal well-being. Exposure to blood during sexual encounters may increase HIV infection risk as evidenced by previous research [12, 19]. Vaginal coital bleeding in this study was more prevalent than previously described [9–11], and direct signs of anal bleeding were rife among MSM, justifying the need for further aetiological analysis for possible prevention measures.

Steady sexual relationships alongside sex work were common, which implies the importance of regular partner testing or considering pre-exposure prophylaxis given that HIV infections within heterosexual regular partnerships and unions classically outweigh the burden of HIV infections through every other mode of exposure in Kenya [31]. Artificial lubricant use was moderately popular with FSWs, indicating a possible benefit of lubricants for vaginal intercourse, confirmed by the sex workers' favourable assessment of lubricants as a remedy against dyspareunia. Lubricants, in combination with condoms, have been recommended for MSM [32] and have found high acceptance with Black American women [33]. Uptake of lubricants for anal sex is regularly promoted by Hoymas for MSM in Kenya. Lubricants are included in the package of services provided for MSM during a visit. Intravaginal substance insertion was common in the FSW sample and linked to an increased risk of living with HIV, yet the effect was small, and the large-scale impact of intravaginal practices as a driver of the HIV pandemic seems limited according to meta-analyses [7]. Painkillers and sedatives were reported to be used in moderation but alcohol use was very common among the sex workers and this may be a possible risk factor for HIV transmission due to reduced self-care and precaution measures under the influence of alcohol. Alternatively, drinking and drug use may be a self-treatment for dyspareunia, and thus the association between living with HIV and sex drug or alcohol use may in turn be mediated via the infection risk from epithelial disruption linked to painful intercourse.

Contrary to the hypothesis that longer sexual abstinence breaks may subsequently lead to HIV acquisition, longer abstinence in the previous month was positively associated with living without HIV among FSWs. This may be due to life-long tendencies of reduced numbers of clients and continuously rare sexual contacts with them for some participants living without HIV. Some sex workers living with HIV may, in turn, have taken fewer abstinence breaks between clients recently, which, however, may not reflect their abstinence intervals at the time around their actual HIV infection as participants had contracted HIV earlier than the previous month. For the longest abstinence gaps in adult life from memory, there was no significant association with HIV status, neither among FSWs nor MSM, so the association with abstinence remains unclear. Determining the exact role of abstinence intervals for HIV acquisition would require determining abstinence behaviour at the time of the actual HIV acquisition in the past, which was an impossible task within this cross-sectional approach. Therefore, a lack of significant associations between longest memorized abstinence gaps in adult life and HIV status may not necessarily contradict the hypothesis of shorter abstinence gaps or higher intercourse regularity as protective against HIV acquisition. Nonetheless, we could not establish any confirmatory relationships between higher memorized maximum abstinence intervals and HIV infection risk. Studies confirming such a putative link

may be difficult to set up and may involve only assuredly early stage or acute HIV infections, at a time when participants can still remember their exact sexual behaviour and sex frequencies in previous weeks or months. The potential transmission risk factor of longer abstinence periods may be regarded as innately elusive in this respect, yet with some conceptual and empirical plausibility from the theoretical background the study was based on.

We found that later sexual debut may protect against HIV infection, which is somewhat intuitive. The apparent protection against HIV acquisition by having anonymous partners and by longer intercourse duration that is implied by the cross-sectional significant associations with HIV status is not clear and needs further exploration. While FSWs agreed that longer duration of intercourse may increase discomfort, it may also be the case that distensible vaginal epithelial lining naturally protects against HIV transmission through less disruption and concomitantly allows for longer intercourse sessions. The apparent protection against HIV infection by foreplay may similarly be explained by more relaxed tissues and better lubrication and hence less epithelial trauma, reducing the efficiency of HIV infection.

The hypothesis linking sexual dysfunction and epithelial trauma signs to HIV infection status was confirmed in so far as dyspareunia levels and frequency, as well as epithelial trauma signs, were positively associated with living with HIV among FSWs. The temporal direction and causal relevance of this suggested link remains debatable given the cross-sectional study design, and further investigation is needed. The more general relationship satisfaction item (ii) was the only item of the dyspareunia score without a significant association with self-reported HIV status in the FSW sample; and general satisfaction with sexual life (item (iii)) turned out to be significantly higher in FSWs living with HIV than in those living without HIV. All other sexual dysfunction score items showed the same direction of association. The differences between the means of the individual score values, however, were small as were standardized effect sizes. When items of unidirectional differences from the score were combined, however, a small to medium standardized effect size of 0.29 was reached, e.g., for items (iv)-(viii). The relevance and utility of this cluster of subjective complaints and epithelial trauma signs for HIV risk will need to be determined by further study.

The subjective assessment of dyspareunia factors by FSWs may imply modes of prevention for further investigation. Steady partnerships seem to be beneficial as FSWs highly agreed that discomfort occurs less with a steady partner than with casual ones. Whatever their protective mechanism, they are difficult to maintain for FSWs and other people who are promiscuous or unable to enter steady relationships or living in social contexts favouring concurrency. As for more experience with sex partners and having several partners at once, no clear recommendation can be drawn from the sex workers' assessment for the prevention of dyspareunia. Longer duration of intercourse may worsen discomfort so that extremely prolonged sex may be recommended against although the bivariate analysis suggested the opposite effect of sex duration regarding the odds of living with HIV (see above). Higher regularity of intercourse, foreplay and lubricant use may be considered as protective as the women agreed that these factors may ease sexual dysfunction. The ideal maximum abstinence gaps between receptive sex appear unclear at the time of writing, and further investigation is needed. Interviewer and confirmation bias cannot be ruled

out for the consensus of sex regularity as preventing painful intercourse, and blinded interviewing in further studies may be advisable to corroborate or refute the links to HIV risk and overall sexual health. Condoms seem not to interfere as most women judged their effect on dyspareunia to be irrelevant, so their role as an effective means to HIV prevention may be upheld. Finally, alcohol or sedative and analgesics use may increase HIV infection risk as seen in the inferential statistics, and there was no subjective agreement that drugs or alcohol would ease dyspareunia in any way.

Limitations of the study

The study revealed significant associations among FSWs for known HIV risk-taking behaviour such as early sexual debut, intravaginal substance insertion, alcohol and drug use as well as for the new links between sexual dysfunction variables and HIV serostatus. The latter, however, was self-reported, which helped establish a trusting relationship with participants but brought less reliability and objectivity for the HIV status variable. Among MSM, who also self-reported HIV status and were interviewed in the same fashion as sex workers, no similar significant results were found for anal dyspareunia. This difference may be due to more pronounced variation in the extent of vaginal sexual dysfunction in the sample because of higher variability of disorders of lubrication, arousal, and of psychological confounding factors, because of physiological vaginal variation, co-infections or bacterial vaginosis. Gynaecological or rectal examinations and laboratory tests were not performed, which further limits the validity of these findings, especially since the implication of epithelial disruption by painful intercourse or perceived discomfort was largely conceptual. The Nairobi population is culturally and ethnically diverse, and the role of genetics and different ethnic traits would need to be taken into consideration in further studies. Differences in vaginal anatomy were found between African-American and white women [34], and Frank Plummer had observed in his early HIV immunity research that many highly exposed persistently seronegative FSWs were related to one another [35]. As for anal HIV transmission risk, matters of anatomy and physiology may be of a more uniform nature so that differences in anal epithelial disruption may be more elusive and harder to differentiate in a sample because related complaints and signs may in turn be more uniform among MSM than among heterosexual women. Other psychological, medical, and behavioural factors may also play a role for sexual dysfunctions and minor epithelial trauma in MSM, including general anorectal health factors. These were hard to represent and differentiate with a cross-sectional, questionnaire-based study design.

The significant relationship between direct and indirect signs of epithelial disruption and self-reported HIV infection status, as well as the FSWs' majority assessment on sex regularity as alleviating painful intercourse, may partly be due to interviewer or confirmation bias. Interviewer-blinded ways of data collection should be aimed at in future investigations using similar sexual dysfunction scores for the validation of an associated HIV infection risk. Although various classical HIV risk-taking behaviours and medical factors, such as early sexual debut, other STIs and intravaginal practices, were analysed in this study and yielded significant associations, their standardized effect sizes were lower than some of the more novel dyspareunia and epithelial disruption sign variables. Their confounding effects and those of the novel factors presented have to be evaluated in a multivariate logistic regression analysis, which was

not done in this early stage cross-sectional study. The same holds true for cross-links between sedative or analgesic drug use and painful intercourse for establishing independent relationships of these factors with HIV infection status. The aim of the current study was to search for preliminary evidence for a novel factor that carried empirical and conceptual plausibility from previous HIV immunity and sexual health research. For this reason, direct implications for HIV prevention science, let alone preventive interventions, are highly limited. The results and relationships established nonetheless justify further investigations and refinements regarding the epithelial disruption signs and sexual dysfunction scores and their association with HIV infection status or HIV acquisition.

Conclusions

Recurrent exposure to blood during sexual intercourse and other minor epithelial disruption signs were highly prevalent in the HIV key population samples, as was recurrent painful intercourse, which may impact overall sexual health and carry a risk for HIV transmission. Significant associations between various aspects of sexual dysfunction and HIV infection status were found, which may be evidence that HIV transmission risk is linked to painful intercourse and to signs and symptoms of minor epithelial trauma. More foreplay, later sexual debut, and the reduction of intravaginal practices, of alcohol consumption and of sedative and analgesic drug use may protect against HIV acquisition while the exact mechanisms, causal directions and cross-links of these factors require further exploration. Aetiological analysis of sexual dysfunction and epithelial trauma may help develop innovative prevention strategies against ongoing HIV transmissions. Subjective assessments on dyspareunia factors by female sex workers indicate that prevention may include the promotion of sexual intercourse regularity, foreplay, and artificial lubricant use after rechecking their respective protection against HIV acquisition.

Based on our findings, longitudinal studies on HIV infection risk may benefit from considering these behavioural variables and the level of sexual dysfunction. Analysing epithelial trauma and sexual dysfunction as potential HIV infection risks may have to be more fine-grained for anal transmission than for vaginal transmission in order to find significant associations.

Future studies on sexual dysfunction and HIV risk may advantageously be extended to key populations in different settings and to general populations with a high HIV prevalence, and next steps for research programmes may include examining and differentiating underlying biological factors. The study proposes novel opportunities for HIV prevention science and sexual health improvement.

Abbreviations

MSM

men who have sex with men

STI

sexually transmitted infection

FSW

female sex worker
CTL
cytotoxic T lymphocyte

Declarations

Ethical Approval

Ethical approval was obtained from Kenyatta National Hospital–University of Nairobi Ethics and Research Committee in June 2019 (KNH-ERC/A/216, P160/02/2019).

Consent to Participate

Written informed consent was obtained from all individual participants included in the study.

Consent for Publication

Not applicable.

Availability of Data and Material

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Competing Interests

The authors declare that they have no competing interests.

Funding

No funding was received. The study was financed privately and conducted in partnership with the Kenyan ministry of health through the key national stakeholders. No funding was received to assist with the preparation of this manuscript.

Authors' Contributions

LK and BF designed the study protocol. LK served as lead researcher on site in Nairobi, coordinated the project with the University of Nairobi and all other authors. LK and IM did the field coordination and data collection. BM and EK prepared the statistical analysis and data interpretation. BF conceived the research hypothesis and drafted the manuscript. WJ supervised the project, guided and revised the analysis and presentation of data and the preparation of the manuscript. All authors read and approved the final manuscript.

Acknowledgements

Not applicable.

References

1. World Health Organization. Progress report on HIV, viral hepatitis and sexually transmitted infections. Accountability for the global health sector strategies, 2016–2021. Geneva: World Health Organization; 2019 (WHO/CDS/HIV/19.7).
<https://apps.who.int/iris/bitstream/handle/10665/324797/WHO-CDS-HIV-19.7-eng.pdf?ua=1>. Accessed 16 June 2021.
2. UNAIDS. Communities at the Centre – Global AIDS Update 2019. UNAIDS.
https://www.unaids.org/sites/default/files/media_asset/2019-global-AIDS-update_en.pdf. Accessed 16 June 2021.
3. Buve A, Jespers V, Crucitti T, Fichorova RN. The vaginal microbiota and susceptibility to HIV. *AIDS*. 2014 Oct 23;28(16):2333-44.
4. Hayes R, Watson-Jones D, Celum C, van de Wijgert J, Wasserheit J. Treatment of sexually transmitted infections for HIV prevention: end of the road or new beginning? *AIDS*. 2010 Oct;24 Suppl 4(0 4):S15-26.
5. Ward H, Rönn M. Contribution of sexually transmitted infections to the sexual transmission of HIV. *Curr Opin HIV AIDS*. 2010 Jul;5(4):305–10.
6. Li Y, Marshall CM, Rees HC, Nunez A, Ezeanolue EE, Ehiri JE. Intimate partner violence and HIV infection among women: a systematic review and meta-analysis. *J Int AIDS Soc*. 2014;17(1):18845.
7. Hilber AM, Francis SC, Chersich M, Pippa S, Redmond S, Bender N, et al. Intravaginal practices, vaginal infections and HIV acquisition: systematic review and meta-analysis. *PLoS One*. 2010 Feb 9;5(2):e9119.
8. Longo DL, Fauci AS. The human retroviruses. In: Kasper DL, Fauci AS, Hauser SL, Longo DL, Jameson JL, Loscalzo J, editors. *Harrison's Principles of Internal Medicine*. 19th edition. New York: McGraw Hill Professional; 2015. p. 225e.
9. Kalichman SC, Simbayi LC. Sexual exposure to blood and increased risks for heterosexual HIV transmission in Cape Town, South Africa. *Afr J Reprod Health*. 2004 Aug;8(2):55–8.
10. Kalichman SC, Simbayi LC. Sexual exposure to blood and behavioural risks among STI clinic patients in Cape Town, South Africa. *Sex Health*. 2005;2(2):85–8.
11. Kalichman SC, Simbayi LC, Cain D, Cherry C, Jooste S. Coital bleeding and HIV risks among men and women in Cape Town, South Africa. *Sex Transm Dis*. 2006 Sep;33(9):551–7.
12. Kalichman SC, Cain D, Simbayi LC. Behavioral changes associated with testing HIV-positive among sexually transmitted infection clinic patients in Cape Town, South Africa. *Am J Public Health*. 2010 Apr;100(4):714–9.
13. Coplan PM, Gortmaker S, Hernandez-Avila M, Spiegelman D, Uribe-Zuniga P, Mueller NE. Human immunodeficiency virus infection in Mexico City. Rectal bleeding and anal warts as risk factors

- among men reporting sex with men. *Am J Epidemiol.* 1996 Nov 1;144(9):817 – 27.
14. Chmiel JS, Detels R, Kaslow RA, Van Raden M, Kingsley LA, Brookmeyer R. Factors associated with prevalent human immunodeficiency virus (HIV) infection in the Multicenter AIDS Cohort Study. *Am J Epidemiol.* 1987 Oct;126(4):568–77.
 15. Darrow WW, Echenberg DF, Jaffe HW, O'Malley PM, Byers RH, Getchell JP, et al. Risk factors for human immunodeficiency virus (HIV) infections in homosexual men. *Am J Public Health.* 1987 Apr;77(4):479–83.
 16. Coates RA, Calzavara LM, Read SE, Fanning MM, Shepherd FA, Klein MH, et al. Risk factors for HIV infection in male sexual contacts of men with AIDS or an AIDS-related condition. *Am J Epidemiol.* 1988 Oct;128(4):729–39.
 17. Niang CI, Tapsoba P, Weiss E, Diagne M, Niang Y, Moreau AM, et al. 'It's raining stones': Stigma, violence and HIV vulnerability among men who have sex with men in Dakar, Senegal. *Culture Health & Sexuality.* 2003 Nov;5(6):499–512.
 18. Lane T, Shade SB, McIntyre J, Morin SF. Alcohol and sexual risk behavior among men who have sex with men in South african township communities. *AIDS Behav.* 2008 Jul;12(4 Suppl): S78-85.
 19. Xu HL, Jia MH, Min XD, Zhang RZ, Yu CJ, Wang J, et al. Factors influencing HIV infection in men who have sex with men in China. *Asian J Androl.* 2013 Jul;15(4):545–9.
 20. Beyrer C, Baral SD, van Griensven F, Goodreau SM, Chariyalertsak S, Wirtz AL, et al. Global epidemiology of HIV infection in men who have sex with men. *Lancet.* 2012 Jul 28;380(9839):367 – 77.
 21. Rosser BR, Short BJ, Thurmes PJ, Coleman E. Anodyspareunia, the unacknowledged sexual dysfunction: a validation study of painful receptive anal intercourse and its psychosexual concomitants in homosexual men. *J Sex Marital Ther.* Oct-Dec 1998;24(4):281–92.
 22. Damon W, Rosser BR. Anodyspareunia in men who have sex with men: prevalence, predictors, consequences and the development of DSM diagnostic criteria. *J Sex Marital Ther.* Mar-Apr 2005;31(2):129–41.
 23. Vansintejan J, Vandevoorde J, Devroey D. The GAY MEn Sex StudieS: Anodyspareunia among Belgian gay men. *Sex Med.* 2013 Dec;1(2):87–94.
 24. Fowke KR, Nagelkerke NJ, Kimani J, Simonsen JN, Anzala AO, Bwayo JJ, et al. Resistance to HIV-1 infection among persistently seronegative prostitutes in Nairobi, Kenya. *Lancet.* 1996 Nov 16;348(9038):1347–51.
 25. Rowland-Jones SL, Dong T, Fowke KR, Kimani J, Krausa P, Newell H, et al. Cytotoxic T cell responses to multiple conserved HIV epitopes in HIV-resistant prostitutes in Nairobi. *J Clin Invest.* 1998 Nov 1;102(9):1758-65.
 26. Kaul R, Rowland-Jones SL, Kimani J, Dong T, Yang HB, Kiama P, et al. Late seroconversion in HIV-resistant Nairobi prostitutes despite pre-existing HIV-specific CD8 + responses. *J Clin Invest.* 2001 Feb;107(3):341–9.

27. Awad SF, Abu-Raddad LJ. Could there have been substantial declines in sexual risk behavior across sub-Saharan Africa in the mid-1990s? *Epidemics*. 2014 Sep;8:9–17.
28. Musyoki H, Kellogg TA, Geibel S, Muraguri N, Okal J, Tun W, et al. Prevalence of HIV, Sexually Transmitted Infections, and Risk Behaviours Among Female Sex Workers in Nairobi, Kenya: Results of a Respondent Driven Sampling Study. *AIDS Behav*. 2015 Feb; 19(Suppl 1):S46-58.
29. Bhattacharjee P, Rego D, Musyoki H, Becker M, Pickles M, Isac S, et al. Evaluation of community-based HIV self-testing delivery strategies on reducing undiagnosed HIV infection, and improving linkage to prevention and treatment services, among men who have sex with men in Kenya: a programme science study protocol. *BMC Public Health* 2019 Jul 23;19(1):986.
30. Rosen R, Brown C, Heiman J, Leiblum S, Meston C, Shabsigh R, et al. The Female Sexual Function Index (FSFI): a multidimensional self-report instrument for the assessment of female sexual function. *J Sex Marital Ther*. Apr-Jun 2000;26(2):191–208.
31. Gelmon L, Kenya P, Oguya F, Cheluget B, Haile G. Kenya HIV Prevention Response and Modes of Transmission Analysis. Final Report. Kenya National AIDS Control Council. <https://icop.or.ke/wp-content/uploads/2016/09/KenyaMOT-2009.pdf>. Accessed 16 June 2021.
32. Beyrer C, Sullivan PS, Sanchez J, Dowdy D, Altman D, Trapence G, et al. A call to action for comprehensive HIV services for men who have sex with men. *Lancet*. 2012 Jul 28;380(9839):424 – 38.
33. Sanders SA, Crosby RA, Milhausen RR, Graham CA, Tirmizi A, Yarber WL, et al. Women's willingness to experiment with condoms and lubricants: A study of women residing in a high HIV seroprevalence area. *Int J STD AIDS*. 2018 Mar;29(4):367–374.
34. Pendergrass PB, Reeves CA, Belovicz MW, Molter DJ, White JH. Comparison of vaginal shapes in Afro-American, caucasian and hispanic women as seen with vinyl polysiloxane casting. *Gynecol Obstet Invest*. 2000;50(1):54–9.
35. Plummer FA, Ball TB, Kimani J, Fowke KR. Resistance to HIV-1 infection among highly exposed sex workers in Nairobi: what mediates protection and why does it develop? *Immunol Lett*. 1999 Mar;66(1–3):27–34.