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Heterosexual Anal Intercourse: A Neglected Risk Factor for HIV?

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Abstract

Heterosexual anal intercourse confers a much greater risk of HIV transmission than vaginal intercourse, yet its contribution to heterosexual HIV epidemics has been under researched. In this article we review the current state of knowledge of heterosexual anal intercourse practice worldwide and identify the information required to assess its role in HIV transmission within heterosexual populations, including input measures required to inform mathematical models. We then discuss the evidence relating anal intercourse and HIV with sexual violence.

Keywords

Anal intercourse; HIV; infectiousness; sexual violence

Introduction

Much effort and research has gone into identifying risk factors for HIV transmission, which have played a substantial role in driving the heterosexual HIV pandemic. While the increased risk of transmission through anal compared with vaginal intercourse (VI) has long been known,[1] its contribution to HIV transmission at the population level has been insufficiently studied. In this article, we identify the information we require to assess the contribution of anal intercourse (AI) to heterosexual epidemics: who is having unprotected AI? How frequently and with whom? What is the risk of HIV transmission from AI with an infected partner? The combined biological and epidemiological context is important to determine the role of AI in HIV spread through a heterosexual population. Key biological and epidemiological factors are summarized in Table I. Part of the bio-/epidemiological context involves understanding the pathways of association between sexual violence and unprotected AI because AI may be more widely practiced with coerced or forced sex, HIV transmission risk may be higher during violent acts due to the associated trauma leading to local inflammation within the rectal mucosa, facilitating the process of infection, condom use is likely to be lower[2,3], and violence perpetrators are more likely to engage in other

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high-risk behaviors such as having multiple sex partners and engaging in transactional sex.[2,4–6]

HIV transmissibility through AI

The risk of HIV transmission is greater during unprotected receptive anal intercourse (URAI) than during unprotected receptive vaginal intercourse (URVI) because the rectal mucosa lacks the protective humoral immune barrier present in cervicovaginal secretions and is more susceptible to traumatic abrasions that may facilitate transmission.[7,8] Current evidence estimates the risk of HIV acquisition as 1.4% [95% confidence interval (95% CI), 0.2–2.5][9] during URAI compared with 0.08% (95% CI 0.06–0.11) during URVI acts in developed countries,[10] that is, approximately an 18-fold increased risk for women from URAI versus URVI (forced AI is likely to involve even higher transmission risk because it involves more trauma than consensual sex). This confirms the role of AI as a risk factor for HIV transmission. However, the relative role of AI in heterosexual HIV epidemics is unclear given the considerable uncertainty surrounding these infectiousness estimates (as highlighted by the width of the CI) because of the methodological difficulties in measuring this quantity.[9,11,12] Furthermore, the population-level impact of AI also depends on how frequently it is practiced, by whom and with whom, and in which context.

Who has AI? To what extent is it practiced in heterosexual populations?

AI appears to be almost ubiquitous across populations, age groups, and countries, with some studies reporting that up to 20% or more of selected populations in America, Africa, and elsewhere have ever engaged in AI.[1,9] For example, among female sex workers (FSW) in sub-Saharan Africa, 0[13] to 43%[14] have reported ever having practiced AI, with 40% of FSW from Kenya reporting AI in the previous 3 months[15] (Fig. 1a; results from a systematic search of published literature on AI among FSW; details of search strategy available on request). In comparison, among the general population in sub-Saharan Africa, where the majority of HIV-infected individuals live,[16] prevalence ranged from 2% reporting ever having had AI in Kenya[17] to 20% of Angolan soldiers reporting it in the previous 3 months[18] and 28% of sexually transmitted infection (STI) clinic attendees in South Africa reporting it with their current partner[19] (Fig. 1b). Among young populations in sub-Saharan Africa, often in those where HIV incidence is highest,[16] rates have ranged from 1.3% of South African high school students reporting ever having had AI[20] to 56% and 64% of university students in Nigeria and Zimbabwe, respectively, reporting its practice in the previous 2 months[21] (Fig. 1c). Studies have found differences in gender for various sexual behaviors in Western countries, including for AI, with some studies suggesting that men are more likely to report experience of AI.[22,23] However, a systematic review of AI practice is required to formally investigate differences by gender in other settings.

AI is often under-reported. For example, the percentage of married men from the general population in Cotonou, Benin, reporting ever having heterosexual AI was 3.5% during face-to-face interview (FTFI) but 17.5% using the more anonymous polling booth survey (PBS) method.[24] In Malawi, 5.0% of women participating in a microbicide trial reported AI in the past 3 months using audio computer-assisted self-interviewing (ACASI), but only 0.2% with FTFI ($P < 0.001$).[25] FSW in India reported levels of URAI with a client in the previous 30 days as 18.8% in FTFIs but 36.2% in the PBS.[26] Also in India, Lowndes et al.[27] found that responses regarding HIV risk behaviors asked through FTFI and PBS were very different for stigmatizing risk behaviors such as AI (ever heterosexual AI reported by 5.5% through PBS but only 1.9% through FTFI for married men; 6.3 versus 0.9% for married women, respectively). There were large discrepancies between responses through PBS and FTFI methods for many other HIV risk behaviors. The magnitude of such discrepancies will depend on social taboo that may vary from place to place. There is a need for further development of tools facilitating anonymous survey responses. Existing methods work well for simple questions but are often limited for more complex questions, such as some of the examples in Table I, where respondents need to be able to count (e.g., for how many of your AI acts in the last week did you use condoms?). How frequently is AI practiced? How? With whom?

Despite extensive reporting of AI practice, there is little published research on its frequency and circumstances. For example, our systematic search of published literature on AI practice among FSW in the past decade identified 26 studies reporting prevalence of AI but only 12 reporting prevalence of unprotected AI and four reporting on frequency. Information of this kind, for high-risk and low-risk heterosexual populations, is necessary to assess the contribution of AI to the overall HIV epidemic and for prevention purposes. It is equally important to know to what extent condoms are used during AI (rates of condom use for heterosexual AI are lower than for vaginal sex[1,28]) and in which context it is practiced. For example, how often does AI accompany sexual violence? This is important because if AI is a regular occurrence, then an individual's risk becomes substantial, especially if it represents the largest number of unprotected sex acts. Protected AI minimizes risk of HIV transmission, while forced URAI is likely to increase risk.

Figure 2a shows how a woman's cumulative risk of acquiring HIV increases with number of URAI acts with an HIV-infected partner. It shows how our uncertainty regarding the transmissibility of HIV through URAI leads to great uncertainty regarding a woman's cumulative risk after repeated sex acts. Risk rapidly increases with increasing number of exposures, which demonstrates the importance of knowing the frequency with which URAI is practiced (despite this measure having received little attention from researchers).

In a context of violence, a woman suffering one act of forced URAI with an HIV-infected perpetrator may have a higher risk of transmission. We have modeled a hypothetical threefold increased risk due to sexual violence (therefore, 4.2% risk per act if we assume 1.4% transmissibility per URAI act without force). A woman undergoing repeated forced URAI within an HIV discordant relationship, with an average one forced URAI act per week, has a cumulative risk of acquiring HIV over just 6 months of 67%.

Figure 2b illustrates the risk of HIV acquisition for various frequencies of URAI (percent of all sex acts that are URAI, the remainder being URVI). This simple model of individual-level risk (binomial model, see figure legends for details) is simplistic, assuming that infectiousness is constant throughout a relationship (not accounting for HIV stage and other risk factors for transmission such as incidence of STIs) and no difference in risk between individuals. Nevertheless, these hypothetical scenarios demonstrate the extent to which the uncertainty regarding infectiousness of AI influences the estimate of an individual's cumulative risk of infection over time/multiple exposures and especially in the case of forced sex because we do not know how much this increases HIV transmissibility. Despite this uncertainty, it is clear that a very small number of URAI acts with an infected partner rapidly lead to a high risk of infection. Therefore, there is a need to gain more detailed information on the frequency of AI within a relationship.

Figures 2a and b illustrate how AI affects a woman's individual-level risk of acquiring HIV, given that her partner is HIV-infected. However, this is not sufficient to assess the role of AI in heterosexual HIV epidemics. It demands a fuller knowledge of the epidemiological context. What is the chance that the partners of such women are infected? And what are the chances of such women passing on infection to others? Fig. 2c shows a hypothetical heterosexual network where two women would play very different roles in HIV spread within the population. Woman A's risk of acquiring HIV may be very large, but she is unlikely to pass infection on. Woman B's risk is lower, but if she does become infected, there is more chance of further spread to a large part of the sexual network. We need more information on the characteristics of those practicing AI to assess its role within heterosexual HIV epidemics. For example, do males practicing unprotected insertive anal intercourse (UIAI) with their regular partners also practice it with other women? Is it practiced more frequently among pregnant women and could therefore contribute to the elevated HIV acquisition risk during pregnancy? Under what circumstances are condoms used or not used?

To explore the potential population-level impact of AI and what part it plays in the heterosexual HIV pandemic, we can use mathematical modeling to create a simplified version of the risk environment, parameterized as accurately as possible using empirical data. A study from Cape Town, South Africa, reported that 10.4% of women and 14.6% of men recruited from townships and STI clinics practiced AI in 40–50% of all their sex acts in the past 3 months, suggesting that overall, 6–10% of all unprotected sex acts reported by study participants were AI.[29] Boily[30] constructed a mathematical model of heterosexual HIV transmission parameterized using these data. In these simulations, HIV risk was estimated as 1- to 4-fold and 4- to 20-fold higher for UIAI and URAI compared with VI, respectively. The HIV risk during the primary and late phase of HIV infection was estimated as 5- to 19-fold and 5- to 12-fold higher than during the long asymptomatic period of HIV infection, respectively. Model results suggest that this relatively low frequency of URAI (i.e., 5–10% of all sex acts) may be as, or more, important to overall HIV transmission (approximately 8–48% of all HIV transmission in the general population) as the highly infectious acute phase of HIV infection (approximately 7–31% of all HIV transmission), with a higher population-attributable fraction for women (Fig. 3), at least partly explained because URAI confers greater HIV acquisition risk than UIAI.[30] These findings have important implications for interpreting model results in the population-level effectiveness of vaginal microbicides in heterosexual populations, because vaginal microbicides cannot be used for AI. The model predicts that even if only 5% of all unprotected sex acts are AI, this could be sufficient to reduce the impact of microbicides (in terms of cumulative fraction of HIV infections averted) by 17–39% over 25 years.[10,30] This and other mathematical modeling studies can demonstrate how AI may mitigate the impact of certain HIV interventions such as vaginal microbicides[31] as well as identifying new avenues for HIV prevention in various settings.

AI, HIV and sexual violence

AI has emerged as an understated risk mechanism for HIV transmission through sexual violence, which requires further study (J. E. Draughon, M. B. Lucea, J. K. Stockman, M. T. Paterno, D. R. Bertrand, P. W. Sharps, D. W. Campbell, J. C. Campbell, personal communication).[32] Qualitative evidence has suggested that violence and coercion are frequently associated with AI.[33–35] In their HIV prevention program involving FSW in Karnataka state, India, Beattie et al.[36] found that FSW who reported violence were significantly more likely to report AI [10.4% ever had AI among those not beaten or raped in the previous year versus 32.4% among those who had been; adjusted odds ratio, 3.70 (95% CI, 2.67–5.12)]. Among adolescent and young women in the United States reporting engaging in recent unprotected sex, reporting having been forced to have sex was significantly predictive of engaging in AI (adjusted odds ratio, 2.72; 95% CI, 1.32–5.60).[37] Another form of sexual violence, female genital mutilation (FGM), may also contribute to higher frequency of AI because some evidence suggests higher rates of AI among women with FGM due to difficult and painful VI.[38] There is some evidence that HIV and STI prevalence is higher among higher-risk violent males as compared to other males.[39]

Data requirements

Table I lists the primary data inputs that would inform mathematical models designed to assess the role of AI within heterosexual epidemics. For all questions on AI, the equivalent question regarding VI is required to build a complete understanding of an individual's potential HIV exposure through heterosexual sex (despite there being a real HIV risk through oral sex, it is small compared to that through VI and AI[40] and is therefore not included).

The epidemiological context shown in Table I relates to proximate determinants of HIV transmission only; that is, we are not looking at the underlying motivations or causes of AI practice among heterosexuals. The role of violence within this framework is at both the biological and epidemiological levels, and additional data would be required to determine how many sex acts occur in the context of violence. Coercion is likely to increase the HIV transmission risk through AI (biological) and also affects the epidemiological context as an underlying determinant affecting some of the listed proximate determinants: likelihood of condom use and the risk behavior of perpetrators of sexual violence (do they practice other high HIV risk behaviors?). There are extensive reports on prevalence of AI for certain populations (e.g., many behavioral surveys report on proportion of respondents ever having had AI), but an individual's risk of HIV acquisition and then onward transmission are hugely dependent on how frequently they practice AI and whether condoms are used. Although useful to determine the maximum size of the population at risk of acquiring HIV through AI, there are limits to the utility of just knowing how many people have ever had AI. Just one AI act is unlikely to markedly increase an individual's risk of HIV acquisition over their entire sexually active lifetime, however, that of course depends on who they have AI sex with (Table I).

Better data on HIV transmission risk through AI are difficult to collect because quality is limited by recall bias (of frequency of AI practice) and the challenge of identifying the HIV infection status of all partners of studied individuals (so most heterosexual HIV transmission studies recruit monogamous couples to monitor HIV transmission from an infected partner to their initially uninfected partner: discordant couple studies).

Data on who is having AI, how frequently and whether it is protected or not can be collected using appropriate survey methods for targeted populations. Data by gender are important to input into models because the very large difference in transmission risk between URAI and UIAI (i.e., male-to-female and female-to-male) means men and women must be modeled separately.

We have briefly discussed above the importance of appropriate survey methods to minimize recall and social desirability bias.[41] The method of elicitation will affect the quality of sexual behavior data collected from surveys. Detailed questioning of respondents partner-by-partner (e.g., in how many of the last ten sex acts with your most recent partner did you use condoms?) allows the characteristics of each partner, such as frequency of sex, frequency of condom use, perceived HIV status, to be documented separately for each partner. In such a way, more detailed patterns of sexual risk for different types of partner can be simulated. However, the additional resources required to collect these detailed data compared with aggregate data (e.g., in how many of your last ten sex acts did you use condoms?) must be taken into account for large surveys. (Table I presents questions to collect aggregate data but could be modified to elicit responses partner-by-partner, which may be useful to quantify who is having AI with whom and may in some instances facilitate recall.) Furthermore, alternative survey methods such as PBS designed to avoid the biases associated with FTFI for non-literate populations, where ACASI is not possible, may not be suitable for collecting such detailed information for each sexual partner.

A further key factor to consider is who is having AI with whom. This determines the sexual network structure suggested in Fig. 2c, which influences the spread of HIV at the population level. Stable, monogamous couples practicing unprotected AI will contribute very little to population-level HIV risk, whereas FSW practicing AI with their clients could quickly seed an HIV epidemic within a previously uninfected population. Aggregate and partner-by-partner data can give us insights, but all studies will be limited by respondents' knowledge of their partners' serostatus and risk behaviors.

In modeling analysis, additional data on the relationship between AI practice and HIV prevalence are important to validate model predictions, to better assess the role of AI as a risk factor for HIV transmission. For example, a model run with parameters that results in 100% of those practicing AI becoming HIV-infected within 1 week would not tally with observed patterns of HIV prevalence and therefore needs to be re-parameterized. Although this is outside the scope of this article, a non-systematic scan of published data indicates that the patterns of HIV prevalence among those practicing and those not practicing AI have not been consistent. Among higher-risk populations, Grijsen et al.[42] found only a marginal, non-significant increased HIV prevalence among women practicing receptive AI in the previous 3 months [adjusted odds ratio (aOR), 1.2; 95% CI, 0.5–2.5]. Auvert et al.[43] found a borderline significantly decreased HIV incidence for FSW in South Africa reporting AI (adjusted hazard ratio, 0.35; 95% CI, 0.12–1.0). Kalichman et al. found the same HIV prevalence (7%) whether or not men had practiced AI in the last month, and lower prevalence (8%) among women practicing AI than those not practicing AI (12%) in the last month.[44] Studying the general population, Nel et al. found the association between ever having had AI and HIV prevalence went in opposite directions for two provinces in South Africa.[45] Lane et al. found that among South African youth, men ever having practiced AI had nearly twice the prevalence of HIV (OR, 1.7; 95% CI, 1.0–3.0), but the association was non-significant for young women (OR, 1.2; 95% CI, 0.7–2.0).[46] However, the problem with the interpretation of these study results is that much of the information that we need to know to assess the role of AI (Table I) is incomplete. We do not know the frequency with which AI is practiced or the proportion of AI acts that were protected with condoms for these studies. With the exception of Auvert et al.[43], studies reported HIV prevalence rather than incidence, and we therefore do not know about each respondent's sexual behavior around the time that they acquired infection. Auvert et al.[43] gave the hazard ratio for practicing AI, yes or no, but we do not know how this question was asked – what time frame, how frequently. The effect of AI may be diluted as it will depend on how frequently it is practiced and with whom (Table I), not just that it is practiced at all. It is therefore difficult to interpret the results of these studies. To demonstrate the increased risk of HIV acquisition from AI, we need to know the frequency of AI practice of respondents who are then followed up to measure their HIV incidence. Even in this case, the levels of mixing between different types of partner (regular, casual, AI-practicing, non-AI-practicing, and so on) will obscure the picture. With these limitations, mathematical modeling is useful to help fill our knowledge gaps.

This article is a call for further data collection, but we cannot wait for reliable data on all these factors before attempting to estimate the role of AI for heterosexual HIV transmission. If we appreciate the limitations and biases associated with existing data, we can estimate likely ranges for some of these key parameters to explore the likely impact of AI for HIV, while appreciating the level of uncertainty involved. Through the process of sensitivity and uncertainty analysis, we can identify those factors that most affect our conclusions and therefore identify the directions in which our research should be prioritized.

Conclusions

AI is a high HIV risk practice and occurs across all heterosexual populations to some extent. A small fraction of AI acts (5–10%) may be as important to overall HIV transmission as the acute phase of infection, especially for women. However, the uncertainty regarding infectiousness of AI (forced or otherwise) and frequency of its practice make it difficult to compare these two factors. We need to quantify how much AI occurs due to sexual violence and its context (intimate partner violence, conflict, rape, FGM), and we need better estimates on the effect of trauma due to forced sex, and its long-term effect, on HIV infectiousness. More data are required on the frequency of AI, when it is practiced (are condoms used?) and why, in both the general population and high-risk groups. Better survey methods should be employed as there may be under-reporting of such behavior due to factors such as social desirability bias.[24] For researchers, public health planners, and other stakeholders to gain a more precise understanding of the role of AI in the heterosexual pandemic in different contexts, and to design effective prevention, it is important to more precisely quantify the frequency of unprotected AI and to understand when it is practiced. It remains to be known how sexual violence influences the prevalence and frequency of heterosexual AI and HIV transmission probability. Heterosexual AI has seldom been considered in current HIV models that estimate the impact of prevention interventions, potentially leading to overestimation of the impact of some types of interventions such as vaginal microbicides.

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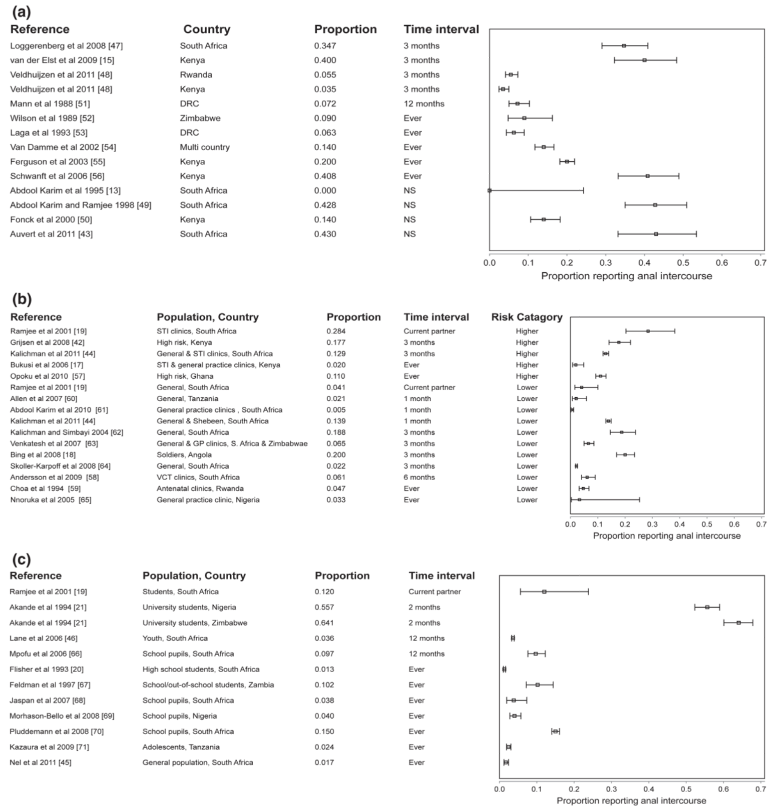

Fig 1.

(a) Prevalence of anal intercourse (AI) reported by female sex workers (FSW) in sub-Saharan Africa. Data taken from a systematic review and meta-analysis of prevalence and frequency of AI among FSW reported in publications from 2002 onwards (details of search strategy available on request). Van Damme et al. reported from four countries of which three are from sub-Saharan Africa (Cote d'Ivoire, Benin, South Africa, the fourth being Thailand), and so it is included here. Errors bars represent 95% confidence intervals (CIs). DRC, Democratic Republic of Congo; NS, not stated; VCT, voluntary counseling and testing attendees. (b) Collection of published studies of prevalence of AI reported by the general population in sub-Saharan Africa. Errors bars represent 95% CIs. 'Shebeen' is a beer hall/ bar. 'High-risk' women refer to women reporting ≥2 partners in the previous 3 months (Opoku[58]) or a collection of different risk types including women with STIs, those with multiple sex partners, and some FSW.[43] 'Current partner refers to AI at any time with a current partner. GP, general practice; STI, sexually transmitted infection; VCT, voluntary counseling and testing. (c) Collection of published studies of prevalence of AI reported by youth (mean age of sample <25 years) in sub-Saharan Africa. Young adults refer to school-age students, adolescents, and university students. 'Out-of-school' refers to youth of school age but not currently attending school. Errors bars represent 95% CIs.

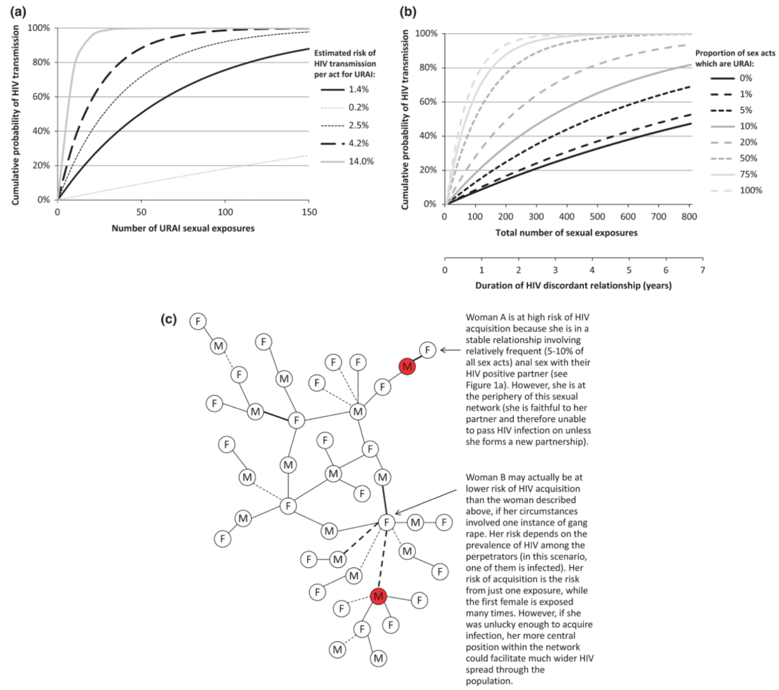

Fig 2.

(a) Figure shows women's cumulative individual-level risk of HIV acquisition by number of exposures to HIV involving unprotected receptive anal intercourse (URAI). Several plots are provided: 1.4% HIV transmission probability per URAI act represents the current estimate for URAI for heterosexual and men who have sex with men couples, based on empirical evidence,[9,74] with 0.2 and 2.5% representing the 95% confidence intervals.[9] The 4.2 and 14% transmission risks per act represent possible increased risk of transmission if the sex act is forced rather than consensual (3- and 10-fold increased risk, respectively), reflecting greater risk of trauma to the mucosa. Calculations based on the relationship: cumulative HIV risk = $(1 - \beta_A)^n$ where n is number of sex acts (all assumed to be URAI) and β_A is HIV transmission probability per URAI act. (b) Women's cumulative individual-level risk of HIV acquisition accounting for all sex acts [both unprotected receptive vaginal intercourse (URVI) and URAI]. Plots show different frequencies of URAI within the relationship from 0 to 100% of all sex acts. Risk per act for URVI and URAI are set to 0.08[11] and 1.4%[9], respectively [i.e., model represents unforced anal intercourse (AI) or that there is no increased risk of HIV transmission if it is forced]. Horizontal axis is total number of sex acts, but we have included a second axis estimating relationship duration, which assumes 10 sex acts per month, to estimate the rate of transmission within an HIV discordant relationship. Calculations based on the relationship: cumulative HIV risk = $(1 - \beta_A)^{nf}(1 - \beta_V)^{n(1-f)}$ where n is number of all sex acts, β_A is HIV transmission probability per URAI act, β_V is that for URVI and f is the fraction of all sex acts that are URAI. (c) Schematic of a heterosexual network. Individuals are represented by circles (M, males, F, females, red, HIV-infected, white, uninfected), and lines represent sexual relationships between them. Figure represents a static network (i.e., no partnership formation or dissolution, just a snapshot in time). Thicker lines represent relationships that involve some frequency of AI; thinner lines involve vaginal sex only. Short-term (even just one sex act) partnerships are represented by dotted lines and long-term sexual partnerships by solid lines. Figure illustrates the very different individual-level and population-level HIV risks experienced by women suffering different forms of sexual violence and with different positions in the sexual network.

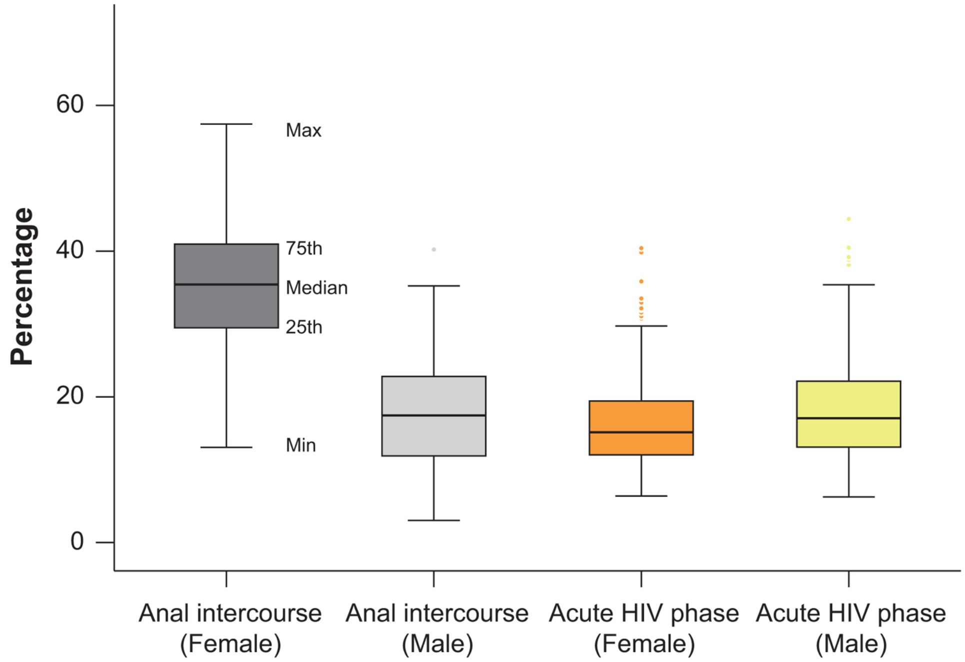

Fig 3.

Box and whisker plot of population-attributable fraction of new HIV infections per year due to AI and primary (acute) HIV infection (PI). Estimations from a mathematical model[30] parameterized using sexual behavior data reported by men and women recruited from townships and sexually transmitted infection (STI) clinics in Cape Town, South Africa.[29] AI, anal intercourse; max, maximum; min, minimum. Plotted dots represent outliers.

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Table I

Input Measures Required to Inform Mathematical Models Estimating the Role of AI Within Heterosexual HIV Epidemics

Biological context	Information required (from epidemiological studies, for example [73,74])
Relative increase in HIV transmission risk for heterosexuals, receptive and insertive AI compared to VI	Risk of HIV infection per act of: unprotected VI UIAI (i.e., female-to-male) URAI (i.e., male-to-female) (or relative risks of UIAI and URAI compared with VI)
Variation in HIV infectiousness by disease stages, other cofactors for transmission	Risk of HIV infection during the acute, asymptomatic, and late stages of infection Risk of HIV infection with cofactors, for example sexually transmitted infections and uncircumcised males
Epidemiological context	Information required (from sexual behavior surveys)
Who is having AI?[a]	Have you ever had AI? Have you had AI in the past month/6 months/year?
How frequently?[ab]	How many VI acts have you had in the past week/month/3 months? And how many AI acts?
Are condoms used?[ab]	For how many of these VI acts were condoms used? And for AI acts?
With whom?	Do you have AI with regular or casual partners? Do you have unprotected AI with regular or casual partners? Questions regarding age of partner, perceived HIV status, perceived sexual activity: Do you know if your partner has AI with other partners? Do they use condoms for AI with other partners?

AI, anal intercourse; UIAI, unprotected insertive anal intercourse; URAI, unprotected receptive anal intercourse; VI, vaginal intercourse.

[a]Most important information to collect.

[b]Information currently lacking from most studies.