Explaining gender differences in the risk of prevalent HIV infection: analyses of the Tanzania and Côte d'Ivoire AIS

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Abstract

This paper seeks to identify the sources of gender disparities in risk of prevalent HIV infection through analysis of AIDS Indicator Surveys (AIS) for Côte d'Ivoire, where infected women outnumber infected men by more than two to one, and the United Republic of Tanzania, where HIV prevalence among women is only slightly higher than that among men. A conceptual framework that unifies principles of infectious disease epidemiology with empirical literature on risk factors for sexual transmission of HIV is used to elaborate hypotheses as to potential sources of gender disparities in HIV risk. Logistic regression is conducted to pinpoint the individual and contextual factors that yield disparate risks of HIV infection among men and women. Results indicate that, in addition to biological explanations, gender-specific risks associated with sexual behaviour determine gender differences in HIV risk, and the relevant risk factors vary across the two populations with differing degrees of gender-disparity in risk.

Background

While it has long been recognized that men and women face unequal risk for HIV infection, explanations for the sources of gender differences in risk remain relatively weak. That in some major world regions, gender disparities appear to be widening such that women make up a growing proportion of persons living with HIV (UNAIDS 2007) lends urgency to calls for new research that identifies and explains the factors that work to place men and women at disparate risk for HIV infection.

Two main hypotheses have been proposed to explain why in generalized HIV epidemics where HIV prevalence among adults exceeds 1 per cent, HIV prevalence among women tends to be higher than that among men (Glynn et al. 2001). First and most commonly cited is that women face greater biological susceptibility to HIV infection through heterosexual intercourse than do men. One well-controlled prospective study of HIV-serodiscordant heterosexual couples estimated a per-coitus transmission probability that was 50 per cent higher for male-to-female transmission compared to female-to-male transmission (Mastro and de Vincenzi 1996). Women's greater biological susceptibility has been variously attributed to the greater exposed surface area in the female genital tract compared to the male genital tract, higher concentrations of HIV in seminal fluids than in vaginal fluids, the larger amount of semen than vaginal fluids exchanged during intercourse, and greater potential for injury to the cell wall during intercourse for women compared to men (Moss et al. 1991; Pettifor et al. 2004).

A second explanation for gender disparities in HIV risk cites differences between men and women in the probability of encountering an infected sex partner. For men, the risk of selecting an infected partner increases with patronage of commercial sex workers or having multiple casual partners, for example (Quigley et al. 1997). For women, the risk of encountering an infected partner appears to increase when the male partner is much older or if her husband travels (Auvert et al. 2001; Pettifor et al. 2005; Gregson et al. 2002; Lagarde et al. 2003). Thus differences in sexual behaviours and in men's and women's positioning within the sexual network is believed to contribute to gender disparities in HIV risk.

Only a few studies have explicitly sought to identify empirically the sources of gender-differences in risk for HIV infection. Gregson and colleagues (2002) analyzed gender-specific risk of incident HIV infection among young people aged 17 to 24 years in Manicaland, Zimbabwe. They concluded that the tendency for young females to partner with males 5 to 10 years older than themselves was chiefly responsible for the more rapid rise in HIV prevalence among young women compared to men. That the strong gender effect persisted even after factors associated with exposure were controlled for indicated that increased susceptibility to infection among women likely also plays a role. Because their study did not include men and women over the age of 24 years, it is not possible to determine whether the sexual network that ties young women to older men contributes to sex disparities in HIV prevalence within the population as a whole.

Glynn and colleagues (2001) set out to examine the factors responsible for the disparity in HIV prevalence between men and women aged 15 to 49 years in two urban populations in Africa with high HIV prevalence: Kisumu, Kenya and Ndola, Zambia. They found that despite the tendency for women to have older partners, young men were at least as likely to encounter an HIV-infected partner as young women. The authors concluded that women's greater susceptibility to HIV infection, exacerbated by high prevalence of herpes simplex virus type 2 infection in women, is primarily responsible for the observed sex differences in HIV prevalence in the two populations. However, their data permitted controlling for only a small number of individual characteristics believed to be associated with exposure to HIV, and thus they are unable to definitively rule out behavioural factors as a source of gender differences in HIV risk.

Two decades of medical, public health, and social science research has taught us that determinants of HIV risk are infinitely more complex than can be understood by an average transmission probability and general statements about the sexual network. Indeed, numerous individual and community-level factors influence the sexual transmission probabilities of HIV including male circumcision (Auvert et al. 2004), coinfection with sexually transmitted infections (Fleming and Wasserheit 1999), the age of the female partner (Buzy and Gayle 1996), and condom use (Holmes et al. 2004), to name a few. An individual's exposure to HIV in a sexual network is also dependent on a multitude of factors including his or her own sexual activities, the behaviour of partners, and the behaviours of the partners' partners (Anderson and May 1991). Examining gender disparities in HIV risk requires a nuanced understanding of the many factors that come together to determine an individual's risk of HIV infection and how those factors may operate differently for men and women.

This paper strives to further understanding of gender differences in HIV risk in two parts. First, theoretical models of infectious disease epidemiology are united with empirical evidence in order to elaborate a conceptual framework for the risk of acquiring HIV infection through sexual contact. The framework is utilized to generate hypotheses as to the potential sources of gender disparities in HIV risk. In the second portion of the paper, analyses of gender differences in the risk of prevalent HIV infection are conducted for the countries of Côte d'Ivoire and the United Republic of Tanzania using nationally representative AIDS Indicator Surveys (AIS) that enable an empirical test of the hypotheses developed out of the conceptual framework. Results indicate that biological factors and differences in sexual behaviour in men and women fail to explain most of the observed gender disparity in risk. In addition, gender disparities vary across population subgroups defined by characteristics such as household wealth and HIV/AIDS-related knowledge (Tanzania) and religion and marital status (Côte d'Ivoire).

Conceptual Framework

Figure 1 illustrates the conceptual framework linking HIV risk to the many risk factors associated with HIV infection within the context of HIV/AIDS epidemics driven by heterosexual transmission[1]. Consistent with the general principles of infectious disease epidemiology, the framework begins with the illustration of HIV risk as a function of two independent risks: the risk of sexual exposure to HIV and the risk of HIV infection given sexual exposure (Anderson and May 1991). Both risks may be described in terms of their respective proximate determinants – that is, the factors that directly influence their levels. The proximate determinants terminology employed here is borrowed from demographic models originally developed to describe fertility variation observed across populations (Bongaarts 1978). While the use of a proximate determinants model in discussions of HIV epidemics is not new (Awusabo-Asare and Anarfi 1999; Boerma and Weir 2005; Zaba et al. 2005), previous efforts have focused primarily on describing HIV risk at the macro level – that is, to explain variation in HIV prevalence across populations. The framework elaborated here is designed specifically to describe the web of risk factors for HIV infection on the micro level – that is, in the individual.

In taking a micro-level approach to developing the conceptual framework, the results of more than two decades of research – both theoretical and empirical – have been reviewed to assess the state of knowledge about important risk factors for HIV infection. The established risk factors have been classified in terms of what are the proximate determinants of HIV risk and which are the more remote background determinants associated with risk only through their various associations with the proximate determinants. The risk factors are organized in Figure 1 in a manner that facilitates discussion of the multiple linkages between their independent, confounding and interactive effects.

The risk of HIV infection given sexual exposure is shaped by the numerous proximate determinants that work to enhance or suppress the per-exposure transmission probabilities of

[1] An estimated 70 per cent of the number of people living with HIV in 2005, lived in a country experiencing a generalized HIV/AIDS epidemic driven by heterosexual transmission (UNAIDS 2006). The dynamics of HIV epidemics where injecting drug use and sex between men, for example, play a larger role in disease transmission differ from generalized epidemics and are outside the scope of this analysis.

HIV. Primarily biological in nature, they operate by influencing the infectivity of the infected host, altering the susceptibility of the non-infected individual or establishing a barrier to block disease transmission. The risk of HIV infection given a sexual exposure between HIV serodiscordant partners may be understood as a function of three factors: (1) the susceptibility of the non-infected partner; (2) the behaviours that influence the transmission probability of HIV; and (3) the infectiousness of the HIV infected partner.

Among determinants of susceptibility to HIV infection is male circumcision, which has been shown to reduce the risk of HIV infection in men between 48 and 60 percent (Auvert et al. 2004; "Circumcision Halves H.I.V. Risk, U.S. Agency Finds" New York Times, December 14, 2006). While male circumcision may explain a large part of the distribution of HIV infection among men, it is less clear what role male circumcision plays in explaining how HIV risk differs for men and women. Male circumcision may widen sex disparities in HIV risk by further reducing female-to-male sexual transmission probability. At the same time, the reduction in HIV risk to men that accompanies circumcision may result in lower HIV prevalence among men and thus lower risk of women's exposure to HIV through heterosexual sex (Turner et al. 2007).

Susceptibility to HIV infection is also influenced by age. More specifically, young age at exposure to sexual intercourse is associated with increased biological susceptibility to HIV among women but not among men (Moscicki et al. 2001; Pettifor et al . 2004). Some have suggested that the mucous membrane of the vagina and cervix in adolescent women is very thin and the vaginal mucous, which protects the vaginal and cervical walls during intercourse and has immunoprotective properties, may not be produced as readily in adolescent women. Both features may contribute to greater biologic vulnerability to HIV transmission in adolescent women relative to both older women and men (Buzy and Gayle 1996; Wawer et al. 1991).

Arguably the most commonly cited cofactor influencing both infectivity of and susceptibility to HIV infection via sexual contact is the presence of other sexually transmitted infections (STI). STI comorbidities enhance per-contact HIV transmission probabilities by reducing immune function, increasing viral shedding in the HIV-infected partner, and providing an efficient path for the virus to enter the body in the susceptible partner. STI coinfections are believed to enhance the heterosexual transmission probabilities of HIV by a factor ranging from two to five, although a handful of studies have estimated an even larger effect (Fleming and Wasserheit 1999).

Because STI, like HIV, have a sexual etiology, STI as cofactors for HIV transmission have received a great deal of attention in the HIV literature. But, as Stillwaggon (2006) aptly points out, the biological mechanisms that lead STI to facilitate HIV transmission are the same as for other HIV cofactors that are not sexually transmitted. For example, malnutrition and parasite infection are two additional factors known to undermine immune system response and which may contribute to HIV risk in sub-Saharan Africa in particular. Nutrition is a key determinant of susceptibility to most disease because of its importance to maintaining the skin and mucous membranes as protective barriers and because nutrition supports immune response at the cellular level. Parasite infections such as malaria, leishmanaiasis and schistosomiasis—all of which are endemic to sub-Saharan Africa, where the highest HIV prevalence is found (WHO 1987)—cripple the immune system by demanding chronic immune response to foreign bodies, thereby increasing susceptibility to HIV infection given an exposure.

We have already seen that coinfection with other STI enhances the infectiousness of HIV, but several other characteristics of the HIV-infected partner also impact his or her infectiousness by determining the amount of the HIV virus contained in the body fluids. This measure is referred to as the "viral load". Viral load has been identified as a key predictor of HIV transmission, with evidence of a dose-response relationship (Quinn et al. 2000; Riore et al. 1997). Three factors determine the viral load in adults with HIV infection: (1) the duration since initial infection with HIV (Pilcher et al. 2004; Prins et al. 2005); (2) the strength of the immune system; and (3) treatment with antiretroviral therapy (ART) (Nicastri et al. 2005).

The susceptibility of the non-infected partner and the infectiousness of the HIV-infected partner are largely biologically determined. But the risk of HIV infection given a sexual exposure is further determined by a small number of behaviours that proximately alter the risk of HIV infection given a sexual exposure. Most effective among these behaviours is condom use. Condoms protect against sexual transmission of HIV in both men and women by establishing a barrier that prevents transfer of the body fluids that harbor the virus (Davis and Weller 1999). Apart from condoms, certain sexual practices are associated with variable risk for HIV transmission. For example, anal intercourse is more infectious than penile-vaginal intercourse (5 to 30 infections per 1,000 contacts compared to less than 1 infection per 1,000 contacts) (World Bank 1997). Receptive oral sex is associated with only a very small risk of HIV transmission (Graham 2001). The use of vaginal drying agents, which increase friction during intercourse and may increase the likelihood of injuries to the vaginal and cervical lining, may facilitate the transmission of HIV in women. Intercourse during menstruation increases the likelihood of HIV transmission to both men and women (Edwards 1992).

The risk of HIV infection given sexual exposure is meaningless for an individual's risk of acquiring HIV if there is no simultaneous risk of exposure to the HIV virus. To understand the proximate determinants of sexual exposure to HIV, we move all the way to the right-hand-side of the conceptual framework illustrated in Figure 1, and begin with exposure to sexual activity. One important determinant of an individual's risk of acquiring HIV through sex is the number of unique sexual partners a person encounters over time. An increased number of sexual partners for an individual corresponds to increased opportunities for exposure to HIV. Numerous studies have found a positive association between risk of becoming infected with HIV in both men and women and the number of lifetime sexual partners (Auvert et al. 2001; Gregson et al. 2002; Pettifor et al. 2005; Quigley et al. 1997).

It is worth noting that an increased number of partners for an individual carries with it no risk of acquiring HIV if partners are selected exclusively from a population of non-infected individuals. Thus an individual's risk of sexual exposure to HIV is a function not only of the exposure to sexual activity, but also of the HIV prevalence among sex partners, which is a function both of the characteristics of partners and of the HIV prevalence among various population subgroups. If an individual's sexual partners are chosen at random from the population, then the HIV prevalence among partners will be equal to the HIV prevalence in the population. In practice however, sex partners are not chosen randomly. Rather, individuals select sex partners with certain characteristics such as those pertaining to age, socioeconomic status, religion, place of residence, marital status, availability for transactional sex, etc.

Numerous studies have demonstrated that sexual partner characteristics are associated with the risk of HIV infection, independent of measures of exposure to sexual activity. For example, having a sexual partner who is a commercial sex worker increases the risk of infection for men (Auvert et al. 2001; Zablotska et al. 2006), having a partner who is considerably older than oneself is associated with increased HIV risk among young women (Auvert et al. 2001; Beagle and Ozler 2006), and having a partner who travels away from home for one or more nights is associated with increased risk of HIV infection among both men and women (Kishamawe et al. 2006). These associations arise from the fact that partners with these characteristics are more likely to be infected with HIV themselves, a necessary condition for passing HIV to a sexual partner.

Partner characteristics are also associated with the risk of HIV infection via the determinants of the infectiousness of the HIV positive partner, especially the viral load as influenced by the duration since infection. HIV is most highly infectious during the acute period that occurs in the days and weeks following seroconverstion. Thus sexual intercourse with a partner who was very recently infected with HIV carries a high risk of HIV transmission. An individual who has multiple sexual partnerships that overlap in time – that is, who engages in concurrent partnerships – is more likely to have sexual contact with a susceptible partner soon after having become infected. Hence having a partner who has other concurrent partnerships carries a heightened risk of HIV infection for men and women (Morris 1997).

In addition to concurrent partnerships, various other partner characteristics are associated with the infectiousness of the HIV-positive partner. Just as HIV infection is not randomly distributed in a population, certain population subgroups have higher prevalence of STI. Many of the same proximate and background characteristics associated with the risk of HIV are also associated with the risk of infection with another STI (Boerma and Weir 2005). Thus the characteristics of sexual partners influence and individual's risk of HIV infection through both the HIV prevalence among partners that determines exposure to HIV, and the STI prevalence among partners that determines the risk of HIV transmission given exposure.

The HIV prevalence among population subgroups depends upon the level and pattern of sexual activity in the population as well as the average transmission efficiency of HIV. These are represented in Figure 1 under the heading Population patterns of exposure to HIV. Mathematical models have illustrated that the average rates of sexual partner change (the rate at which new sexual partners are acquired) in a population and the distribution of the population according to sexual activity groups defined by their respective rates of sexual partner change have important effects on the resulting HIV epidemic curve (e.g., Anderson et al. 1991; Bongaarts 1989; Morris 1997). These models have further illustrated how the network of sexual partnerships in a population critically determine the rate of disease spread and which population subgroups are most at risk of infection.

Rates of sexual partner change and mixing patterns between population subgroups determine the distribution of exposure to HIV-infected partners in the population. Other population-level determinants influence the distribution of HIV infection by determining the average transmission probabilities of HIV. Just as concurrent partnerships increase the likelihood of sexual contact with a susceptible partner during the early stages of acute HIV infection for an individual, the prevalence of concurrent partnerships in a population increases the rate of HIV spread by creating a web of sexual partnerships through which the virus may travel very rapidly (Morris and Kretzschmar 1997; Morris and Kretzschmar 2000). Likewise, the prevalence and distribution of the other proximate determinants of risk of transmission given sexual exposure including male circumcision, sex in adolescence for women, coinfection with STI, nutrition, parasite coinfection, condom use, and treatment with ART in a population determine the HIV prevalence among population subgroups, thereby affecting an individual's risk of acquiring HIV.

The distribution of HIV infection within the population is a direct product of the history of risk factors associated with HIV infection (Boerma and Weir 2005). This endogeneity is represented in the framework by the dotted line that loops the individual's risk of HIV infection to the HIV prevalence among population subgroups.

To this point, we have seen how the numerous proximate factors together determine an individual's risk of HIV infection by influencing the risk of sexual exposure to HIV or the risk of

HIV transmission given a sexual exposure. But understanding the proximate determinants alone is of limited utility. The relevant proximate determinants for any individual are neither readily observed nor easily measured, making it difficult to adequately account for these determinants in analysis or in targeting intervention and prevention programmes. In light of these obstacles, it is prudent to attempt an understanding of the uneven distribution of HIV risk across individuals by considering the measurable background characteristics, which operate on HIV risk through the various proximate determinants.

A consideration of the background characteristics commonly associated with HIV risk requires a somewhat different approach than that taken in the discussion of the proximate determinants. While the contribution of each of the proximate determinants to the overall HIV epidemic may vary across countries, principles of epidemiology indicate that the independent effect of each proximate determinant on an individual's risk should be more or less constant across populations. In contrast, great variation in the independent effects of the background characteristics on HIV risk is expected across populations with different sociocultural contexts. As such, it is not inconsistent to accept, for example, that while years of educational attainment is *positively* associated with HIV risk among women in Zambia (Fylkesnes et al. 1997), education is *negatively* associated with HIV risk among men and women in South Africa (Pettifor et al. 2005), both countries with high HIV prevalence. The variation across countries we observe results from the context-specific link between the background characteristics – in this case, years of education – and the proximate determinants of HIV risk. In a study of the socioeconomic correlates of risky sexual behaviour, Dehaneffe, Carael and Noumbissi (1998) found a positive association between education and higher risk sexual behaviour (including recent non-marital sexual activity and transactional sex) among men in five out of ten countries analyzed. In two countries, the opposite relationship was detected and analysis for the three remaining countries showed no statistically significant association between education and risky sexual behaviours.

The context-specificity of the links between background characteristics and proximate determinants means that the broad generalizations developed through the earlier discussion of proximate determinants are inappropriate to the discussion of background characteristics and HIV risk. Instead, for purposes of illustration, the discussion below focuses on some of the common pathways through which each of the background characteristics have been shown to be associated with the proximate determinants of HIV risk. In practice, any observed association between the background characteristics and HIV risk will depend on the relative importance of the multiple pathways through which background characteristics are linked to the proximate determinants.

As the arrows in figure 1 indicate, the individual-level background characteristics listed in the box at the bottom of the figure operate through five different categories of proximate determinants: 1) susceptibility to the risk of HIV infection given sexual exposure; 2) behaviours that influence HIV transmission; 3) exposure to sexual activity; 4) partner characteristics; and 5) population patterns of exposure to HIV. Each individual background characteristic operates through at least one of the pathways, and often multiple pathways link a single background characteristic to the risk of HIV infection.

Religion, for example, tends to be correlated with male circumcision, which may partially explain the low HIV prevalence observed in predominantly Muslim populations (Auvert et al. 2001; Over 1998). In addition, expectations and norms established within religious communities are highly influential in determining the ages at which sexual activity is initiated. An analysis of the Cameroon DHS indicated that Christian men and women tended to be younger at their first sexual experience than men and women of other religious traditions (Kongnyuy and Wiysonge 2007).

The proximate determinants of susceptibility to HIV infection such as STI and other health conditions are often linked to socioeconomic disadvantages, such as unemployment, lack of education, poverty, inadequate access to health care, and gender inequality. Furthermore, socioeconomic disadvantages may impede an individual's health-seeking behaviours, resulting in failure to address the treatable health conditions, including certain STI, which increase susceptibility to HIV infection through sexual exposure (Zierler and Krieger 1997).

Behaviours that influence the risk of HIV transmission, and condom use in particular, are observed to vary according to the sociocultural and demographic characteristics of individuals including religion (Bailey, Neema and Othieno 1999), marital status (De Walque 2006), alcohol use (Zablotska et al. 2006), educational attainment (Filmer 1998), and health literacy and access to health services (Zierler and Krieger 1997). Studies have also associated HIV/AIDS-related knowledge and attitudes, such as an understanding of transmission routes and of the efficacy of condoms in protecting against sexual transmission, with the risk of contracting HIV (Pettifor et al. 2005; Zamani et al. 2005).

Gender plays an important role in how the background characteristics link to HIV risk through the behaviours that influence HIV transmission. For example, barriers to women's education may contribute to increased HIV risk in women by leaving them inadequately equipped with the knowledge and tools necessary to adopt protective measures or to seek health services for conditions that enhance susceptibility to HIV infection. Even when women are well-informed as to their risk of acquiring HIV through sexual intercourse with their male partners, gender disparities in negotiating power within relationships may leave women less able to refuse sex or insist on condom use, especially within marriage (Bajos and Marquet 2000).

In addition, gender inequality impacts women's HIV risk more directly through their exposure to gender-based violence. A study of women in stable relationships in Rwanda showed that HIV-infected women were more likely to report a history of physical violence and sexual coercion by their male partners than were women without HIV (van der Straten et al. 1998). A Tanzania study also noted that among young women under 30 years of age, positive HIV status was associated with having at least one report of physical or sexual violence from their current partner (Dunkle et al. 2004). A Soweto, South Africa study concluded that both intimate partner violence and higher levels of male control in a woman's current relationship were associated with HIV seropositivity, even after controlling for a woman's own HIV risk behaviours such as multiple, concurrent and casual male partners and transactional sex (Dunkle et al. 2004). The authors postulate that abusive men are more likely to have HIV themselves and to impose risky sexual practices on partners.

Apart from the risk of HIV transmission given sexual exposure, the individual background characteristics are additionally linked to HIV risk via their association with the risk of sexual exposure to HIV. For example, when considered in tandem with current age, the age at first sexual intercourse describes the length of time an individual has been sexually active and thus potentially exposed to the risk of HIV infection. At least one community-based cross-sectional study from Zimbabwe has detected a statistically significant inverse association between age at sexual debut and risk of HIV infection among both young men and young women ages 17 to 24 (Gregson et al. 2002).

Age at marriage, together with the age a first sexual intercourse, describes the duration of pre-marital sexual activity, which has been shown to be positively correlated with the number of unique sexual partners and exposure to risk of HIV infection (Bongaarts 2007). Marital status and number of marital partners is correlated with the number of lifetime sexual partners, while polygamous marriage describes an individual's location in a concurrent sexual network.

A great deal of attention has been paid to the role of geographic mobility in increasing HIV risk among both men and women (Quigley et al. 1997; Wawer et al. 1994; Lagarde et al. 2003). Mobility is widely believed raise the risk of HIV infection both by increasing the likelihood of multiple sexual partnerships and by increasing exposure to populations with high HIV prevalence. A recent longitudinal study of sexual behaviour and HIV status in rural Tanzania found that "short-term mobile" men (those who had slept outside the household at least once on the night preceding one of five follow-up interviews) were more likely to report having multiple sexual partners in the past year compared to men who had not traveled (Kishamawe et al. 2006).

Individual background characteristics may be associated with an individual's risk of HIV infection via a pathway through their partners' characteristics. Depending upon the sociocultural context, partnerships may be formed assortatively or disassortatively according to any or all of the individual background characteristics listed in Figure 1. In general, characteristics of selected partners tend to be correlated with one's own age, socioeconomic status, marital status, religion, and geographic mobility. The context-specific social organization of sexual partnerships describes the association between an individual's background characteristics and those of their partner(s), thereby establishing an additional pathway through which individual characteristics may be associated with HIV risk.

The final pathway linking individual background characteristics to the proximate determinants and HIV risk operates through the association between the population distribution of background characteristics and the population patterns of exposure to HIV. Contextual factors are increasingly recognized as highly relevant for the discussions of numerous health conditions (Diez Roux 2002). In HIV research, the population or community characteristic that has been most often considered is the greater HIV risk experienced in urban areas compared to rural locations (Filmer 1998). Urban areas are thought to be more conducive to multiple partnerships and casual sexual relationships as well as commercial sexual activity because of higher population density, greater degree of economic and social activity, and presence of urban social spaces that facilitate partnering between individuals of different population subgroups (e.g., Boisier et al. 2004; Pettifor et al. 2005; Fylkesnes et al. 1997). For example, in a cross-national study of urban areas, Over and Piot (1993) found that HIV prevalence rates were significantly higher in urban areas where there were many fewer young adult women than men. That this relationship was even stronger for the HIV prevalence among prostitutes, suggested that the association between the sex ratio and HIV may operate through the prevalence of commercial sexual activity. A separate study noted that the two West African cities with the highest sex ratios, Abidjan and Dakar, also had the highest HIV prevalence among urban areas in the region (Ahlburg and Jensen 1998).

In perhaps the most comprehensive ecologic study of background characteristics and HIV risk, Mead Over (1998) regressed HIV prevalence as estimated for the urban populations of 72 countries on eight summary measures of background risk factors including the age of the epidemic, GNP per capita, per cent foreign born, percent Muslim, the Gini index of inequality, the male-female literacy gap, the sex ratio of the adult population, and per cent of the population in the military. Over found that these eight variables were capable of explaining from one-half to two-thirds of the cross-country variation in infection rates. Age of the epidemic, per cent foreign-born, income and gender inequality, masculine population and per cent military were all positively associated with HIV prevalence as estimated for urban populations, while per capita GNP and per cent Muslim were inversely associated with HIV prevalence. The author concludes that these background factors likely influence adult HIV prevalence through their impact on the prevalence of risky sexual behaviours and male circumcision (for per cent Muslim). Aral and colleagues (2006) updated Over's 1998 study with the addition of the proximate determinants of HIV transmission efficiency, gonorrhea and syphilis prevalence. This addendum further improved the explanatory power of the model—both were positively associated with urban HIV prevalence. Other less rigorous ecological analyses have indicated that young population age structure, lack of health care infrastructure, international migration, urbanization and calorie supply are all additionally associated with greater HIV prevalence (Drain et al. 2004; Stillwaggon 2006).

In developing the conceptual framework in Figure 1, special consideration is given to the many ways that sex and gender impact differential HIV risk for men and women. Observed gender disparities in risk may be thought of as the consequence of two processes at work in the conceptual framework. First, the effect of each of the proximate and background determinants on HIV risk may be identical for men and women, but the distribution of those determinants across the subpopulations of men and women may be very different. In this case, a greater prevalence of risk factors among women, for example, would yield a higher prevalence of HIV infection among women compared to men, even if the independent effects of each of the risk factors does not vary by gender. In analytical terms, we would expect that multivariate modeling that controls for all risk factors in the framework would show no independent risk associated with gender.

Second, the various risk factors may differ in their effect on HIV risk by gender. Thus while the distribution of risk factors across the two groups may be the same, we can consider that the same risk factor may, for example, hold greater risk for women relative to men, thereby producing a greater risk of HIV infection in women. Analytically speaking, this type of effect would be revealed in multilevel modeling that includes an interaction term between gender and the risk factors of interest. In practice, sex-differences in HIV risk likely result from a combination of the two dynamics at play.

In the remainder of this paper, the conceptual framework is utilized to understand the sources of gender disparities in HIV risk revealed in recent HIV prevalence surveys conducted among adults in Côte d'Ivoire and the United Republic of Tanzania. Both countries are currently experiencing mature, generalized HIV/AIDS epidemics driven primarily by heterosexual transmission. In the United Republic of Tanzania, the first AIDS cases were diagnosed and reported in 1983. By 1986, AIDS cases had been reported in all regions of the Tanzania mainland. Tanzania's 2003-2004 AIS (excludes Zanzibar) estimated that 7.0 per cent of adults aged 15-49 years were living with HIV. This survey also revealed that women in the United Republic of Tanzania are disproportionately affected by the epidemic; 7.7 percent of women tested positive for HIV compared to 6.3 per cent of men (Tanzania Commission for AIDS and ORC Macro 2005).

HIV/AIDS arrived in Côte d'Ivoire somewhat later relative to the United Republic of Tanzania. AIDS was first diagnosed and reported there in 1989. The 2005 AIS conducted in Côte d'Ivoire measured an HIV prevalence of 4.7 per cent among adults aged 15-49 years. A comparison of prevalence among females to prevalence among males reveals an even larger gap relative to the United Republic of Tanzania; 6.4 per cent of women in Côte d'Ivoire were infected with HIV according to the 2005 AIS, compared to 2.9 per cent of men (Ministère de la Lutte contre le Sida and ORC Macro 2006).

It is anticipated that the gender differences in both the proximate determinants of HIV risk and the background characteristics associated with HIV risk through the various proximate determinants will explain a portion of the observed gender disparities in risk of HIV infection in the United Republic of Tanzania and Côte d'Ivoire. Because only a select number of proximate determinants are available in the data to be included in the model, it is further anticipated that background characteristics will also contribute to explaining gender disparities in risk by proxying for the context-specific linkages that connect those characteristics to HIV risk via the unmeasured proximate determinants.

Data

The recently completed AIDS Indicator Surveys (AIS) for the populations of the United Republic of Tanzania and Côte d'Ivoire are utilized in an empirical test of the factors contributing to gender differences in HIV risk. AIS was developed out of the Demographic and Health Surveys (DHS) initiative in order to facilitate effective monitoring of national HIV/AIDS epidemics and programmes. A two-stage cluster sampling design was used to select households that are nationally and regionally representative, such that analysis can be performed for urban and rural areas separately and, for select indicators, at the level of the DHS administrative region. Male and female respondents were asked to report their sexual history, HIV/AIDS related knowledge and attitudes, recent experience with STIs, and perceived risk of contracting HIV. In both the Tanzania and Côte d'Ivoire AIS, respondents were asked to provide a capillary blood sample to be submitted for HIV testing. To maintain anonymity, individual and household identifying information was stripped prior to linking the HIV test results to individual survey responses. Respondents were not notified of their AIS HIV test results, but were provided an opportunity to take an additional test and to receive that result. The AIS are among the first surveys to permit assessment of gender differences in HIV risk on a nationally representative scale (Garcia-Calleja et al. 2006).

Eighty-four percent of eligible women and 77 per cent of eligible men agreed to provide blood samples for HIV testing in the United Republic of Tanzania (Tanzania Commission for AIDS and ORC Macro 2005). Response rates were somewhat lower in Côte d'Ivoire, although more equitable for men and women. Seventy-six per cent of eligible women and 78 per cent of eligible men agreed to provide blood for HIV testing in Côte d'Ivoire (Ministère de la Lutte contre le Sida and ORC Macro 2006). In their assessment of the potential impact of non-response on HIV prevalence estimates obtained with the DHS and AIS surveys, Mishra and colleagues (2006) note that while predicted HIV prevalence tends to be higher in non-tested men and women than in those who agree to the test, the overall effects of non-response on the observed prevalence estimates are minimal.

Tables 1 and 2 describe the characteristics of female and male AIS respondents who completed the questionnaire but did not complete the HIV test portion of the survey and those who completed both the questionnaire and the HIV test for the United Republic of Tanzania and Côte d'Ivoire, respectively. Among respondents in Tanzania, the age distribution of males and females who completed the HIV test is similar to those who did not complete the test. Indeed the characteristics of tested and untested respondents in the Tanzania AIS are quite similar, with a few notable exceptions. Respondents who were not tested were more likely to be wealthy than those who completed the test: 36.3 per cent of females and 43.4 per cent of males who did not complete the test were members of households in the highest wealth quintile, while among respondents who did complete the HIV test, only about one quarter resided in household in the highest wealth quintile. In addition, both male and female respondents who completed the HIV test were more likely than those not tested to report an STI symptom (discharge or genital sores) or diagnosis in the 12 months leading up to the survey.

Among questionnaire respondents to the Côte d'Ivoire AIS, those who completed the HIV test tended to be younger than those who did not complete the test and this was especially the case for men. Of tested male respondents, 56.1 per cent were between the ages of 15 and 29 years, compared to only 41.2 per cent of male respondents not tested. Similar to Tanzania AIS respondents, those who did not complete the HIV test in the Côte d'Ivoire AIS tended to live in wealthier households. In addition, those not tested were more likely to have been ever married or to be in a polygamous union. Among male respondents, 55.1 per cent of those tested reported ever having been married and 6.6 per cent reported a polygamous marriage. 65.1 per cent of male respondents not tested for HIV reported being ever married and 10.1 per cent reported a polygamous marriage. The gap in marital status and polygamous marriage between those tested and not tested for HIV was somewhat smaller among female respondents in Côte d'Ivoire. Also similar to the characteristics of Tanzania respondents, men and women who responded to the Côte d'Ivoire AIS and did not complete the HIV test were more likely to report STI symptoms or diagnosis in the past 12 months. Nearly 21 per cent of women tested for HIV reported a recent STI symptom or diagnosis, compared to less than 16 per cent of women who were interviewed but not tested. Among men, 8.8 per cent of respondents tested reported recent STI symptom or diagnosis, compared to only 4.7 per cent of those not tested.

Because differences among those tested and non-tested respondents are generally small, this source of non-response is not anticipated to have an important impact on the results of multivariate models. However, that a substantial proportion of non-response occurred among those who also did not complete the questionnaire is a source of additional concern. In the Tanzania AIS 4.1 per cent of eligible women and 8.7 per cent of eligible men completed neither the questionnaire nor the HIV test. In the Côte d'Ivoire AIS, those figures were 10.2 per cent and 12.5 per cent, respectively. The characteristics of these eligible respondents, who were not interviewed, are not represented in Tables 1 and 2 and it is not possible to ascertain whether their characteristics differ appreciably from tested respondents. The results of multivariate modeling may be biased if the associations between the proximate determinants, background characteristics, and HIV status vary across tested and non-tested eligible respondents. While this is not anticipated to be the case, the results must be evaluated with this potential source of bias in mind.

Methods

Logistic regression is undertaken to identify the factors that account for the gender differences observed in risk of prevalent HIV infection among sexually experienced adults aged 15 to 49 years in Côte d'Ivoire and the United Republic of Tanzania. A stepwise procedure is utilized to introduce independent variables representing each component of the conceptual framework. Interaction terms are included to test whether selected components of the conceptual framework hold distinct gender-specific associations with the risk of prevalent HIV infection. Because the focus of the analysis is on heterosexual transmission of HIV, the analysis is restricted to those respondents who report ever having experienced sexual intercourse[2].

Variables representing the individual-level proximate determinants include reporting having had an STI symptom (unusual discharge or sores in the genital area) or diagnosis at any point during the 12 months prior to the survey, the number of years between the respondent's first sexual intercourse and the survey date (a proxy for years of exposure to sexual activity) and the number of unique sexual partners in the respondent's lifetime. Individual-level background characteristics included in the analysis are respondent's current age, age at first sexual intercourse, years of premarital sexual exposure, ever married status, polygamous union, religion, whether a usual resident or an overnight visitor in the surveyed household, educational attainment, household wealth index quintile, employment status and occupational category, alcohol use during sexual encounters, identification of AIDS as an avoidable illness (an indicator of HIV/AIDS knowledge), knowing a place to obtain an HIV test (an indicator of both

[2] In the Tanzania AIS, 29 HIV cases were detected among respondents who reported no sexual activity in their lifetimes. In the Côte d'Ivoire AIS, 4 HIV cases were detected among respondents who reported no sexual activity in their lifetimes. All but six of these cases across the two surveys occurred among respondents under the age of 20 years.

HIV/AIDS knowledge and access to HIV-related services) and whether the respondent can refuse sex with a partner (an indicator of perceived self-efficacy in sexual relationships).

One key feature of the conceptual framework shown in Figure 1 is that it highlights the contextual factors that operate on a macro level to contribute to an individual's risk of HIV infection. Each of those factors, such as the percentage of males circumcised and the adult population sex ratio, for example, is associated with HIV risk through its link to the HIV prevalence among sexual partners. To account for the contextual factors influencing HIV risk and represent the HIV risk among potential partners, a summary variable is created for the HIV prevalence among opposite sex respondents in the region. This variable is then included in the logistic regression model as an independent proximate determinant of HIV risk.

While the AIS are rich data sources, not all of the components of the conceptual framework may be adequately represented based on responses to the AIS questionnaires. Detailed information about partner characteristics, for example, is scant and the questionnaire design does not permit identification of partnership concurrency apart from polygamous marriage. It is important when interpreting the results of multilevel models that account for only a portion of the framework components to also keep in mind those important variables that are omitted from the analysis.

Results

The first set of results is presented for the United Republic of Tanzania AIS, where the gender distribution of HIV prevalence is more equitable relative to the experience of Côte d'Ivoire. The female-to-male ratio of HIV prevalence measured in the Tanzania 2003-04 AIS is 1.2. Table 3 summarizes the individual-level proximate determinants and background characteristics of respondents by gender and HIV status. As expected, HIV-positive respondents were more likely to report a recent STI symptom or diagnosis and to have a greater number of years of sexual activity relative to those who tested HIV-negative. Also consistent with expectations, for women, having multiple lifetime partners was associated with positive HIV status: 51.7 per cent of HIV-positive females reported three or more lifetime partners, compared to 31.4 per cent of HIV-negative females. For men, 76.6 per cent of HIV positive males reported three or more lifetime partners, compared to 65.2 per cent of HIV-negative males.

Among both men and women, prevalent HIV infection was positively associated with having been ever married, polygamous union, Catholic and Muslim religion, being an overnight visitor as opposed to a usual resident, higher level of education and household wealth, employment in a professional occupation, alcohol use during sexual encounters, and knowledge of an HIV testing facility.

Multivariate modeling begins with the analysis of the associations between the individual-level proximate determinants and prevalent HIV infection. Table 4 displays the odds ratios of HIV prevalence for females compared to males predicted in logistic regression of the proximate determinants of prevalent HIV infection. The unadjusted bivariate logistic regression model, Model 1, yields an odds ratio for women compared to men of 1.25 [95 per cent CI: 1.07 – 1.45]. Adjustment for a recent STI symptom or diagnosis (Model 2) and years of sexual activity (Model 3) results in little change in the predicted odds ratio for gender. Additionally controlling for reported number of unique sexual partners in the lifetime increases the odds ratio associated with gender to 1.44 [95 per cent CI: 1.23 – 1.69]. Model 5 further includes the region-level proximate determinant indicating the HIV prevalence among opposite sex respondents. Results of this model indicate that after adjusting for differences in the distribution of proximate determinants for men and women, the odds of prevalent HIV infection are more than twice as high for women compared to men. Thus gender disparities in the distribution of proximate determinants do not appear to explain gender disparities in prevalent HIV infection in the United Republic of Tanzania. On the contrary, the results of Model 5 indicate that the uneven distribution of proximate determinants masks larger underlying disparities that exist between men and women who are otherwise equal with respect to the proximate determinants of HIV risk.

To assess whether the various proximate determinants hold unequal implications for HIV risk in men and women, each of the proximate determinants is interacted with gender in the logistic regression model. Only the number of reported lifetime sexual partners showed a statistically significant interaction by gender. The results of Model 6 show the female to male odds ratio of prevalent HIV infection adjusted for each of the proximate determinants and estimated separately according to reported number of lifetime partners. Among men and women reporting one sexual partner in the lifetime, the female-to-male ratio of the odds of prevalent HIV infection is 1.09 (95 per cent CI: 0.67-1.79), indicating no statistically significant difference by gender. Gender differences are apparent among those reporting multiple sexual partnerships in the lifetime. Among those reporting two lifetime partners, the odds ratio for gender is 2.57 (95 per cent CI: 1.73 – 3.82), and among those reporting three or more partners, the adjusted odds ratio is 2.29 (95 per cent CI: 1.86 – 2.81).

Table 5 presents the predicted odds ratios associated with gender from logistic models that consider only the individual-level background characteristics as independent variables. Background characteristics are first considered apart from the proximate determinants because the proximate determinants are thought to lie within the causal pathway linking the background characteristics to HIV risk. Adjusting for respondent's current age alone (Model 7) yields little change in the odds ratio associated with gender (OR=1.27; 95 per cent CI: 1.08 – 1.48). Additionally adjusting for age at first sexual intercourse, years of premarital sexual exposure and marital status (Model 8) increases the odds ratio only slightly to 1.30 (95 per cent CI: 1.20 – 1.55). Adjusting for the full set of background characteristics (Model 9) yields a smaller odds ratio associated with gender (OR=1.14; 95 per cent CI: -.95 – 1.37), and no statistically significant difference in the odds of prevalent HIV infection is detected between women and men.

The final model result presented in Table 5 (Model 10) introduces terms for the background characteristics interacted with gender. The predicted odds ratios associated with gender from this model reveal that the associations between prevalent HIV infection and two background characteristics – household wealth quintile and knowledge of a place to obtain an HIV test – differ for women and men. The adjusted odds ratio increases along with household wealth and is lower among those who report that they know of a place to obtain an HIV test compared to respondents who do not know where to obtain an HIV test. Among respondents in the lowest wealth quintile, women are less likely than men to test positive for HIV. The adjusted female-to-male ratio of the odds of prevalent HIV infection is 0.64 (95 per cent CI: 0.36 – 1.15) among those who do not know where to obtain an HIV test and 0.40 (95 per cent CI: 0.23 – 0.70) among those who can identify a place to get tested for HIV. In the highest household wealth quintile, women are more likely to be infected with HIV among those who do not know of a place to obtain an HIV test (adjusted OR=1.67; 95 per cent CI: 1.05 – 2.67). No statistically significant difference in the odds of prevalent HIV infection between men and women is detected among those in the highest wealth quintile who do know of a place to obtain an HIV test (adjusted OR=1.04; 95 per cent CI: 0.75 – 1.43).

Table 6 reports the results of a logistic regression model including both the proximate determinants and background characteristics as independent variables (Model 11). Consistent with the expectation that the proximate determinants lay within the causal pathway linking the background characteristics to the risk of HIV infection, several associations lose statistical significance in the combined model (results not shown). Respondents' current age is removed from the model due to high collinearity with the number of years of sexual activity. Statistically significant terms for gender interacted with lifetime partners, household wealth quintile and knowledge of a place to obtain an HIV test persist in the combined model. The adjusted odds ratios from Model 11 again show no statistically significant difference in the odds of prevalent HIV infection between men and women reporting only one lifetime partner, regardless of household wealth quintile and for those without knowledge of an HIV testing facility. Among those reporting two or three or more partners, women are more likely than men to test HIV positive, and that disparity is largest among those with greater household wealth and who do not know of a place to obtain an HIV test. For those with two lifetime partners and who do not know a place for an HIV test, women are nearly four times as likely as men to test positive for HIV (adjusted OR=3.96; 95 per cent CI: 2.24 – 7.03). For those with three or more partners and who do not know of a place for an HIV test, the gender disparity is similar (adjusted OR=3.85; 95 per cent CI 2.43 – 6.10).

The next set of results is produced for the Côte d'Ivoire AIS, using a similar stepwise progression as was employed for the United Republic of Tanzania above. Table 7 shows the descriptive statistics by gender and HIV status for sexually experienced respondents to the Côte d'Ivoire AIS. Little difference is seen in recent STI symptom or diagnosis between HIV-positive women and HIV-negative women. In contrast, for men nearly 21 per cent of those testing positive for HIV reported a recent STI symptom or diagnosis, compared to only 8.4 percent of HIV-negative men. Multiple lifetime partnerships were associated with HIV infection among both women and men: 63.7 percent of HIV-positive women and 83.5 per cent of HIV-positive men reported three or more partners in the lifetime, compared to 38.0 per cent of HIV-negative women and 77.3 per cent of HIV-negative men. HIV-positive men and women in Côte d'Ivoire tended to be somewhat older than HIV-negative respondents and reported greater exposure to premarital sexual activity. HIV-positive men were more likely to report ever having been married compared to HIV-negative men (78.7 per cent compared to 54.3 per cent). Marriage does not appear to be associated with HIV status for women: 76.0 per cent of HIV-positive women and 73.0 per cent of HIV-negative women reported ever having been married. Among women, those testing positive for HIV were somewhat more likely to report being in a polygamous marriage relative to HIV-negative respondents. For men, the opposite relationship is observed: 6.7 per cent of HIV-negative men reported a polygamous marriage, compared to only 2.9 per cent of HIV-positive men.

Table 8 presents the female-to-male ratios of odds of prevalent HIV infection estimated with adjustments for the various proximate determinants of HIV risk. Model 12, the unadjusted model, shows an odds of prevalent HIV infection that is more than twice as high for women compared to men (unadjusted OR=2.31; 95 per cent CI: 1.84 – 2.88). Adjusting for recent STI symptom or diagnosis (Model 13) and years of sexual activity (Model 14), yields little change in the odds ratio for gender. Further adjusting for the reported number of lifetime partners (Model 15) increases the odds ratio for gender to 3.07 (95 per cent CI: 2.41 – 3.91) and additionally adjusting for the HIV prevalence among opposite sex respondents in the region (Model 16) produces a jump in the odds ratio to 4.55 (95 per cent CI: 3.06 – 6.77). As was the case for the United Republic of Tanzania, adjusting for the uneven distribution of proximate determinants for men and women in Côte d'Ivoire fails to explain the observed gender disparity in prevalent HIV infection. Instead, adjusting for the uneven gender distribution of proximate determinants yields a doubling of the estimated gender disparity in HIV risk.

Introducing interaction terms for gender and the proximate determinants to the logistic regression model reveals gender-specific associations between both recent STI and reported number of lifetime partners and risk of prevalent HIV infection. Gender disparities increase with a greater number of lifetime partners and are smaller among respondents who report a recent STI symptom or diagnosis than for those who do not. For respondents with no recent STI symptom or diagnosis and three or more lifetime partners, women are nearly five times more likely to test HIV-positive than men (adjusted OR=4.84; 95 per cent CI: 3.15 – 7.44). Among those with no recent STI symptom or diagnosis and only one lifetime partner, women are substantially less likely than men to test positive for HIV (adjusted OR=0.22; 95 per cent CI: 0.09 – 0.55).

Models 18 through 21 presented in Table 9 consider only the associations between background characteristics and risk of prevalent HIV infection. Adjusting for the distribution of background characteristics does not explain gender differences in the risk of prevalent HIV infection. Instead the adjusted odds ratio 2.94 (Model 20) (95 per cent CI: 2.25 – 3.84) is larger than that estimated in the unadjusted model (Model 12). Interacting the various background characteristics with gender shows gender-specific associations between marital status, polygamous marriage, and religion and the risk of prevalent HIV infection (Model 21). Gender disparities in HIV risk are greatest among Muslim and Protestant respondents compared to Catholic respondents. Among all religious groups, gender disparities in HIV risk are larger among those never married compared to ever married respondents in non-polygamous unions. Even larger gender disparities in risk are evident among respondents in polygamous unions compared to those never married. Polygamous union is protective against HIV for men, but not for women. For Muslim and Protestant respondents, women in polygamous unions are more than ten times more likely to be infected with HIV compared to men in polygamous unions (adjusted OR for Muslim=10.64; 95 per cent CI:3.27 – 34.62; adjusted OR for Protestant 10.91; 95 per cent CI: 3.18 – 37.40).

As was the case for the United Republic of Tanzania, the combined model for Côte d'Ivoire, accounting for both proximate determinants and background characteristics (Table 10, Model 22), reveals that many background characteristics held statistically significant associations with HIV risk even after controlling for the proximate determinants. Even respondents' age, which was collinear with years of sexual activity for Tanzania, showed a statistically independent association with HIV status for Côte d'Ivoire. As polygamous union is correlated with the reported number of lifetime sexual partners for men, the gender interaction with polygamous union is omitted from the combined model. Model 22 shows that the largest gender disparities in HIV risk are observed among those who report three or more lifetime partners and who have never been married. Among Muslim respondents in this category, women were nearly 20 times more likely than men to test positive for HIV (adjusted OR=19.55; 95 per cent CI: 8.89 – 42.98), while the adjusted odds ratio for Protestant respondents in this category was 13.09 (95 per cent CI: 6.55 – 26.13).

Discussion and conclusions

The United Republic of Tanzania and Côte d'Ivoire—both countries experiencing mature, generalized HIV/AIDS epidemics—display unique profiles of gender disparities in HIV risk. The female-to-male ratio of HIV prevalence measured in the Tanzania 2003-04 AIS was 1.2, indicating that adult women between the ages of 15 and 49 were about 20 per cent more likely to be infected with HIV compared to men in the same age range. The gender disparity in risk of prevalent HIV infection measured in the Côte d'Ivoire 2005 AIS was even wider, showing that women were more than two times more likely to be infected with HIV. A conceptual framework was developed to facilitate understanding of the major factors that determine an individual's HIV risk and how gender disparities might arise. The framework identified numerous proximate determinants which operate on both the individual (micro) and population (macro) levels to influence HIV risk by determining the risk of sexual exposure to HIV or the risk of HIV transmission given a sexual exposure. A second set of background characteristics, also relevant on multiple levels, is associated with an individual's risk of acquiring HIV only through the various proximate determinants.

The conceptual framework guided an empirical analysis of gender disparities in risk of prevalent HIV infection using the Tanzania and Côte d'Ivoire AIS, two nationally representative HIV seroprevalence surveys. The analysis revealed that in both countries the uneven distribution of proximate determinants across men and women did not explain the observed gender disparities in HIV prevalence. Instead, those gender disparities widened after adjusting for the distribution of measured proximate determinants.

Not all of the relevant proximate determinants identified in the conceptual framework could be adequately represented in empirical models given the available data. For example, although information on condom use at last sexual intercourse was collected in the AIS, more detailed information on the consistency of condom use was not included, thus condom use during exposures relevant to a prevalent HIV infection could not be represented in the models. In light of this and other similar omissions, it was useful to examine the associations between the background characteristics and HIV risk to identify where other factors may contribute to gender disparities in risk.

Such analysis for the United Republic of Tanzania indicated that gender disparities in risk varied according to household wealth quintile and knowledge of an HIV testing facility. While HIV risk increases with household wealth, so too do gender disparities in risk. Among respondents to the Tanzania AIS who reported multiple lifetime sexual partners, women's and men's risk of HIV infection was essentially not distinguishable in the lowest household wealth quintile. In the highest wealth quintile however, women were nearly four times more likely than men to be infected with HIV. While knowledge of an HIV testing facility was positively associated with HIV infection among both men and women, gender disparities were generally smaller among those who knew of a facility relative to those who did not, indicating that lack of knowledge leaves women more vulnerable to HIV infection than men in the United Republic of Tanzania.

Analysis for Côte d'Ivoire also revealed gender disparities in HIV risk that varied substantially across population subgroups. Whereas the relevant subgroups for the United Republic of Tanzania were defined by household wealth and knowledge of an HIV testing facility, in Côte d'Ivoire the relevant subgroups were instead identified by religion and marital status. The gender disparity was especially pronounced among Muslim respondents, providing support for the notion that male circumcision may contribute to wider gender disparities by lowering men's biological susceptibility to HIV infection relative to women's because Muslim men tend to have higher rates of circumcision compared to other religious groups. That the gender disparity among Muslim respondents further varies according to marital status and lifetime partnerships, however, suggests that other mechanisms influencing exposure are likely at play as well.

While understanding gender disparities in HIV risk across the various background determinants contributes importantly to appreciation of the gender-specific impact of an HIV epidemic, it does not point explicitly to the proximate determinants that link each background determinant to gender disparities in risk. Additional work is needed to introduce omitted proximate and background determinants to the model in order to further investigate the sources of gender disparities in HIV risk. Future work should concentrate especially on understanding the network of sexual partnerships and how that network may contribute to differential exposure to HIV-infected partners for men and women. Gregson and colleagues' (2002) study indicated that large age differences between young women and their older male partners explained much of the gender disparity in risk observed among young people in a community of Zimbabwe. More work is needed to understand gender disparities in HIV risk on a national scale.

Also important to keep in mind is that HIV prevalence, as measured in national seroprevalence surveys, is not a measure of risk per se and the proximate and background determinants observed to be associated with prevalent HIV infection in these cross-sectional surveys are not always the relevant exposures for the prevalent infection. Many of the women and men who tested HIV-positive in the AIS acquired the infection years before the survey was taken, thus covariates such as recent STI infection, marital status, or household wealth measured in the survey do not necessarily reflect the conditions at the time of HIV infection. Only long-term longitudinal studies with short follow-up intervals are able to detect incident HIV infection and assess relevant exposures. As these surveys are both time and resource intensive, none has been conducted on a nationally representative scale. HIV-testing technologies that identify recently acquired infections among prevalent HIV cases (Janssen et al. 1998) may one day permit estimation of incidence in nationally representative surveys, but very large sample sizes will be required in order to allow analysis of the proximate determinants and background characteristics associated with incident HIV infections.

In continuation of the analysis initiated here, a similar analysis that examines the relationship between partner characteristics and HIV risk and their contribution to gender disparities in risk using the Tanzania and Côte d'Ivoire AIS is presently underway. The study sample is restricted to those AIS respondents who were in a marital or cohabiting union at the time of the study, as these are the partners for whom information on proximate determinants and background characteristics are available. This analysis permits inclusion of additional proximate determinants and background characteristics beyond what was accomplished using the full sample of sexually experienced adults. It is hoped that continued study will yield further insight into the sources of gender disparities of HIV risk in the United Republic of Tanzania and Côte d'Ivoire and point to explanations for why those disparities differ across the two countries with mature, generalized HIV epidemics.

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Figure 1: Conceptual framework for HIV risk

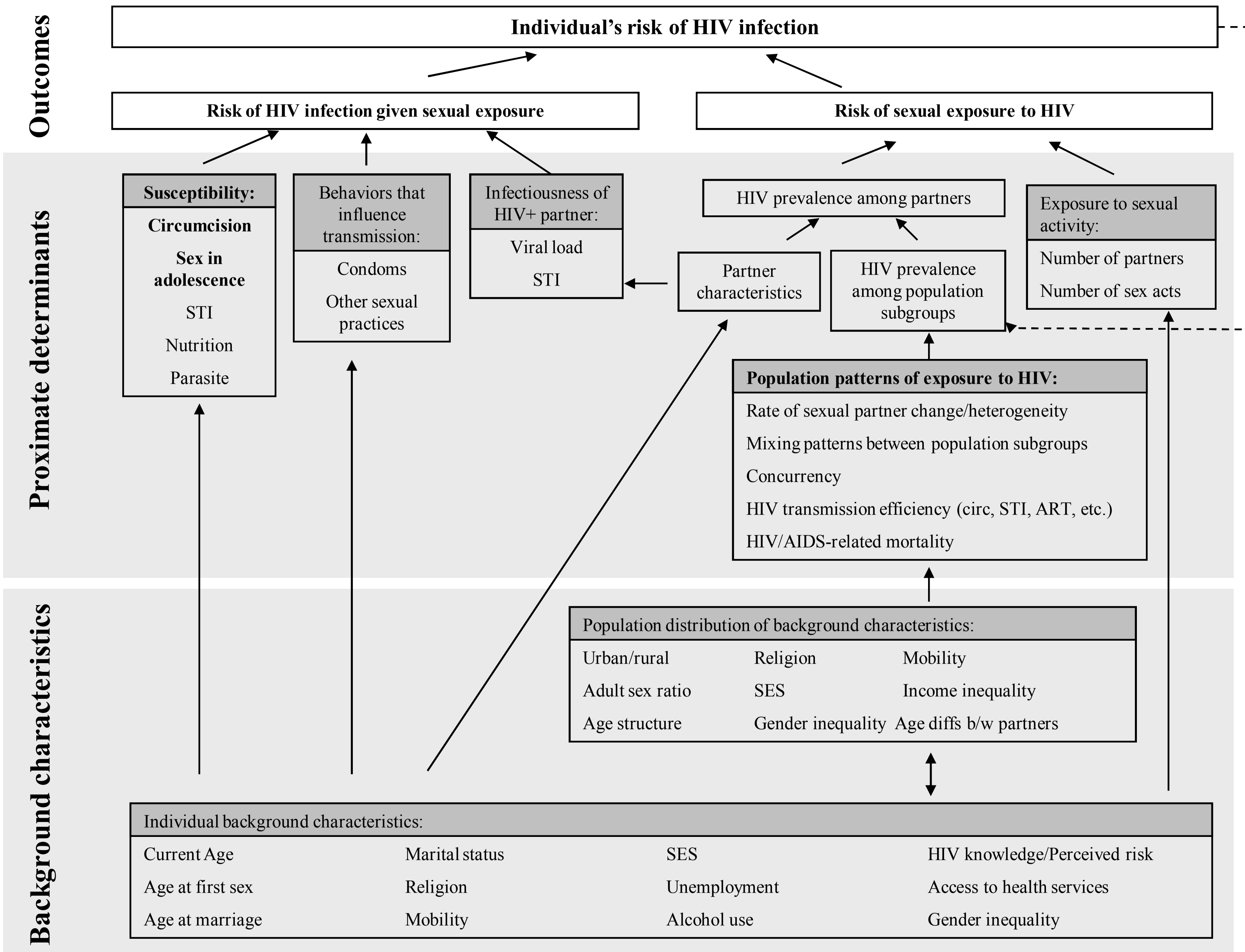

Table 1. Characteristics of respondents to the Tanzania 2003-04 AIS, by gender and whether tested for HIV

	Female respondents		Male respondents	
	NOT tested for HIV (n=756)	Tested for HIV (n=5217)	NOT tested for HIV (n=710)	Tested for HIV (n=3949)
Age range (%)				
15 - 19	12.3	12.0	12.0	12.3
20 - 24	23.4	21.4	18.4	18.9
25 - 29	21.4	21.4	19.5	19.8
30 - 34	17.5	15.8	17.4	16.7
35 - 39	10.9	12.8	14.6	14.1
40 - 44	7.9	9.4	11.3	9.6
45 - 49	6.7	7.2	6.6	8.6
Religion (%)				
Catholic	23.1	32.2	28.3	33.0
Muslim	32.3	30.7	35.0	30.2
Protestant	26.4	28.1	25.5	25.8
Other	17.9	8.9	11.3	10.9
Education (%)				
< Primary	35.5	38.5	23.9	26.7
Primary	55.2	54.8	60.1	62.7
Secondary +	9.3	6.7	16.0	10.5
Wealth quintile (%)				
1 (lowest)	13.9	18.7	7.9	16.7
2	17.1	18.5	13.9	20.0
3	13.5	18.9	13.4	18.5
4	18.9	20.0	21.3	19.1
5	36.6	24.0	43.4	25.6
Marital status (%)				
Ever married	84.0	86.9	68.9	70.2
Polygamous	5.8	7.4	5.3	6.3
Sexual activity				
1 partner in lifetime (%)	47.8	41.9	15.5	14.9
2 partners in lifetime (%)	26.3	24.8	18.7	16.9
3+ partners in lifetime (%)	25.3	33.2	60.1	66.0
STI symptom or diagnosis (%)	2.6	5.6	2.6	7.1

Table 2. Characteristics of respondents to the Côte d'Ivoire 2005 AIS, by gender and whether tested for HIV

	Female respondents		Male respondents	
	NOT tested for HIV (n=582)	Tested for HIV (n=4160)	NOT tested for HIV (n=574)	Tested for HIV (n=3396)
Age range (%)				
15 - 19	13.6	18.0	8.9	12.2
20 - 24	23.2	23.3	15.2	23.1
25 - 29	19.0	19.3	17.1	20.8
30 - 34	17.7	13.9	20.1	14.5
35 - 39	11.3	10.4	18.0	12.4
40 - 44	9.1	8.4	13.1	8.7
45 - 49	6.1	6.7	7.5	8.3
Religion (%)				
Catholic	19.9	21.4	19.7	22.7
Muslim	47.0	35.1	47.4	33.1
Protestant	23.3	25.7	17.6	22.3
Other	9.9	17.6	15.2	21.9
Education (%)				
< Primary	71.6	78.9	53.2	55.3
Primary	22.1	19.2	32.3	35.1
Secondary +	6.2	1.9	14.5	9.6
Wealth quintile (%)				
1 (lowest)	11.1	18.0	10.0	16.4
2	14.1	19.3	13.0	19.1
3	19.9	19.7	18.2	19.9
4	27.3	21.1	28.3	20.8
5	27.5	22.0	30.4	23.9
Marital status (%)				
Ever married	78.3	73.2	65.1	55.1
Polygamous	21.0	18.6	10.1	6.6
Sexual activity				
1 partner in lifetime (%)	38.5	33.2	10.4	8.9
2 partners in lifetime (%)	25.6	25.6	12.8	10.3
3+ partners in lifetime (%)	32.4	39.8	69.8	77.5
STI symptom or diagnosis (%)	15.7	20.9	4.7	8.8

Table 3. Descriptive statistics for sexually experienced respondents to the Tanzania 2003-04 AIS, by gender and HIV serostatus

	Females				Males			
	HIV-positive (n=414)		HIV-negative (n=4803)		HIV-positive (n=252)		HIV-negative (n=3697)	
Individual-level proximate determinants								
STI symptom or diagnosis %	9.9		5.2		9.4		6.9	
Years sexually active mean (s.d.)	19.1	(0.4)	17.4	(0.1)	20.6	(0.5)	17.0	(0.2)
1 lifetime partner %	18.7		44.1		7.4		15.5	
2 lifetime partners %	29.0		24.4		12.0		17.3	
3+ lifetime partners %	51.7		31.4		76.6		65.2	
Individual-level background characteristics								
Age %								
15 - 19	4.0		12.8		4.2		12.9	
20 - 24	16.0		21.9		11.0		19.5	
25 - 29	23.5		21.2		19.6		19.9	
30 - 34	23.7		15.0		20.6		16.4	
35 - 39	17.3		12.4		19.6		13.6	
40 - 44	10.6		9.3		16.8		9.1	
45 - 49	4.9		7.5		8.2		8.6	
Age at first sex (s.d.)	17.0	(0.1)	17.0	(0.0)	17.7	(0.2)	18.0	(0.1)
Years of pre-mar sexual activity (s.d)	2.5	(0.2)	1.8	(0.1)	5.4	(0.4)	4.7	(0.1)
Ever married %	90.0		86.6		85.2		69.1	
Polygamous marriage %	8.5		7.3		8.1		6.2	
Religion %								
Catholic	35.0		31.9		41.9		32.4	
Muslim	34.2		30.4		28.0		30.4	
Protestant	25.1		28.4		22.9		26.0	
Other	5.7		9.2		7.2		11.2	
Visitor %	6.0		4.2		5.0		3.7	
Education %								
< Primary	28.6		39.5		21.6		27.1	
Primary	61.5		54.1		66.1		62.5	
Secondary +	9.9		6.4		12.3		10.4	
Wealth quintile %								
1 (lowest)	6.6		19.8		11.1		17.2	
2	10.6		19.2		13.5		20.5	
3	16.6		19.1		13.4		18.9	
4	28.1		19.2		24.3		18.8	
5	38.2		22.6		37.7		24.7	
Employment %								
Unemployed	12.4		11.3		6.1		7.1	
Agricultural employment	46.3		65.7		47.6		61.0	
Manual labour employment	2.7		3.1		20.0		14.5	
Professional employment	38.5		19.8		26.3		17.4	
Alcohol use during sex %	18.6		14.7		17.5		11.4	
Says AIDS is avoidable %	89.6		90.1		97.3		94.9	
Knows a place for an HIV test %	65.8		60.1		81.1		71.9	
Can refuse sex with partner %	60.8		64.7		70.4		68.5	

Table 4. Gender disparities in odds of positive HIV serostatus for Tanzanian adults aged 15 to 49 years who reported sexual debut, adjusted for proximate determinants of HIV risk

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	Unadjusted OR (95% CI)	Adjusted OR for STI in past year (95% CI)	Adjusted OR for STI and years of sexual activity (95% CI)	Adjusted OR for STI, yrs of sexual activity and lifetime partners (95% CI)	Adjusted OR for STI, yrs of sexual activity, lifetime partners and HIV prevalence among opposite sex respondents in the region (95% CI)	Adjusted OR for STI, yrs of sexual activity and HIV prevalence among opposite sex respondents in the region (95% CI)
Female/Male	**1.25** **(1.07 – 1.45)**	**1.29** **(1.08 – 1.47)**	**1.27** **(1.08 – 1.48)**	**1.44** **(1.23 – 1.69)**	**2.18** **(1.83 – 2.60)**	
Female/Male for those reporting 1 lifetime partner						1.09 (0.67 – 1.79)
Female/Male for those reporting 2 lifetime partners						**2.57** **(1.73 – 3.82)**
Female/Male for those reporting 3 or more lifetime partners						**2.29** **(1.86 – 2.81)**
N	9166	9166	9166	9166	9166	9166
-2 Log Likelihood	5068	5054	4935	4840	4710	4703

Bolded indicates statistically significant at the 95 per cent confidence level.

Table 5. Gender disparities in odds of positive HIV serostatus for Tanzanian adults aged 15 to 49 years who reported sexual debut, adjusted for background characteristics associated with HIV risk

	Model 1	Model 7	Model 8	Model 9	Model 10	
	Unadjusted OR (95 % CI)	Adjusted OR for age (95% CI)	Adjusted OR for age, age at sexual debut, premarital sexual exposure and marital status (95% CI)	Adjusted OR for all individual-level background characteristics[a] (95% CI)	Adjusted OR for age, age at sexual debut, premarital sexual exposure marital status, religion, occupational category and ability to refuse sex with a partner (95% CI)	
Female/Male	**1.25** **(1.07 – 1.45)**	**1.27** **(1.08 – 1.48)**	**1.30** **(1.10 – 1.55)**	1.14 (0.95 – 1.37)		
					Does not know of a place to obtain an HIV test	Knows a place to obtain an HIV test
Female/Male among those in household wealth quintile 1 (lowest)					0.64 (0.36 – 1.15)	**0.40** **(0.23 – 0.70)**
Female/Male among those in household wealth quintile 2					1.09 (0.64 – 1.84)	0.67 (0.41 – 1.11)
Female/Male among those in household wealth quintile 3					1.64 (0.99 – 2.71)	1.02 (0.65 – 1.60)
Female/Male among those in household wealth quintile 4					1.56 (0.98 – 2.48)	0.96 (0.67 – 1.39)
Female/Male among those in household wealth quintile 5 (highest)					**1.67** **(1.05 – 2.67)**	1.04 (0.75 – 1.43)
N	9166	9166	9166	9166	9166	
-2 Log Likelihood	5068	4951.39	4937.56	4730.04	4718.09	

[a] Includes age, age at sexual debut, years of premarital sexual exposure, marital status, religion, household wealth quintile, occupational category, knowledge of a place to obtain an HIV test and ability to refuse sex with a partner.
Bolded indicates statistically significant at the 95 per cent confidence level.

Table 6. Gender disparities in odds of positive HIV serostatus for Tanzanian adults aged 15 to 49 years who reported sexual debut, adjusted for proximate determinants and background characteristics associated with HIV risk

	Model 11 Adjusted OR for proximate determinants and background characteristics[a] (95% CI)					
	1 lifetime partner		2 lifetime partners		3 or more lifetime partners	
	Does not know of a place to obtain an HIV test	Knows a place to obtain an HIV test	Does not know of a place to obtain an HIV test	Knows a place to obtain an HIV test	Does not know of a place to obtain an HIV test	Knows a place to obtain an HIV test
Female/Male among those in household wealth quintile 1 (lowest)	0.56	**0.36**	1.31	0.64	1.28	0.82
	(0.27 - 1.17)	**(0.17 - 0.75)**	(0.67 - 2.58)	(0.33 - 1.24)	(0.72 - 2.28)	(0.47 - 1.43)
Female/Male among those in household wealth quintile 2	0.93	0.59	**2.17**	1.39	**2.11**	1.35
	(0.46 - 1.85)	(0.30 - 1.17)	**(1.17 - 4.02)**	(0.77 - 2.52)	**(1.26 - 3.55)**	(0.83 - 2.21)
Female/Male among those in household wealth quintile 3	1.40	0.90	**3.30**	**2.12**	**3.20**	**2.05**
	(0.72 - 2.74)	(0.48 - 1.70)	**(1.80 - 6.06)**	**(1.20 - 3.72)**	**(1.93 - 5.32)**	**(1.31 - 3.23)**
Female/Male among those in household wealth quintile 4	1.51	0.97	**3.54**	**2.27**	**3.44**	**2.20**
	(0.80 - 2.84)	(0.55 - 1.71)	**(2.00 - 6.26)**	**(1.39 - 3.71)**	**(2.16 - 5.46)**	**(1.54 - 3.16)**
Female/Male among those in household wealth quintile 5 (highest)	1.69	1.08	**3.96**	**2.54**	**3.85**	**2.47**
	(0.89 - 3.20)	(0.62 - 1.88)	**(2.24 - 7.03)**	**(1.61 - 4.02)**	**(2.43 - 6.10)**	**(1.82 - 3.35)**
N	9166					
-2 Log Likelihood	4546.03					

[a] Includes STI symptom or diagnosis in the past 12 months, years of sexual activity, HIV prevalence among opposite sex respondents in the region, age at sexual debut, years of premarital sexual exposure, marital status, religion, occupational category and ability to refuse sex with a partner.
Bolded indicates statistically significant at the 95 per cent confidence level.

Table 7. Descriptive statistics for sexually experienced respondents to the Côte d'Ivoire 2005 AIS, by gender and HIV serostatus

	Females				Males			
	HIV-positive (n=255)		HIV-negative (n=3905)		HIV-positive (n=91)		HIV-negative (n=3305)	
Individual-level proximate determinants								
STI symptom or diagnosis %	21.8		20.8		20.8		8.4	
Years sexually active mean (s.d.)	20.9	(0.7)	17.0	(0.2)	22.9	(1.0)	16.9	(0.2)
1 lifetime partner %	19.1		34.2		8.4		8.9	
2 lifetime partners %	15.3		26.4		6.6		10.5	
3+ lifetime partners %	63.7		38.0		83.5		77.3	
Individual-level background characteristics								
Age %								
15 - 19	1.5		19.2		1.1		12.6	
20 - 24	15.6		23.9		2.4		23.8	
25 - 29	20.9		19.2		19.5		20.8	
30 - 34	29.6		12.7		25.5		14.1	
35 - 39	12.5		10.3		19.6		12.1	
40 - 44	10.2		8.2		19.5		8.4	
45 - 49	9.7		6.5		12.4		8.2	
Age at first sex mean (s.d.)	16.2	(0.4)	15.9	(0.1)	17.6	(0.7)	17.4	(0.1)
Years of pre-mar sexual activity (s.d.)	5.0	(0.5)	3.1	(0.1)	8.9	(0.7)	6.4	(0.1)
Ever married %	76.3		73.0		78.7		54.3	
Polygamous marriage %	20.1		18.5		2.9		6.7	
Religion %								
Catholic	17.6		21.7		36.6		22.3	
Muslim	29.0		35.6		21.2		33.4	
Protestant	39.8		24.6		23.4		22.2	
Other	13.6		17.9		18.8		22.0	
Visitor %	10.8		7.3		2.1		8.6	
Education %								
< Primary	71.1		79.5		44.6		55.6	
Primary	25.3		18.7		51.1		34.6	
Secondary +	3.6		1.8		4.2		9.8	
Wealth quintile %								
1 (lowest)	9.8		18.6		10.1		16.6	
2	11.1		19.9		23.0		19.0	
3	19.1		19.7		29.7		19.6	
4	25.9		20.7		14.9		20.9	
5	34.0		21.1		22.4		23.9	
Employment %								
Unemployed	25.3		30.7		17.5		19.2	
Agricultural employment	16.7		22.0		35.2		38.1	
Manual labour employment	14.6		13.1		29.9		24.8	
Professional employment	43.3		33.8		16.3		16.3	
Alcohol use during sex %	1.6		1.6		7.6		5.1	
Says AIDS is avoidable %	77.9		64.8		86.4		81.1	
Knows a place for an HIV test %	21.1		19.1		28.0		39.9	
Can refuse sex with partner %	30.3		35.5		n/a		n/a	

Table 8. Gender disparities in odds of positive HIV serostatus for Côte d'Ivoire adults aged 15 to 49 years who reported sexual debut, adjusted for proximate determinants of HIV risk

	Model 12	Model 13	Model 14	Model 15	Model 16	Model 17	
	Unadjusted OR (95% CI)	Adjusted OR for STI in past year (95% CI)	Adjusted OR for STI and years of sexual activity (95% CI)	Adjusted OR for STI, yrs of sexual activity and lifetime partners (95% CI)	Adjusted OR for STI, yrs of sexual activity, lifetime partners and HIV prevalence among opposite sex respondents in the region (95% CI)	Adjusted OR for STI, yrs of sexual activity and HIV prevalence among opposite sex respondents in the region (CI)	
Female/Male	**2.31**	**2.22**	**2.28**	**3.07**	**4.55**		
	(1.84 – 2.88)	**(1.77 – 2.78)**	**(1.82 – 2.86)**	**(2.41 – 3.91)**	**(3.06 – 6.77)**		
						No STI	STI
Female/Male for those reporting 1 lifetime partner						0.70	**0.22**
						(0.32 – 1.51)	**(0.09 – 0.55)**
Female/Male for those reporting 2 lifetime partners						1.80	0.56
						(0.77 – 4.23)	(0.21 – 1.48)
Female/Male for those reporting 3 or more lifetime partners						**4.84**	1.50
						(3.15 – 7.44)	(0.84 – 2.67)
N	7556	7556	7556	7556	7556	7556	
-2 Log Likelihood	3046	3041	2890	2846	2834	2798	

Bolded indicates statistically significant at the 95 per cent confidence level.

Table 9. Gender disparities in odds of positive HIV serostatus for Côte d'Ivoire adults aged 15 to 49 years who reported sexual debut, adjusted for background characteristics associated with HIV risk

	Model 12	Model 18	Model 19	Model 20	Model 21		
	Unadjusted OR (95 % CI)	Adjusted OR for age (95% CI)	Adjusted OR for age, age at sexual debut, premarital sexual exposure and marital status (95% CI)	Adjusted OR for all individual-level background characteristics[a] (95% CI)	Adjusted OR for age, age at sexual debut, premarital sexual exposure household wealth, occupational category, knowledge of an HIV testing facility and ability to refuse sex with a partner (95% CI)		
Female/Male	**2.31** **(1.84 – 2.88)**	**2.54** **(2.03 – 3.18)**	**3.15** **(2.46 – 4.04)**	**2.94** **(2.25 – 3.84)**			
					Never married	Ever married non-polygamous	Ever married polygamous
Female/Male among Catholic					**2.54** **(1.40 – 4.59)**	0.82 (0.50 – 1.34)	3.09 (0.92 – 10.40)
Female/Male among Muslim					**8.73** **(4.48 – 17.00)**	**2.83** **(1.70 – 4.72)**	**10.64** **(3.27 – 34.62)**
Female/Male among Protestant					**8.73** **(4.82 – 16.63)**	**2.90** **(1.80 – 4.69)**	**10.91** **(3.18 – 37.40)**
Female/Male among Other religion category					**6.06** **(2.97 – 12.34)**	**1.97** **(1.10 – 3.51)**	**7.38** **(2.08 – 26.15)**
N	7556	7556	7556	7556		7556	
-2 Log Likelihood	3046	2855.19	2828.23	2749.67		2715.69	

Bolded indicates statistically significant at the 95 per cent confidence level.

Table 10. Gender disparities in odds of positive HIV serostatus for Côte d'Ivoire adults aged 15 to 49 years who reported sexual debut, adjusted for proximate determinants and background characteristics associated with HIV risk

	Model 22 Adjusted OR for proximate determinants and background characteristics[a] (95% CI)					
	1 lifetime partner		2 lifetime partners		3 or more lifetime partners	
	Never married	Ever married	Never married	Ever married	Never married	Ever married
Female/Male among Catholic	0.58	**0.29**	1.10	0.55	**4.12**	**2.07**
	(0.22 - 1.55)	**(0.11 - 0.75)**	(0.39 – 3.11)	(0.20 - 1.52)	**(2.11 – 8.05)**	**(1.08 – 3.99)**
Female/Male among Muslim	**2.75**	1.38	**5.19**	2.61	**19.55**	**9.83**
	(1.05 – 7.18)	(0.57 – 3.35)	**(1.84 – 14.62)**	(0.99 – 6.89)	**(8.89 – 42.98)**	**(4.76 – 20.30)**
Female/Male among Protestant	1.84	0.93	**3.47**	1.75	**13.09**	**6.58**
	(0.66 – 5.10)	(0.36 – 2.40)	**(1.19 – 10.15)**	(0.63 – 4.81)	**(6.55 – 26.13)**	**(3.52 – 12.30)**
Female/Male among Other religion category	1.45	0.73	2.74	1.38	**10.31**	**5.19**
	(0.49 – 4.26)	(0.26 – 2.02)	(0.90 – 8.35)	(0.48 – 3.98)	**(4.61 – 23.08)**	**(2.44 – 11.01)**
N	7556					
-2 Log Likelihood	2678.74					

[a] Includes STI symptom or diagnosis in the past 12 months, years of sexual activity, HIV prevalence among opposite sex respondents in the region, current age, age at sexual debut, years of premarital sexual exposure, household wealth quintile, occupational category, knowledge of an HIV testing facility and ability to refuse sex with a partner.
Bolded indicates statistically significant at the 95 per cent confidence level.