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ABSTRACT

Introduction: HIV is one of the worst epidemics ever, with about 22.5 million people in sub-Saharan Africa living with the virus. The epidemic is extremely heterogenic and dynamic. HIV prevention depends upon a good understanding of population-specific transmission determinants. Therefore, this study of the magnitude and determinants of the recently observed decrease in HIV infection in Tanzania will help define the future direction of HIV interventions in the country.

Methods: Data from the 2003/04 and 2007/08 AIDS indicator surveys from Mainland Tanzania were used in this analysis. In these surveys a multi-stage cluster sampling method utilizing two-stage sample design was employed to recruit participants age 15-49 from throughout the country. Socio-demographic, behavioral and biological determinants for HIV transmission were collected, and HIV testing was done to all consenting participants. In this analysis, data were restricted to Mainland Tanzania, people who reported to be sexually active, and people who had a valid HIV test result. A total sample of 3,944 men and 5,213 women from the 2003/04 survey and 3,708 men and 5,311 women from the 2007/08 survey were included in this analysis.

Results: Apart from a significant increase between 2003/04 and 2007/08 in the proportion of people reporting having ever had an HIV test, other socio-demographic, behavioral and biological variables remained similar across the two surveys. Overall, HIV infection decreased by 14% (from 7.9% to 6.8%) over the four years between surveys, but this decrease was only significant among urban males. In both surveys among both women and men, formerly married individuals were at higher HIV risk, In the 2007/08 survey, however, single women were 60% less likely than married women to be infected. Risk of infection increased with wealth for both sexes and in both surveys. Risk was two to three times higher among rural residents compared with urban residents. In the 2007/08 survey educational attainment was associated with HIV infection in rural areas but not in urban areas. Having many lifetime sexual partners was a risk factor among both men and women, in both rural and urban areas, and in both surveys. Having a sexually transmitted infection (STI) was an important biological determinant for HIV infection in the 2007/08 survey, with twice the likelihood of infection for infected men and

women compared with those uninfected. Male circumcision was associated with 60-80% lower odds of HIV infection.

Conclusion and recommendation: HIV prevalence is decreasing among men in urban areas of Tanzania. Overall, men and women have similar determinants of HIV transmission, as do rural and urban populations. However, the study identified a number of transmission determinants that varied by sex and by urban-rural residence across the two surveys. Hence, interventions must address specific determinants in order to be effective. Similarly, interventions must address urban and rural populations separately.

BACKGROUND

The HIV epidemic has been one of the worst global epidemics in decades. It has been described as heterogenic, varying from country to country and population to population (UNAIDS and WHO 2010). Earlier research has found some biological factors such as male circumcision and infection with herpes simplex virus type 2 (HSV-2) to partly explain the variability (Bailey et al. 2007, Boerma et al. 2003, Buvé 2006, Gray et al. 2007). But biological determinants only increase the probability of acquisition or transmission of HIV in the presence of unprotected sexual contact. In its absence, the magnitude of male circumcision or HSV-2 does not have any effect on HIV transmission (Buvé 2006, Glynn et al. 2001a, Killian et al. 1999). Therefore, sexual risk behavior such as having unprotected sexual intercourse and multiple sexual partnerships has been described as the cornerstone for HIV transmission, and changes in these behaviors have been associated with reduction in the transmission rate of HIV infection (Cleland et al. 2004, Gregson et al. 2006, Killian et al. 1999, Mmbaga et al. 2007a).

Prevention of the HIV epidemic, like other infectious diseases, depends on having a good understanding of the determinants of the spread of the infections. Monitoring trends in important determinants is crucial in explaining trends in disease magnitude and evaluation of intervention programs (Fylkenes et al. 2001, Gregson et al. 2006, Mmbaga et al. 2007a, Urassa et al. 2006). Variability in HIV transmission between and within countries in sub-Saharan Africa has called for country-specific description of the drivers of the epidemic population (UNAIDS and WHO 2010).

Tanzania is among the countries in sub-Saharan Africa hardest hit by the HIV epidemic. Tanzania HIV and Malaria Indicator Surveys conducted in 2007/08 reported a decrease in estimates of overall HIV prevalence, from 7.0% in 2004 to 5.8% in 2008 (Kwesigabo et al. 1996, TACAIDS et al. 2008, Urassa et al. 2006). The decrease was significant among men but not among women. Urban areas registered a significant decrease in HIV prevalence while in rural areas the decrease was modest (Asamoah-Odei et al. 2004, Gregson et al. 2006, Mmbaga et al. 2007a, TACAIDS et al. 2008, UNAIDS and WHO 2010).

The main drivers of the epidemic to explain the overall trends in the country have not been described. It is also not known whether the main transmission determinants differ by sex or differ between rural and urban areas. Understanding the direction of the change in HIV

prevalence, along with various drivers of HIV transmission in different populations and areas of the country, is of paramount importance in intervention design, evaluation, and scale-up. This quantitative analysis therefore seeks to examine the main determinants of HIV transmission in Tanzania and whether these determinants vary by sex and by rural-urban residence. The study is based on analysis of nationally representative AIDS Indicators Survey data.

LITERATURE REVIEW

HIV Magnitudes and Trends

Sub-Saharan Africa still bears the brunt of the Human Immunodeficiency Virus type 1 (HIV-1) epidemic, with 68% of the global total by the end of 2009. A total of 22.5 million people in the region are living with the infection, and more women than men are infected. In 2009, of the 1.8 million HIV-related deaths globally, 72% occurred in sub-Saharan Africa, despite efforts to scale up antiretroviral therapy (ART) (UNAIDS and WHO 2010). Southern Africa is still home to an estimated 11.3 million people living with HIV, nearly 31% more than a decade earlier (UNAIDS and WHO 2010). The HIV epidemic is stabilizing or decreasing in major epidemic areas of Africa, including Ethiopia, Nigeria, Zambia, and Zimbabwe, but is increasing in Swaziland and Mozambique (Asamoah-Odei et al. 2004, Shafer 2006). In East Africa, Kenya, Tanzania and Rwanda are showing some declining or stabilizing trends in national antenatal prevalence (Fylkenes et al. 2001, Michelo et al. 2006a, Michelo et al. 2006b, Urassa et al. 2006). Meanwhile, there are recent indications of reversal from previously reported declining trends in Uganda and Burundi (Shafer 2006).

Change in HIV Transmission Factors over Time

In spite of emerging reports of an increasing role of injecting drug users in HIV transmission, particularly in Tanzania, Kenya, and Nigeria (Beckerleg et al. 2005, McCurdy et al. 2005), transmission of HIV infection in sub-Saharan Africa remains largely heterosexual (UNAIDS and WHO 2010). Since the beginning of the epidemic, women have been more likely than men to be infected with HIV, partly due to biological differences, social inequalities, trans-generational sex, and lack of negotiating power with men in sexual and reproductive issues (Boerma et al. 2003, Glynn et al. 2001b, Mnyika et al. 1996, Royce et al. 1997). Globally, 52% of adults living with HIV are women, according to UNAIDS. The rate of HIV infection has also remained persistently high among young people age 15-24. In 2006, this group constituted 40% of the population age 15 and older living with HIV population (UNAIDS and WHO 2010). This rate has been explained by higher risk and more vulnerability to HIV infection among young people. However, a shifting of the epidemic to older groups has been observed recently in

Uganda, Botswana, Zimbabwe, and South Africa (Mmbaga et al. 2007b, UNAIDS and WHO 2010, Urassa et al. 2006). Encouraging trends in young people's sexual behavior are associated with declining HIV prevalence among this group in urban and rural Kenya, urban Botswana, Rwanda, rural Tanzania, and Zimbabwe. These positive behavioral changes include increased age at sexual debut, decreased number of sexual partners, and increased condom use with non-regular partners (Killian et al. 1999, Michelo et al. 2006a, Michelo et al. 2006b, Mmbaga et al. 2007a).

It has been suggested that as the HIV epidemic matures in sub-Saharan Africa, the risk of infection will shift from single individuals to those in long-term relationships (Barnett and Whiteside 2006, Carpenter et al. 1999, King et al. 1993). The rate of discordant couples will be high and infection within these relationships will be the core driver of the HIV epidemic (King et al. 1993, Sewardda et al. 1995). The rate of discordant couples has been reported to be increasing in East and Southern Africa, where the epidemic is mature. Studies in these regions have shown a rate of discordant couples ranging from 36% to 85% (King et al. 1993, Sewardda et al. 1995). Increased transmission within marriage undermines the notion of low risk within marital sex. In urban Zambia data show that 60% of people newly infected with HIV through heterosexual transmission are infected within marriage or cohabitation. These figures range from 50% to 65% in Swaziland and 35% to 62% in Lesotho, and are about 44% in Kenya (King et al. 1993, Sewardda et al. 1995).

In sub-Saharan Africa higher levels of educational attainment have been associated with greater risk of HIV infection (Caraël and Holmes 2001, Coombe and Kelly 2001, Hargreaves and Glynn 2002, Michelo et al. 2006b, Smith et al. 1999, Mmbaga et al. 2007c). Educational attainment is linked to higher wealth status and to increased mobility, factors that potentially increase the risk of HIV infection. However, educational attainment also increases access to the media and awareness of HIV-specific health promotion campaigns (Hargreaves and Glynn 2002, Mmbaga et al. 2007c). As these campaigns diffuse throughout a community, educated individuals are the most likely to understand and internalize information about HIV risk and prevention and to change their behavior as a result. An educated community also provides an environment where behavioral change becomes acceptable, particularly behavior that goes against traditional cultural practices (Coombe and Kelly 2001, Hargreaves and Glynn 2002, Mmbaga et al. 2007c). Lower risk of HIV infection among educated individuals has recently

been documented in Zambia, Uganda, Tanzania, and Ethiopia (Hargreaves and Glynn 2002, Mmbaga et al. 2007c). This indicates that as the epidemic matures, HIV infection will follow the usual pattern of other infectious disease, predominantly affecting poor and uneducated communities (Michelo et al. 2006b). Current prevention strategies do not adequately address these changing patterns of HIV transmission. Hence, information on the drivers of the epidemic is of paramount importance in guiding prevention efforts.

Biological Risk Factors for HIV Transmission

The burden of curable reproductive tract infections (RTIs) in sub-Saharan Africa is enormous, with an estimated total of more than 150 million new episodes of syphilis, herpes simplex virus type 2 (HSV-2), gonorrhoea, chlamydia, and vaginitis each year (Kapiga and Aitken 2002, Laga et al. 1993, Weiss 2004, WHO 1995). Poor health-seeking behaviors, lack of diagnostic services and inadequate or nonexistent treatment of RTIs contribute to these high magnitudes in developing countries. The epidemiological synergy between RTIs and HIV infection is well established and the heavy burden of RTIs continues to put sub-Saharan Africa at high risk of an escalating HIV-1 epidemic. Studies of the role of male circumcision in HIV prevention have shown that male circumcision may prevent up to 60% of HIV infections (Auvert et al. 2005, Bailey et al. 2007, Gray et al. 2007). This approach has also been found to be cost-effective in HIV prevention in sub-Saharan Africa. WHO/UNAIDS has also acknowledged this as an HIV-prevention method but has advised that care should be exercised in its implementation (UNAIDS and WHO 2010).

Differential HIV Spread

Sub-Saharan Africa does not experience a single HIV epidemic but rather many epidemics with different dynamics and courses (Boerma et al. 2003, Buvé 2006). Although most of this region shares the same heterosexual mode of transmission among adults, the rate of HIV transmission varies between and within countries (Boerma et al. 2003, Buvé 2006, Caraël and Holmes 2001, Glynn et al. 2001a, UNAIDS and WHO 2010). Variation in timing of the introduction of the epidemic, different HIV sub-types, and differences in transmission factors

and preventive efforts have been postulated to explain the differential spread of HIV-1 infection (Buvé 2006, Caraël and Holmes 2001).

The link between the patterns of sexual risk behaviors and the spread of HIV infection in sub-Saharan Africa has been complex (Boerma et al. 2003, Cleland et al. 2004). This link varies between countries and has evolved as the epidemic has matured. Differences among countries in such factors as male circumcision, STI treatment, mortality and other variables, as well as risk behaviors, affect rates of HIV infection. Thus, behavioral data have low explanatory power for variations between countries but have strong power in explaining trends in HIV within a given setting (Buvé et al. 2001). A multicenter study on differential spread of the HIV epidemic involving four African cities concluded that, apart from differences in the prevalence of HSV-2 infections and male circumcision rates, sexual risk behaviors did not explain the observed differences in HIV prevalence among the four cities (Buvé et al. 2001). Differences in social cohesion between communities and political commitment to fight the HIV epidemic in some countries have also changed the course of the epidemic, contributing to the observed variability (Barnett and Whiteside 2006).

Drawback in Current HIV Surveillance

UNAIDS recommends that every country needs to have in place an effective and efficient system of HIV surveillance, and the most common measure of the HIV/AIDS epidemic is the prevalence of HIV infection in a country's adult population (UNAIDS and WHO 2010). But HIV prevalence offers an unclear picture of recent trends in the epidemic because it does not distinguish between people who acquired the virus recently and those who were infected a decade or more ago, and prevalence is also affected by incidence, mortality, and migration. Hence, extreme caution must be taken in interpreting HIV prevalence data from the population or sentinel subgroups, particularly in the setting of a mature epidemic characterised by high mortality or where economic or social conditions result in substantial population mobility (Bello et al. 2006, Cleland et al. 2004, Glynn et al. 2001a).

Two countries could have the same HIV prevalence but be experiencing very different epidemics. Differentiating these cases would obviously have a huge impact on the kind of

interventions and care that are needed. Various approaches have been used to monitor HIV trends in different countries. Women attending antenatal clinics (ANC), patients with sexually transmitted infections (STIs), and sex workers have been the mostly common studied groups (Fylkenes et al. 2001, Kwesigabo et al. 1996, Swai et al. 2006). However, HIV is associated with lower fertility, both directly and indirectly, so ANC sources tend to underestimate HIV prevalence, due to selective HIV testing and differential use of ANC services, and to distort the picture of the current dynamic of the HIV epidemic (Glynn et al. 2001a, Kwesigabo et al. 1996). ANC attendees also may be more health conscious and differ from the general population in residence, education, socioeconomic status, and other factors affecting HIV risk. Some authors have observed that stable or decreasing HIV seroprevalence as assessed by sentinel surveys is not evidence of a controlled or even a static epidemic (Glynn et al. 2001a, Shafer 2006). Conversely, a focus on clients at STD clinics will tend to overestimate HIV prevalence because of high-risk sexual behavior associated with this group. The Tanzania National AIDS Control Programme (NACP) monitors HIV trends in the country, but this has largely been based on ANC surveillance data, which has inherent potential for biases.

Research Questions

- Did the HIV prevalence, by sex and rural-urban residence, change over time?
- Do the determinants of HIV transmission vary by sex?
- Is the change in HIV prevalence for men and women over time associated with a change in transmission determinants over the same period?
- Do HIV transmission determinants in rural areas differ from those in urban areas?

METHODOLOGY

Study Design and Population

Two cross-sectional surveys involving people age 15-49 from throughout Tanzania were conducted in 2003/04 and 2007/08.

Sampling and Participation

A multi-stage cluster sampling technique was employed to recruit participants in the two surveys. A sampling frame based on the 2002 Population and Housing Census (PHC) was used for both the 2003/04 and 2007/08 surveys. A two-stage sample design was utilized where sample points (clusters) were selected in the first stage. A total of 475 were selected countrywide, with Dar es Salaam having 25 clusters and other regions both in Mainland Tanzania and Zanzibar having 18 clusters. The second stage involved a systematic selection of households listed from the selected clusters, with 16 households selected from each of the clusters in Dar es Salaam, 36 households from Pemba, and 18 households from the remaining regions of Mainland Tanzania and Zanzibar. These variations aimed at allowing reliable estimates of HIV infection for each region. Interviews were conducted with all women and men age 15-49 in the selected households. Sampling excluded the nomadic and institutional populations. Household members who were absent on the day of the interview were re-contacted and were considered absent from the household only after three call-back attempts.

Development of Data Collection Tools

Data from this analysis come from an individual questionnaire designed based on the standard AIDS Indicator Survey and Malaria Indicator Survey questionnaires. The questionnaire was developed in English, modified based on inputs from various stakeholders, and the final version translated into Swahili. Among other things, the questionnaire collected information on demographic and socioeconomic characteristics, marriage, sexual activity, knowledge and attitudes toward HIV/AIDS, and knowledge and prevalence of other STIs.

Variables

Dependent Variable

HIV serostatus as a binary variable (seropositive/seronegative)

Independent Variables

Socio-demographic characteristics: Age, sex, marital status, occupation, wealth, region, urban-rural residence

Behavioral characteristics: Number of lifetime sexual partners, condom use during last sex, high-risk sex (sex with non-spousal non-cohabiting partner), ever tested for HIV, migration (number of trips in the last 12 months), alcohol consumption during last sex in the past 12 months

Biological factors: Ever treated for STI in the past 12 months, male circumcision

Data Collection Procedures

Field teams were formed and trained in data collection. Each team consisted of a leader, four female interviewers and one male interviewer, and a driver. Field editors and team supervisors were provided with additional training in methods of field editing, data quality control procedures, and fieldwork coordination. Field practices on sample testing including HIV dried blood spot collection (DBS) were carried out. Senior staff members from the Bureau of Statistics in Mainland Tanzania and Zanzibar supervised the data collection process. Data collection took an average of four months, with periodic quality checks from the quality control team, which visited the sites and re-interviewed some households.

HIV Testing

At least three blood spots were collected in a filter paper from a finger prick of each participant. The filter paper, the questionnaire, and the field tracking forms were affixed with a label containing a bar code. No other identifiers were attached to the DBS. The HIV testing was

anonymous and it was not possible to provide results of the test to the participants. The DBS samples received from the field were logged in at NBS, checked and transported to the Muhimbili University of Health and Allied Sciences (MUHAS) laboratory for testing. The DBS samples were logged in to the CSPro HIV Testing Tracking System database, each given a laboratory number, and stored at minus-20 degrees centigrade until tested. A standard algorithm designed to maximize the sensitivity and specificity of HIV test results was used in all surveys. The algorithm uses two different HIV antibodies enzyme-linked immunosorbent assays (ELISA), based on different antigens. All discordant samples that were positive in the first test and negative in the second test were retested using both ELISAs. Discordant samples from this second round of testing were classified as "indeterminate" and these samples were subjected to a western blot confirmatory test, the result of which was considered final. Both internal and external quality assurance checks were done. For internal quality assurance 5-10% of the negative testing samples from the first test were retested. External assurance included the retesting of about 5% of the samples by an external reference laboratory.

Both surveys were submitted to the respective ethics committee in Mainland Tanzania and Zanzibar for ethical clearance. An informed consent was obtained from all participants before the interviews. All the interviews took place in a secure place and assured that all information collected would be kept confidential. Before DBS sample collection for HIV testing, all prospective participants were informed about the objective of the testing and about how the DBS sample would be collected. They were also informed that the testing process was anonymous and, therefore, their results would not be available to them, and they were advised of the availability of testing and counselling services. No identifying information other than the unique barcode label affixed at the time of collection of the DBS sample accompanied the specimen to the laboratory.

Reference for HIV Testing

Because HIV testing was anonymous and results could not be given to participants, efforts were made to ensure that all participants had access to HIV testing services. Each respondent eligible for HIV testing, regardless of whether the respondent agreed to be tested for HIV as part of the survey, was also given information on the nearest facility providing voluntary

counseling and testing and encouraged to use these services. In the event that the nearest facility required payment for the test, participants were given coupons to allow them free access to the services.

Data Management

Data Processing

All completed questionnaires were sent to the NBS headquarters in Dar es Salaam for editing, coding of open-ended questions, data entry, and editing of computer-identified errors. All the data were double entered using CSpro software. The concurrent entry of data was a distinct advantage for data quality because supervisors were able to advise field teams of various errors detected during entry.

Description of Analyzed Sample

Because HIV transmission in Mainland Tanzania is largely through heterosexual relationships, and the the main drivers considered in this analysis are related to sexual activity, this analysis was restricted to sexually active respondents—those who reported having ever had sex. Only those with valid HIV test results formed the analyzed sample, because the main outcome variable in this analysis was HIV serostatus. The 2003/04 survey included Mainland Tanzania only, while the 2007/08 survey included both Zanzibar and Mainland Tanzania. To ensure comparability of estimates, this analysis was also restricted to Mainland Tanzania. Therefore, this analysis is based upon a sample of 3,944 men and 5,213 women from the 2003/04 survey and 3,708 men and 5,311 women from the 2007/08 survey. A comparison of both weighted and un-weighted HIV prevalence of the analyzed sample (those who reported to be sexually active) and all individuals tested for HIV was done. As expected, HIV prevalence was consistently higher among the sexually active sample compared with all individuals (including both the sexually active group and the non-sexually-active group) (Table 1).

Table 1. HIV Prevalence among all individuals age 15-49 who were tested for HIV and those who ever had sex, 2003/04 and 2007/08 surveys, Mainland Tanzania

	2003/04				2007/08			
	All tested		Ever had sex		All tested		Ever had sex	
	UW	W	UW	W	UW	W	UW	W
Males	5.7	6.3	6.4	7.1	4.1	4.7	4.9	5.6
Females	7.1	7.7	7.9	8.6	6.4	6.8	7.3	7.7

Note: UW= Un-weighted prevalence, W= Weighted prevalence

Data Analysis

Separate data for HIV risk factors and HIV testing results were merged to form one database for each of the survey years. Important variables addressing the research questions were coded and the results compared with the DHS final report to check for coding accuracy and consistency. HIV serostatus was set as an outcome variable in the analysis. Frequencies were run for all categorical variables and differences between the proportion in different risk factors and HIV status between geographical areas and population groups were explored using the Chi-square test. All continuous attributes were summarized by calculating means and their respective standard deviations. Differences between means were examined using the t test. To describe independent drivers of HIV infection, logistic regression models were built to control for potential confounders and adjusted odds ratios with 95% confidence intervals reported. The analyses were weighed for complex sample and cluster design. All analysis was two-tailed and the significance level was set at 0.05. Due to the difference in the nature of HIV infection between men and women, analyses were done separately for the two sexes.

RESULTS

Coverage for Interviews and HIV Testing

In the 2003/04 survey, a total of 6,901 households were selected and of these 6,595 were found occupied. Interviews were successfully completed in 6,499 households, giving a household response rate of about 99%. In the 2007/08, survey, a total of 9,144 households were selected from both Mainland Tanzania and Zanzibar, of which 8,704 were found occupied. Of the eligible occupied households, 8,497 households were interviewed, giving a response rate of 98%, with women having a relatively higher response rate than men.

Comparison of Socio-Demographic, Behavioral, and Biological Characteristics

Tables 2 and 3 present comparisons of socio-demographic, behavioral, and biological characteristics between the 2003/04 and 2007/08 surveys, by sex. The proportion of people reporting to have ever had an HIV test increased significantly between 2003/04 and 2007/08. For men, the proportion increased from 18% to 33% (p=0.000), while for women the increase was from 17% to 45% (p=0.000). The distributions of the other variables were similar in the two surveys.

Table 2. Comparison of socio-demographic, behavioral, and biological characteristics among men age 15-49 who were tested for HIV and ever had sex, 2003/04 and 2007/08 surveys, Mainland Tanzania

		2003/04			2007/08		
Variable	**Category**	**N (UW)**	**N (W)**	**W %**	**N (UW)**	**N (W)**	**W %**
Age	**(mean)**	**30.4**		**30.2**	**31.0**		**30.9**
Socio-demographic							
Age group (years)	15-19	469	508	12.4	449	660	12.5
	20-24	724	789	19.0	638	916	17.2
	25-29	752	825	19.8	607	910	17.0
	30-34	667	698	16.7	648	925	17.3
	35-39	579	586	14.0	559	777	14.5
	40-44	406	400	9.6	417	592	11.0
	45-49	347	355	8.5	390	563	10.5
		3,944	4,161	100.0	3,708	5,343	100.0

Cont'd..

Table 2. Cont'd

		2003/04			2007/08		
Variable	**Category**	**N (UW)**	**N (W)**	**W %**	**N (UW)**	**N (W)**	**W %**
Education	No education	453	459	11.0	470	697	13.0
	Primary incomplete	656	656	15.8	685	992	18.6
	Primary complete	2,480	2,607	62.6	2,157	3,037	56.8
	Secondary+	355	438	10.6	396	617	11.6
		3,944	4,160	100.0	3,708	5,343	100.0
Marital status	Never married	1,108	1,239	30.1	1,039	1,512	28.5
	Married	2,575	2,635	63.0	2,461	3,509	65.5
	Formerly married	261	287	6.9	208	322	6.0
		3,944	4,161	100.0	3,708	5,343	100.0
Residence	Rural	3,033	2,896	69.6	3,003	4,144	77.5
	Urban	911	1,265	30.4	705	1,199	22.5
		3,944	4,161	100.0	3,708	5,343	100.0
Religion	Muslim	1,258	1,257	30.2			
	Christian	2,320	2,449	58.9			
	None or others	364	453	10.9			
	Missing	2	2	0.0			
		3,944	4,161	100.0			
Employment status	Not employed	243	293	7.1	293	439	8.2
	Employed	3,701	3,867	92.9	3,415	4,904	91.8
		3,944	4,160	100.0	3,708	5,343	100.0
Wealth index	Lowest	763	695	16.7	704	943	17.6
	Second	887	831	20.0	828	1,178	22.0
	Middle	751	772	18.5	753	1,034	19.4
	Fourth	804	798	19.2	730	1,032	19.3
	Highest	739	1,064	25.6	691	1,154	21.7
	Missing	0	0	0.0	2	3	0.1
		3,944	4,160	100.0	3,708	5,343	100.0
Behavioral							
Number of lifetime partners	1	586	621	14.9	554	800	15.0
	2	681	706	17.0	605	872	16.3
	3-4	1,051	1,123	27.0	992	1,399	26.2
	5-9	881	910	21.9	810	1,182	22.1
	10+	661	712	17.1	682	997	18.6
	Missing	84	89	2.1	65	93	1.8
		3,944	4,161	100.0	3,708	5,343	100.0
High-risk sex in past 12 months	No high-risk sex	1,868	1,903	45.7	1,825	2,573	48.1
	Had high-risk sex	1,663	1,801	43.3	1,527	2,236	41.9
	Had no sex in past 12 months	413	457	11.0	356	534	10.0
		3,944	4,161	100.0	3,708	5,340	100.0

Cont'd..

Table 2. Cont'd

		2003/04			2007/08		
Variable	**Category**	**N (UW)**	**N (W)**	**W %**	**N (UW)**	**N (W)**	**W %**
Condom use during last sex in past 12 months	Used condom	672	778	18.7	667	976	18.3
	Not used	2,859	2,926	70.3	2,685	3,826	71.6
	Had no sex in past 12 months	413	457	11.0	356	541	10.1
		19,720	20,805	100.0	18,540	5,343	100.0
Age at first sex	<16 years	877	936	22.5	947	1,382	25.9
	≥ 16 years	3,067	3,224	77.5	2,761	3,962	74.1
		3,944	4,160	100.0	3,708	5,344	100.0
Number of trips away from home in past 12 months	None				1,636	2,361	44.2
	1-2				1,110	1,611	30.2
	3-4				514	723	13.5
	5+				438	634	11.9
	Missing				10	13	0.2
					3,708	16,030	100.0
Ever tested for HIV	No	3,269	3,408	82.0	2,488	3,580	67.0
	Yes	675	753	18.0	1,220	1,763	33.0
		3,944	4,161	100.0	3,708	5,343	100.0
Alcohol consumption at last sex in past 12 months	One or all consumed	453	439	10.6	385	525	9.6
	All not consumed	3,078	3,265	78.5	2,967	4,283	80.2
	Had no sex past 12 months	413	457	10.9	356	535	10.2
		3,944	4,161	100.0	3,708	5,343	100.0
Biological							
Ever had STI in past 12 months	Yes	277	295	7.1	258	394	7.4
	No	3,667	3,866	92.9	3,450	4,949	92.6
		3,944	4,161	100.0	3,708	5,343	100.0
HIV test results	Negative	3,692	3,868	93.0	3,525	5,046	94.4
	Positive	252	293	7.0	183	297	5.6
		3,944	4,161	100.0	3,708	16,029	100.0
Male circumcision	No	1,069	1,184	28.5	1,088	1,746	32.5
	Yes	2,875	2,976	71.5	2,620	3,597	67.5
		3,944	4,161	100.0	3,708	5,343	100.0
Total		23,664	24,965	100.0	22,248	42,744	100.0

Note: UW,-Unweighted; W-Weighted

Table 3. Comparison of socio-demographic, behavioral, and biological characteristics among women age 15-49 who were tested for HIV and ever had sex, 2003/04 and 2007/08 surveys, Mainland Tanzania

		2003/04			2007/08		
Variable	**Category**	**N (UW)**	**N (W)**	**W %**	**N (UW)**	**N (W)**	**W %**
Age	**(mean)**	**29.7**		**29.6**	**30.2**		**30.1**
Socio-demographic							
Age group (years)	15-19	605	603	12.2	592	784	11.4
	20-24	1,103	1,072	21.4	1,056	1,396	20.2
	25-29	1,090	1,075	21.4	1,051	1,374	20.0
	30-34	870	791	15.7	880	1,123	16.2
	35-39	683	641	12.8	734	975	14.1
	40-44	482	469	9.3	524	645	9.3
	45-49	380	363	7.2	474	607	8.8
		5,213	5,014	100.0	5,311	6,904	100.0
Education	No education	1,285	1,200	23.9	1,248	1,615	23.4
	Primary incomplete	763	730	14.6	766	994	14.4
	Primary complete	2,866	2,747	54.7	2,955	3,847	55.7
	Secondary+	299	338	6.8	342	449	6.5
		15,639	15,043	100.0	15,933	6,905	100.0
Marital status	Never married	653	657	13.1	634	848	12.4
	Married	3,873	3,678	73.3	3,947	5,086	73.6
	Formerly married	687	680	13.6	730	970	14.0
		5,213	5,015	100.0	5,311	6,904	100.0
Residence	Rural	3,933	3,543	70.6	4,180	5,234	75.8
	Urban	1,280	1,472	29.4	1,131	1,669	24.2
		5,313	5,015	100.0	5,311	6,903	100.0
Religion	Muslim	1,738	1,541	30.7			
	Christian	3,092	3,023	60.3			
	None or others	379	447	8.9			
	Missing	4	4	0.1			
		5,213	5,015	100.0			
Employment status	Not employed	530	573	11.4	603	811	11.8
	Employed	4,683	4,442	88.6	4,708	6,093	88.2
		67,869	65,191	100.0	5,311	6,904	100.0
Wealth quintile	Lowest	1,092	938	18.7	1,095	1,337	19.4
	Second	1,060	926	18.5	1,024	1,286	18.6
	Middle	987	947	18.8	1,067	1,363	19.7
	Fourth	1,064	1,001	20.0	1,058	1,358	19.7
	Highest	1,010	1,203	24.0	1,070	1,559	22.6
		5,213	5,015	100.0	5,311	6,903	100.0

Cont'd..

Table 3. Cont'd

		2003/04			2007/08		
Variable	**Category**	**N (UW)**	**N (W)**	**W %**	**N (UW)**	**N (W)**	**W %**
Behavioral							
Number of lifetime sexual partners	1	2,150	2,097	41.8	2,106	2,748	39.7
	2	1,267	1,245	24.8	1,438	1,897	27.4
	3-4	1,240	1,172	23.4	1,185	1,538	22.3
	5-9	468	426	8.5	456	549	7.9
	10+	81	66	1.3	104	146	2.2
	Missing	7	8	0.2	22	26	0.5
		5,213	5,014	100.0	5,311	6,904	100.0
High-risk sex in past 12 months	No high-risk sex	3,440	3,296	65.7	3,449	4,429	64.2
	Had high-risk sex	1,216	1,176	23.5	1,284	1,708	24.7
	Had no sex past 12 months	557	543	10.8	578	766	11.1
		5,213	15,043	100.0	15,933	20,711	100.0
Condom use during last casual sex in past 12 months	Used condom	479	504	10.0	560	747	10.8
	Not used	4,177	3,968	79.1	4,173	5,390	78.1
	Missing	557	543	10.9	578	767	11.1
		26,065	35,101	100.0	37,177	48,326	100.0
Age at first sex	<16 years	1,645	1,555	31.0	1,767	2,328	33.7
	≥ 16 years	3,564	3,457	68.9	3,544	4,576	66.3
	Missing	4	3	0.1	0	0	0.0
		5,213	5,015	100.0	5,311	6,904	100.0
Number of trips away from home in past 12 months	None				3,058	3,929	56.9
	1-2				1,766	2,324	33.7
	3-4				341	463	6.7
	5+				140	180	2.6
	Missing				6	8	0.1
					5,311	117,364	100.0
Ever tested for HIV	No	4,433	4,178	83.3	2,898	3,763	54.5
	Yes	780	837	16.7	2,413	3,141	45.5
		5,213	5,015	100.0	5,311	6,904	100.0
Alcohol consumption last time had sex	One or all consumed	785	726	14.5	668	817	11.8
	All not consumed	3,871	3,746	74.7	4,065	5,319	77.1
	Had no sex in past 12 months	557	543	10.8	578	767	11.1
		5,213	5,015	100.0	5,311	6,903	100.0
Biological							
Ever had STI in past 12 months	Yes	295	283	5.7	330	420	6.1
	No	4,918	4,732	94.3	4,981	6,484	93.9
		5,213	5,015	100.0	5,311	6,904	100.0
HIV test results	Negative	4,799	4,583	91.4	4,926	6,373	92.3
	Positive	414	432	8.6	385	531	7.7
		5,213	5,015	100.0	5,311	6,904	100.0
Total		10,426	10,030	100.0	10,622	13,808	100.0

Note: UW,-Unweighted; W-Weighted

Change in HIV Prevalence over Time

Overall, weighted HIV prevalence decreased significantly, from 7.9% in 2003/04 to 6.8% in 2007/08 (p=0.013). However, this decrease was significant only among men (p=0.007), but not among women (p=0.105) (Table 3). Men in urban areas had a significant decreased prevalence (p=0.047) compared with men in rural areas (p=0.169). No statistically significant decrease in HIV prevalence was observed among women regardless of rural (p= 0.448) or urban (p=0.331) residence. Overall, the decrease in prevalence in urban areas had a borderline significance (p=0.088), with no significant decrease in rural areas (p=0.212). HIV prevalence decreased consistently across all age groups over time.

HIV Transmission Determinants among Men and Women

Tables 4 and 5 show results from the logistic regression model of determinants of HIV transmission over time and their variation between men and women among sexually active individuals age 15-49 in Mainland Tanzania.

Table 4. Logistic regression of the determinants of HIV infection among men age 15-49 who were tested for HIV and ever had sex, 2003/04 and 2007/08 surveys, Mainland, Tanzania

		2003/04			2007/08		
Variable	**Category**	**N (%)**	***AOR (95%CI)**	**P-value**	**N (%)**	***AOR (95%CI)**	**P-value**
Socio-demographic							
Age group (years)	15-19	24(6.8)	2.0(1.1-3.7)	0.019	2 (0.4)	0.06(0.01-0.3)	0.001
	20-24	49(12.3)	2.4(0.8-4.5)	0.220	14(1.6)	0.2(0.1-0.5)	0.004
	25-29	58(9.8)	2.2(0.7-6.2)	0.430	48(5.3)	0.8(0.6-2.2)	0.558
	30-34	60(8.7)	1.0(0.6-1.9)	0.759	70(7.7)	1.2(0.6-2.2)	0.464
	35-39	57(7.0)	0.7(0.3-1.4)	0.375	85(11.0)	1.7(1.0-3.0)	0.038
	40-44	33(4.1)	0.5(0.1-1.5)	0.265	42(6.9)	1.0(0.5-2.0)	0.928
	45-49	12(5.4)	1.0		36(6.3)	1.0	
		293			297		
Occupation	Employed	275(6.1)	1.0		293(6.0)	1.0	
	Not employed	18(7.1)	1.7(0.7-4.2)	0.197	4(1.0)	0.7(0.1-2.7)	0.646
		293			297		

Cont'd..

Table 4. Cont'd

		2003/04			2007/08		
Variable	**Category**	**N (%)**	***AOR (95%CI)**	**P-value**	**N (%)**	***AOR (95%CI)**	**P-value**
Education	No education	21(4.6)	1.0		44(6.3)	1.0	
	Primary incomplete	42(6.4)	1.3(0.6-2.7)	0.439	55(5.6)	1.0(0.5-1.8)	0.947
	Primary complete	194(7.4)	1.2(0.7-2.2)	0.411	169(5.5)	0.6(0.4-1.1)	0.164
	Secondary+	36(8.2)	1.1(0.5-2.5)	0.720	30(4.8)	0.5(0.2-1.6)	0.329
		293			298		
Marital status	Married	43(3.5)	1.0		210(6.2)	1.0	
	Never married	207(7.8)	0.5(0.2-1.0)	0.067	41(2.7)	2.2(0.9-5.1)	0.054
	Formerly married	43 (15.0)	1.9(1.1-3.2)	0.019	46(12.3)	2.9(1.5-5.7)	0.001
		293			298		
Residence	Rural	162(5.6)	1.0		203(4.9)	1.0	
	Urban	130(10.4)	1.8(1.0-3.3)	0.031	94(7.8)	1.4(0.8-2.3)	0.173
		292			297		
Wealth quintile	Lowest	33(4.7)	1.0		46(4.8)	1.0	
	Second	40(4.8)	0.8(0.4-1.5)	0.523	49(4.2)	0.8(0.4-1.5)	0.605
	Middle	39(5.1)	0.8(0.4-1.4)	0.569	50(4.9)	1.1(0.6-2.0)	0.737
	Fourth	71(8.9)	1.5(0.8-2.6)	0.145	61(5.9)	1.3(0.7-2.5)	0.316
	Highest	110(10.4)	1.4(0.7-2.9)	0.305	91(7.9)	2.3(1.1-4.7)	0.014
		293			297		
Behavioral							
Number of lifetime partners	1	25(3.5)	0.4(0.2-0.9)	0.038	12(1.5)	0.2(0.08-0.5)	0.003
	2	38(5.0)	0.5(0.3-0.9)	0.048	33 (3.8)	0.3(0.2-0.7)	0.002
	3-4	81(7.1)	0.7(0.4-1.1)	0.174	56(3.9)	0.3(0.2-0.6)	0.001
	5-9	74(8.1)	0.8(0.5-1.2)	0.417	79(6.4)	0.5(0.3-0.8)	0.003
	10+	75(10.1)	1.0		117(11.5)	1.0	
		293			297		
High-risk sex in past 12 months	Had high-risk sex	146(7.7)	1.0		173(6.7)	1.0	
	No high-risk sex	117(6.5)	0.9(0.6-1.3)	0.784	108(4.8)	0.5(0.3-1.0)	0.063
	No sex past in 12 months	30(6.5)	1.1(0.6-2.2)	0.605	15(2.9)	0.1(0.01-1.0)	0.059
		293			297		
Age at first sex	≥ 16	78(8.3)	1.0		222(5.6)	1.0	
	<16	215(6.7)	0.7(0.5-1.0)	0.083	75(5.4)	0.8(0.5-1.2)	0.428
		293			297		
Biological							
Ever had STI in past 12 months	No	266(6.9)	1.0		275(5.4)	1.0	
	Yes	27(9.4)	1.0(0.6-1.8)	0.748	22(9.7)	2.1(1.1-3.8)	0.014
		293			297		
Male circumcision	Not circumcised	84(7.1)	1.0		141 (8.1)	1.0	
	Circumcised	209(7.0)	0.9(0.5-1.5)	0.798	156(4.4)	0.4(0.2-0.7)	0.002
Total		**N= 4,161**	**No. Cases 293**		**N=5,343**	**No. Cases 297**	

Note: OR-Crude Odds Ratio, *AOR -Adjusted Odds Ratio; CI-Confidence Interval; STI-Sexually Transmitted Infection; # N-includes those with an HIV test results and ever had sex.

Table 5. Logistic regression of the determinants of HIV infection among women age 15-49 who were tested for HIV and ever had sex, 2003/04 and 2007/08 surveys, Mainland Tanzania

		2003/04			2007/08		
Variable	**Category**	**HIV+ N (%)**	***AOR (95%CI)**	**P-value**	**HIV+ N (%)**	***AOR (95%CI)**	**P-value**
Socio-demographic							
Age group (years)	15-19	1(2.9)	0.7(0.3-1.6)	0.426	17(2.1)	0.6(0.2-1.7)	0.432
	20-24	69(6.5)	1.3(0.7-2.5)	0.336	94(6.8)	1.8(1.0-3.3)	0.043
	25-29	102(9.4)	1.9(1.0-3.4)	0.028	111(8.1)	1.7(0.9-3.1)	0.079
	30-34	101(12.9)	2.6(1.4-4.5)	0.001	120(10.8)	2.3(1.2-4.4)	0.006
	35-39	75(11.7)	2.0(1.0-3.9)	0.026	95(9.7)	1.8(1.0-3.2)	0.039
	40-44	46(9.8)	1.6(0.9-3.0)	0.087	51(7.9)	1.2(0.6-2.4)	0.441
	45-49	21(55.8)	1.0		43(7.0)	1.0	
		432			531		
Occupation	Employed	378(8.5)	1.0		476(7.8)	1.0	
	Not employed	54(9.4)	1.1(0.7-1.7)	0.513	55(6.5)	0.9(0.6-1.5)	0.839
		432			531		
Education	No education	73(6.1)	1.0		103(6.4)	1.0	
	Primary incomplete	51(7.0)	0.8(0.5-1.4)	0.589	81(8.1)	1.2(0.7-2.1)	0.331
	Primary complete	266(9.7)	1.1(0.7-1.7)	0.514	312(8.1)	1.1(0.7-1.7)	0.588
	Secondary+	43(12.7)	1.1(0.6-1.9)	0.710	35(7.9)	1.1(0.6-2.1)	0.679
		433			531		
Marital status	Married	43(6.6)	1.0		318(6.3)	1.0	
	Never married	255(6.9)	0.7(0.4-1.3)	0.352	39(4.6)	0.4(0.2-0.7)	0.003
	Formerly married	134(19.8)	1.9(1.3-2.8)	0.000	174(17.9)	1.6(1.0-2.5)	0.022
		432			531		
Residence	Rural	227(6.4)	1.0		321(6.1)	1.0	
	Urban	206(14.0)	1.4(1.0-2.1)	0.032	210(12.6)	1.7(1.2-2.4)	0.003
		433			531		
Wealth quintile	Lowest	29(3.0)	1.0		74(5.6)	1.0	
	Second	46(4.9)	1.6 (0.9-2.6)	0.073	96(7.5)	1.6(0.9-2.7)	0.082
	Middle	72(7.6)	2.2(1.3-3.8)	0.002	80(5.9)	1.1(0.6-1.8)	0.679
	Fourth	121(12.1)	3.8(2.4-6.1)	0.000	96(7.1)	1.2(0.7-2.0)	0.319
	Highest	165(13.7)	3.7(2.1-6.5)	0.000	184(11.8)	2.0(1.1-3.7)	0.015
		433			530		
Behavioral							
Number of lifetime partners	1	81 (3.9)	0.2(0.1-0.5)	0.001	85(3.1)	0.1(0.06-0.3)	0.000
	2	126(10.1)	0.6(0.2-1.3)	0.226	142(7.4)	0.2(0.1-0.5)	0.000
	3-4	154(13.2)	0.8(0.4-1.9)	0.763	191(12.4)	0.5(0.3-1.0)	0.070
	5-9	59(13.9))	0.8(0.3-1.9)	0.737	79(14.1)	0.7(0.3-1.4)	0.417
	10+	11(15.3)	1.0		33(21.6)	1.0	
		431			530		

Cont'd..

Table 5. Cont'd

		2003/04			2007/08		
Variable	**Category**	**HIV+ N (%)**	***AOR (95%CI)**	**P-value**	**HIV+ N (%)**	***AOR (95%CI)**	**P-value**
High-risk sex in past 12 months	Had high-risk sex	216(6.6)	1.0		247(5.6)	1.0	
	No high-risk sex	134(11.5)	0.2(0.1-1.2)	0.341	195(11.4)	0.4(0.1-0.8)	0.009
	No sex in past 12 months	82(15.2)	0.001(0.05-0.014)	0.000	88(11.5)	0.03(0.01-0.09)	0.000
		432			530		
Age at first sex	≥ 16 years	301(8.7)	1.0		313(7.0)	1.0	
	< 16 years	131(8.4)	0.9(0.7-1.2)	0.706	218(8.6)	0.8(0.6-1.2)	0.282
		432			531		
Biological							
Ever had STI in past 12 months	No	390(8.2)	1.0		485(7.5)	1.0	
	Yes	43(15.1)	1.5(1.0-2.3)	0.033	45(11.0)	1.0(0.6-1.6)	0.877
		433			530		
Total		**N=5,015**	**No. Cases 433**		**N=6,903**	**No. Cases 531**	

Note: OR-Crude Odds Ratio, *AOR -Adjusted Odds Ratio; CI-Confidence Interval; STI-Sexually Transmitted Infection; # N-includes those with an HIV test results and ever had sex.

Socio-Demographic Determinants

In the 2003/04 survey middle-aged men, men who were formerly married, and men living in urban areas were at higher risk of HIV infection. Only married status remained a risk factor in the 2007/08 survey, although relatively older men (age 35-39) in the highest wealth quintile also were at increased risk. For women, socio-demographic determinants were relatively consistent over the two surveys; women age 20-39, formerly married women, women in urban areas, and women in higher wealth quintiles were at greater risk of HIV infection. However, the 2007/08 survey shows that never-married women were 60% less likely to be infected compared with married women. Furthermore, this survey showed only the highest wealth quintile to be at greater risk of infection, contrary to findings in the earlier survey, where middle wealth quintiles and above were at risk compared with the lowest quintile (Tables 4 and 5).

Behavioral Determinants

Having fewer reported lifetime sexual partners was associated with lower likelihood of HIV infection compared with reporting 10 or more lifetime partners, for both men and women in

both surveys. For women, not having sex during the past 12 months preceding the survey was associated with almost 99% lower likelihood of infection compared with women reporting high-risk sex (sex with a non-spousal non-cohabiting partner). Moreover, the 2007/08 survey indicated that women not reporting high-risk sex were 50% less likely to be infected compared with women reporting high-risk sex (Tables 4 and 5).

Biological Determinants

Among men, reporting an STI during the 12 months preceding the 2007/08 survey was associated with twice the likelihood of HIV infection compared with men reporting not having an STI. In the same survey, male circumcision was associated with 60% reduced odds of HIV infection compared with non-circumcised men. STI status and circumcision were not important determinants in the 2003/04 survey. Conversely, among women, reporting an STI was a determinant of HIV infection in the 2003/04 survey but not in the 2007/08 survey (Tables 4 and 5).

Rural-Urban Differences in HIV Transmission Determinants over Time

Tables 6 and 7 present determinants of HIV transmission in rural and urban areas and their variation between the 2003/04 and 2007/08 surveys.

Table 6. Logistic regression of rural determinants of HIV infection among people age 15-49 who were tested for HIV and ever had sex, 2003/04 and 2007/08 surveys, Mainland Tanzania

		2003/04			2007/08		
Variable	**Category**	**HIV+ N (%)**	***AOR (95%CI)**	**P-value**	**HIV+ N (%)**	***AOR (95%CI)**	**P-value**
Socio-demographic							
Sex	Male	162(5.6)	1.0		203(4.9)	1.0	
	Female	226(6.4)	1.0(0.7-1.4)	0.683	320(6.1)	1.7(1.3-2.4)	0.000
		388			523		
Age group (years)	15-19	13(1.8)	0.5(0.2-1.1)	0.90	11(1.1)	0.04(0.006-0.2)	0.001
	20-24	52(4.1)	0.9(0.5-1.5)	0.714	75(4.3)	0.1(0.05-0.5)	0.005
	25-29	75(5.8)	1.2(0.7-2.2)	0.379	94(5.7)	0.7(0.3-1.6)	0.438
	30-34	96(9.1)	1.9(1.1-3.1)	0.010	121(7.8)	1.2(0.6-2.4)	0.429
	35-39	69(7.9)	1.5(0.8-2.6)	0.143	102(7.8)	1.5(0.8-2.8)	0.160
	40-44	54(8.2)	1.5(0.8-2.8)	0.148	59(6.0)	1.1(0.4-2.2)	0.972
	45-49	30(5.5)	1.0		59(6.2)	1.0	
		289			523		
Occupation	Employed	21(6.0)	1.0		497(5.8)	1.0	
	Not employed	368(8.6)	1.3(0.8-2.2)	0.223	26(3.6)	2.4(0.5-11.0)	0.241
		289			523		
Education	No education	66(4.5)	1.0		125(6.6)	1.0	
	Primary incomplete	58(5.3)	1.1(0.7-1.8)	0.585	94(5.5)	0.8(0.4-1.6)	0.697
	Primary complete	237(6.5)	1.3(0.8-1.9)	0.169	281(3.4)	0.5(0.3-0.9)	0.033
	Secondary+	28(11.7)	2.5(1.2-5.1)	0.010	24(6.0)	0.9(0.2-3.6)	0.985
		289			523		
Marital status	Married	36(3.3)	1.0		346(5.0)	1.0	
	Never Married	264(5.6)	0.6(0.4-1.0)	0.071	33(2.1)	3.1(1.0-9.3)	0.035
	Formerly married	89(13.8)	1.8(1.2-2.6)	0.011	144(15.3)	4.5(2.0-10.1)	0.000
		289			523		
Wealth quintile	Lowest	59(3.7)	1.0		116(5.2)	1.0	
	Second	78(4.8)	1.2(0.7-1.9)	0.349	143(6.0)	1.1(0.6-1.9)	0.719
	Middle	89(5.8)	1.4(0.9-2.3)	0.073	116(5.2)	1.4(0.2-0.9)	0.272
	Fourth	128(9.8)	2.6(1.7-3.9)	0.000	98(5.1)	1.8(0.9-3.6)	0.070
	Highest	35(10.1)	2.4(1.4-4.4)	0.000	50(8.1)	3.0(1.2-7.4)	0.018
		289			523		
Behavioral							
Number of lifetime partners	1	73(3.5)	0.3(0.1-0.5)	0.000	70(2.5)	0.3(0.1-0.9)	0.037
	2	96(6.9)	0.6(0.3-0.9)	0.042	115(5.4)	0.4(0.2-0.8)	0.017
	3-4	109(7.1)	0.6(0.4-1.0)	0.074	150(6.8)	0.4(0.2-0.9)	0.032
	5-9	62(6.5)	0.6(0.4-1.0)	0.080	99(7.2)	0.5(0.3-0.9)	0.020
	10+	49(8.5)	1.0		89(9.8)	1.0	
		389			523		

Cont'd..

Table 6. Cont'd

		2003/04			2007/08		
Variable	**Category**	**HIV+ N (%)**	***AOR (95%CI)**	**P-value**	**HIV+ N (%)**	***AOR (95%CI)**	**P-value**
High-risk sex in past 12 months	Had high-risk sex	207(5.4)	1.0		162(5.8)	1.0	
	No high-risk sex	111(5.8)	1.0(0.7-1.4)	0.995	284(5.1)	0.8(0.4-1.2)	0.230
	Had no sex in past 12 months	71(10.5)	2.1(0.8-3.5)	0.152	77(8.9)	1.4(0.6—2.7)	0.648
		389			523		
Age at first sex	<16 years	114(6.2)	1.0		198(6.3)	1.0	
	≥ 16 years	275(6.0)	0.8(0.6-1.0)	0.213	327(5.2)	0.8(0.5-1.3)	0.383
		389			523		
Alcohol consumption during last sex in past 12 months	All not consumed	253(5.2)	1.0		356(4.8)	1.0	
	One or all consumed	65(7.0)	1.3(09-1.9)	0.125	90(8.4)	1.4(0.8-2.3)	0.150
	No sex in past 12 months	71(10.5)	2.2(0.9-3.5)	0.056	77(8.9)	4.5(0.6-30.8)	0.121
		389			523		
Biological							
Ever had STI in past 12 months	No	358(5.9)	1.0		470(5.54)	1.0	
	Yes	31(7.7)	1.1(0.7-1.8)	0.447	43(8.3)	2.2(1.1-4.1)	0.014
		389			523		
Male circumcision	Not circumcised	70(8.5)	1.0		119(7.4)	1.0	
	Circumcised	92(5.1)	0.4(0.3-0.6)	0.000	84(3.3)	0.3(0.2-0.5)	0.000
		162			202		
Total		**N=6,439**	**No. Cases 398**		**N=9,379**	**No. Cases 523**	

Note: *AOR -Adjusted Odds Ratio; CI-Confidence Interval; STI-Sexually Transmitted Infection; # N-includes those with an HIV test results and ever had sex

Table 7. Logistic regression of urban determinants of HIV infection among people age 15-49 who were tested for HIV and ever had sex, 2003/04 and 2007/08 surveys, Mainland Tanzania

		2003/04			2007/08		
Variable	**Category**	**HIV+ N (%)**	***AOR (95%CI)**	**P-value**	**HIV+ N (%)**	***AOR (95%CI)**	**P-value**
Socio-demographic							
Sex	Male	131(10.4)	1.0		94(7.8)	1.0	
	Female	206(14.0)	1.3(0.8-2.3)	0.339	211(12.6)	1.6(1.1-2.4)	0.006
		337			305		
Age group (years)	15-19	15(8.8)	1.0		7(2.1)	1.0	
	20-24	41(19.4)	2.0(1.0-3.8)	0.027	34(6.1)	2.6(0.6-7.4)	0.063
	25-29	64(18.0)	1.9(0.9-4.2)	0.071	65(10.5)	4.4(1.5-12.5)	0.006
	30-34	67(15.6)	1.5(0.8-3.0)	0.163	70(1.5)	6.3(2.1-18.3)	0.001
	35-39	84(14.1)	1.5(0.9-2.6)	0.102	77(18.7)	8.5(2.7-26.2)	0.001
	40-44	50(8.2)	1.1(0.5-2.2)	0.766	34(12.7)	5.1(1.4-18.9)	0.014
	45-49	16(4.4)	0.7(0.2-2.3)	0.627	18(8.7)	3.4(0.9-12.4)	0.600
		337			305		
Occupation	Employed	286(12.9)	1.0		273(11.6)	1.0	
	Not employed	50(9.8)	1.1(0.6-1.8)	0.664	31(6.0)	0.7(0.4-1.2)	0.240
		337			305		
Education	No education	28(13.6)	1.0		22(10.6)	1.0	
	Primary incomplete	35(11.8)	0.7(0.3-1.8)	0.562	42(14.7)	1.8(0.7-4.2)	0.171
	Primary complete	223(13.1)	1.0(0.5-1.9)	0.912	200(11.8)	1.1(0.5-2.1)	0.764
	Secondary+	50(9.5)	0.8(0.4-1.6)	0.586	41(6.1)	0.6(0.2-1.3)	0.217
		337			305		
Marital status	Married	51(6.2)	1.0		188(11.0)	1.0	
	Never Married	197(12.4)	1.5(0.7-3.0)	0.081	46(5.7)	0.9(0.5-1.8)	0.947
	Formerly married	89(27.6)	3.7(1.2-6.6)	0.005	70(19.7)	1.7(1.1-2.6)	0.007
		337			304		
Wealth quintile	Lowest	2(5.7)	1.0		4(6.2)	1.0	
	Second	7(6.5)	0.8(0.1-5.0)	0.853	2 (2.8)	0.5(0.2-1.2)	0.158
	Middle	21(12.8)	2.3(0.5-9.0)	0.226	14(9.4)	1.2(0.4-1.4)	0.124
	Fourth	65(13.1)	2.3(0.5-10.3)	0.258	60(12.4)	2.3(0.3-4.4)	0.427
	Highest	241(12.5)	2.5(0.2-12.8)	0.243	225(10.8)	1.7(0.3-5.4)	0.713
		337			305		
Behavioral							
Number of lifetime partners	1	33(4.6)	1.0		29(3.8)	1.0	
	2	67(11.7)	1.0(0.5-1.8)	0.908	61(9.1)	2.2(1.1-4.4)	0.020
	3-4	126(16.3)	1.0(0.5-1.8)	0.980	91(12.8)	2.8(1.4-5.6)	0.003
	5-9	75(17.1)	2.6(0.3-4.0)	0.069	58(14.3)	3.1(1.4-7.2)	0.006
	10+	36(15.5)	4.1(1.1-7.3)	0.001	57(23.8)	5.0(2.2-11.2)	0.000
		337			305		

Cont'd..

Table 7. Cont'd

		2003/04			2007/08		
Variable	**Category**	**HIV+ N (%)**	***AOR (95%CI)**	**P-value**	**HIV+ N (%)**	***AOR (95%CI)**	**P-value**
High-risk sex in past 12 months	Had high-risk sex	156(11.6)	1.0		142(12.6)	1.0	
	No high-risk sex	139(3.1)	0.6(0.4-0.8)	0.000	132(8.9))	0. 6(0.3-1.9)	0.386
	No sex past 12 months	41(2.7)	0.3(0.01-0.9)	0.000	30(7.6)	0.5(0.2-1.6)	0.627
		336			304		
Age at first sex	<16 years	94(14.4)	1.0		96(12.2)	1.0	
	≥ 16 years	243(11.7)	0.8(0.5-1.2)	0.491	209(9.5)	0.8(0.5-1.2)	
		337			305		
Alcohol consumption during last sex in past 12 months	All not consumed	238(11.2)	1.0		232(10.4)	1.0	
	One or all consumed	58(20.2)	1.3(0.8-2.1)	0.188	43(17.0)	1.2(0.7-2.0)	0.303
	No sex in past 12 months	41(2.7)	0.01(0.003-0.06)	0.000	30(7.6)	0.1(0.01-0.7)	0.000
		337			305		
Biological							
Ever had STI in past 12 months	No	297(11.6)	1.0		269(10.0)	1.0	
	Yes	39(22.5)	1.7(1.1-2.7)	0.010	36(20.5)	1.9(1.1-4.5)	0.003
		336			305		
Male circumcision	Not circumcised	13(13.5)	1.0		22(16.6)	1.0	
	Circumcised	35(10.1)	0.7(0.6-1.2)	0.491	72(6.8)	0.2(0.1-0.7)	0.015
		130			94		
Total		**N=2,737**	**No. Cases 337**		**N=2,868**	**No. Cases 305**	

Note: *AOR -Adjusted Odds Ratio; CI-Confidence Interval; STI-Sexually Transmitted Infection; # N-includes those with an HIV test results and ever had sex

Socio-Demographic Determinants

In both surveys, in both rural and urban areas women were almost twice as likely as men to report HIV infection. Although education level was not an important determinant in urban areas, the 2003/04 survey found that secondary education and above was associated with increased odds of infection in rural areas. In the 2007/08 survey, primary education was associated with a 50% lower likelihood HIV infection compared with no education. In both surveys, in both rural and urban areas being formerly married was associated with increased odds of infection compared with currently married individuals. Being in the fourth or highest wealth quintile was associated with two to three times higher odds of HIV infection in rural areas but was not an important determinant in urban areas (Tables 6 and 7).

Behavioral Determinants

Higher number of reported lifetime sexual partners was a determinant of HIV transmission in both rural and urban areas, with higher numbers of partners associated with increased likelihood of infection. These findings remained unchanged across the two surveys (Tables 6 and 7).

Biological Determinants

STI status and male circumcision were the main biological determinants examined in these surveys. Findings indicated that reporting an STI was associated with twice the risk of HIV infection, while male circumcision reduced the likelihood of HIV infection by 60-80% in both rural and urban areas and across the two surveys (Tables 6 and 7).

DISCUSSION

Results from the two DHS in 2003/04 and 2007/08 in Mainland Tanzania indicate a 14% nationwide decrease in HIV prevalence over a period of four years, mainly due to significant decreased HIV prevalence among men in urban areas. This decreasing trend is similar to the trends observed in other Eastern and Southern African countries, including Uganda, Malawi, Zimbabwe, and Kenya (Asamoah-Odei et al. 2004, Fylkenes et al. 2001, Gregson et al. 2006, Hallett et al. 2006, Kirungi et al. 2006, Michelo et al. 2006b). Many studies have observed a decrease among young people and in urban areas, with an increasing or stable HIV prevalence reported in some rural populations (Kirungi et al. 2006, Mahomva et al. 2006, Michelo et al. 2006a, Mmbaga et al. 2007a, Mmbaga et al. 2007b).

While the findings in this analysis corroborate findings of other reports, most other reports showing decreasing HIV prevalence are based largely on ANC surveillance data, with few population-based studies available. In contrast, the data analyzed in this paper are nationally representative and cover the general population, including sexually active women and men, rather than only women visiting antenatal clinics.

Of the determinants studied, age, being formerly married, and being in the upper wealth quintiles are associated with HIV infection for both men and women. Also, men and women with higher numbers of lifetime sexual partners are at higher risk of HIV infection. Likewise, reporting an STI in the 12 months preceding the survey is associated with higher odds of HIV infection for both men and women. Among women but not men, however, high-risk sex (sex with a non-marital, non-cohabiting partner) is associated with higher risk of HIV infection. Conversely, in the 2007/08 survey, having an STI appears to be important determinants of HIV infection among men but not among women (as is the case with male circumcision, of course). Overall, women are at twice the risk of HIV infection compared with men, regardless of residence.

These findings are consistent with other studies. Studies have reported that in both rural and urban areas women are at substantial risk of HIV infection due to both biological and social vulnerability (Barnett and Whiteside 2006, Buvé 2006, Carpenter et al. 1999, Glynn et al. 2001b). Women are more likely to be infected at earlier ages, probably through having sex with older sexually experienced men (Glynn et al. 2001b). Being formerly married, through

separation, divorce, or widowhood, could be a result of HIV infection or HIV-related behaviors. Wealth is associated with mobility and hence exposure to different populations with differing HIV risk and prevalence (Barnett and Whiteside 2006).

Urban-Rural Residence

The analysis of urban-rural determinants shows that, although education level is not an important determinant in urban areas, secondary education and above appears to be associated with increased odds of infection in rural areas. Similarly, being in the upper wealth quintile is a higher risk factor for HIV infection in rural areas but not in urban areas. Other studies have also found that people in urban and rural areas have different HIV prevalence as well as transmission risk factors (Buvé 2006, Caraël and Holmes 2001, Mmbaga et al. 2007b).

In the present study the reason that these findings are significant among the rural population but not the urban population is probably that in Tanzania the urban population is likely to be exposed to HIV intervention measures, regardless of education level. Being wealthier in rural areas was associated with infection risk but not in urban areas probably because wealthy individuals are more likely to be mobile, travelling to urban areas where HIV prevalence is high and sex for pay is more available.

In the beginning of the HIV epidemic in Africa, educated individuals were at higher risk of infection compared with the uneducated. This has been explained as the result of increased mobility for work and the potential to have disposable income to pay for sex (Coombe and Kelly 2001, Hargreaves and Glynn 2002, Mmbaga et al. 2007c). However, as intervention measures are rolled out, educated individuals are more likely to access, understand, internalise and act on them and change their behavior (Coombe and Kelly 2001). This dynamic has been give as an explanation for the observed shift in HIV infection risk from educated to uneducated groups.

Sexual Risk Taking

Sexual risk behaviors have been widely reported as the cornerstone for HIV transmission (Boerma et al. 2003, Buvé et al. 2001, Killian et al. 1999), and reducing the number of sexual

partners has been described as instrumental in reducing HIV transmission risk (Fylkenes et al. 2001, Hallett et al. 2006, Killian et al. 1999, Kirungi et al. 2006). The decreasing trends in HIV prevalence in sub-Saharan Africa and elsewhere could be due to positive behavioral change (Hallett et al. 2006, Killian et al. 1999,).

The present analysis found that in Mainland Tanzania the number of lifetime partners is an important determinant of HIV among both women and men, while high-risk sex (sex with a non-marital, non-cohabiting partner) is an important transmission determinant among women but not men. Male circumcision is a determinant for men only, as is having an STI. These differences underpin the need for population-specific intervention measures. Intervention measures in Tanzania should take in to consideration the role of biological factors in HIV transmission and control, which studies have shown to be significant (Auvert et al. 2005, Bailey et al. 2007, Fleming and Wasserheit 1999, Kapiga and Aitken 2002, Mastro and de Vincenzi 1996, Weiss 2004, WHO 1995).

Strength of the Findings

Analysis of data from these two surveys has the following strengths:

A standardized data collection tool and data collection procedures allow comparison of results between surveys.

The use of nationally representative samples in these surveys makes it possible to infer the results to the whole of the Tanzanian population. This plays an important part in the external validity of the results.

Rigorous quality control of the HIV testing ensures internal validity of the results.

Limitations of the Findings

The results of this analysis should be interpreted in light of the following potential limitations:

The cross-sectional nature of the survey limits the ability to establish a cause-and-effect relationship between HIV infection and various determinants identified. The association could be due to reverse causality, as it is not possible to establish if the exposures preceded the outcome (HIV infection).

This analysis included reported behavioral data, which are susceptible to desirability bias. Due to the fact that sex is a taboo topic in some parts of Africa, collection of information related to sex could be affected by this bias, thus distorting the association between various behavioral factors and HIV infection.

Data presented in this analysis are based on the de facto household population, and because the de jure population may have different HIV prevalence, this may have affected the estimates presented. Moreover, DHS surveys include the household population but exclude the non-household population, such as military, homeless persons, and prisoners, who may have different risk of HIV infection. This may result in to underestimation of the magnitude of presented determinants and HIV prevalence.

Due to the fact that the sampling procedure was intended to represent the whole nation, analysis of determinants at local levels such as district was not possible. This limits the identification of population-specific determinants at levels lower than the country as a whole.

Conclusions and Recommendations

HIV prevalence is decreasing especially among men in urban areas of Tanzania. Overall, men and women have similar determinants of HIV transmission, as do rural and urban populations. However, the study identified a number of transmission determinants that varied by sex and by urban-rural residence across the two surveys. Hence, interventions must address specific determinants in order to be effective. Similarly, interventions must address urban and rural populations separately. In particular, there is significant heterogeneity in important determinants such as high-risk sex, STIs, and male circumcision. HIV transmission determinants vary over time both by sex and location. There is no single solution to the problem of HIV transmission in Mainland Tanzania. Development of new interventions or modifications of

existing ones need to take into consideration this heterogeneity and dynamism in HIV magnitude among different population groups and according to different transmission determinants.

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