AGE AT SECOND SEXUAL PARTNERSHIP: DATA FROM SUB-SAHARAN AFRICA ON A POORLY DESCRIBED DETERMINANT OF HIV TRANSMISSION

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Abstract

(Updated from the abstract which appears in the conference programme)

Age at first sex marks the start of an individual's exposure to HIV infection: the acquisition of a second partner marks the point at which that individual could transmit infection. Unlike age at first sex, progression to a second sexual partner is not well documented. We describe this transition in selected sub-Saharan African countries using data from the Africa Centre Demographic Information System (South Africa), the Masaka District Cohort Study (Uganda), the Manicaland cohort (Zimbabwe) and nationally representative surveys (Namibia, Tanzania, Uganda, Zambia and Zimbabwe). From the cohort data, standardised for age, men were more likely to have had a second partner than women (68% v. 44% in South Africa, 70% v. 57% in Uganda, and 65% v. 27% in Zimbabwe). The survey data yield similar estimates: 71% v. 52% in Namibia, 68% v. 50% in Tanzania, 70% v. 47% in Uganda; 70% v. 45% in Zambia & 63% v. 27% in Zimbabwe. If the data are reliable they suggest that many women have no potential to sexually transmit infection.

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Introduction

The determinants of HIV transmission are not necessarily the same as the determinants of acquisition [1 2]. In population-based studies where sexual partners cannot be linked, it is not feasible to directly measure the determinants of onward HIV transmission by infected individuals and so little is known about these in a generalised epidemic.

Central to the theory of communicable disease transmission is the concept of the reproductive number, the number of new infections arising from each infection and defined as a product of the number of contacts, the probability of transmission per contact and the duration of infectiousness [3]. For sexually transmitted infections, the number of contacts can be conceptualised as the number of sexual partners, the number of sexual acts or some combination of the two. Mathematical modelling suggests that the reproductive number is influenced not only by the number of partners but also the distribution [4], the density and structure of sexual networks [5 6] and the degree of assortative mixing. Relationships between these components, and between these characteristics and the reproductive number may not be straightforward [4 7].

Age at first sex marks the start of an individual's exposure to sexually-transmitted HIV infection. The acquisition of a second partner marks the point at which an infected individual could pass on infection. Infected people who have not, yet, had a second partner have a reproductive number of 0 and therefore do not contribute to the onward spread of infection, at least until they acquire a new sexual partner.

The association between having multiple sexual partners and an increased chance of acquiring HIV infection is well established at the individual level [8-11]. However, this association is not evident at the population level [12]. Acquisition of a second sexual partner in sub-Saharan African countries is of interest because many women, and some men, report only one lifetime partner. There is very little heterogeneity between populations in lifelong sexual abstinence: almost everyone acquires at least one sexual partner [13 14]. There is variation in the timing of this first partnership but the range is just a few years and almost everyone has had one or more partners for the majority of their adult life. The second sexual partnership represents the first opportunity that an individual has for onward transmission of infection. Heterogeneity in acquisition of a second partner would imply that the opportunities for transmission of HIV vary more by age than the opportunity for the acquisition of infection. The degree of heterogeneity in the number of lifetime sexual partners, and the speed with which these are acquired, will affect the level of variation in the number of secondary cases arising from each case.

It is therefore interesting to describe the timing of this transition from zero or one lifetime partner to at least two lifetime partners. Age at first sex is well documented[15-20] but progression to a second sexual partner is not. In part, this is because of the lack of detailed data on lifetime partners. There are good data on numbers of partners in the recent past (usually 1 year) for most African populations[13 14] but fewer sources of data on the lifetime number of partners [13 20]. Where data on lifetime partners has been collected it is usually limited to the total number of partners and there is seldom any information on when the second partner was acquired. An exception is a study in a small Swedish population which found that, for both men and women, the median age at which the second partner was acquired about two years later than the median age at first sex[21]. In this study the interval between sex with first and second partners appeared to be fairly constant for women, whereas for men the interval increased at older ages suggesting that men with a younger age at first sex acquired a second partner sooner than men whose first sex was later in life.

We present data on the patterns of acquisition of multiple lifetime partners in sub-Saharan Africa using data from cohort studies and selected Demographic and Health Surveys (DHS) and AIDS Indicators Surveys (AIS). We illustrate the transition from 0 or 1 lifetime partner to 2 or more and compare these by sex and between countries.

Data and Methods

Data

Data on lifetime partners are available from cohort studies in Uganda, Zimbabwe and South Africa. The AIS and most recent DHS have collected the total number of lifetime partners.

In South Africa, data come from the Africa Centre Demographic Surveillance System (ACDIS) in Umkhanyakude in rural KwaZulu-Natal [22 23]. Demographic surveillance is conducted in a circumscribed population within Umkhanyakude district. Lifetime sexual partner data were collected in the first (2003-2004) of five behavioural surveys, among 15-49 year old women and 15-54 year old men. A secret voting method similar to that used in Manicaland, Zimbabwe[24] was offered to participants as an alternative to face-to-face interview.

In Uganda, the Masaka cohort study based in Masaka district in South Western Uganda has included questions about lifetime partners in five survey rounds: 1992/3, 1994/5, 1998/9, 2005/6 and 2006/7. The cohort includes an adult population (13+ years) of about 11,000 people. Annual household surveys collect data on socio-demographic and behavioural factors and HIV serostatus[25].

In Zimbabwe, the Manicaland cohort in the rural eastern highlands has collected data on lifetime partners over three surveys between 1998 and 2005[26]. An informal confidential voting system is used to collect behavioural data, as a means of reducing social-desirability bias[24].

We have used survey data from Namibia (2007 DHS), Tanzania (2007 AIS), Uganda (2006 DHS), Zambia (2007 DHS) and Zimbabwe (2005 DHS).

Neither the cohort nor DHS/AIS data include the age at which respondents acquired their second partner. We can infer the average age of this transition from the current status of the respondents at the time of the survey, but cannot estimate individual ages.

Analytical Methods

We categorised respondents into three groups based on their reported number of lifetime partners: none, one more than one. To describe the overall proportion of respondents who had made the transition to a second partner we calculated age-standardised distributions, of men and women aged 15-49, by their number of lifetime partners. The proportion was standardised because the age structure of the populations is quite different. The standard population used was the UN 2005 medium variant projection for sub-Saharan Africa, by 5-year age group with both sexes combined [27].

For men and women we calculated: the ages at which at least 50% of respondents reported a) at least one lifetime partner and b) more than one lifetime partner and c) the difference between those ages.

We graphed the proportion reporting more than one lifetime partner by country, sex and age at survey. There is some fluctuation in this proportion so we smoothed the graphs by taking a moving average and used a 3 year window to retain the maximum amount of detail.

For each country we obtained estimates of population size by 5-year age group and sex from the UN 2005 medium variant projection [28]. The distribution of lifetime partners for men and women in each 5-year age group was used to draw a population pyramid for each data source with the bars subdivided by the grouped number of lifetime partners.

DHS and AIS data were analysed accounting for the complex survey design using Stata 10's survey commands [29]. The response rates for the DHS and AIS were taken from the survey reports [30]. The participation rates for the cohort studies were calculated as the proportion, of eligible individuals, who were enumerated in the relevant surveys.

Results

The number of respondents and the response/participation rates for each data source are shown in Table 1. All DHS/AIS surveys had high response rates (82-97%). Round by round participation in the cohort-based surveys was lower (44-83%). Each data source had higher response rates for women compared to men.

In the survey data, but not in the cohort data, men were less likely than women to have answered the question on lifetime partners. In the DHS/AIS almost all women (about 99.5%) gave an answer whereas around 2% of men did not. The Namibian survey had higher levels of non-response to this question: 4.6% and 2.4% of men and women respectively. In Masaka, 99% of men and 97% of women responded to the question in the 2006/7 round. In Manicaland, 99.8% of respondents in round 3 responded to this question. Response was lowest in the ACDIS cohort with 74% of men and 76% of women having answered this question.

The distributions of lifetime partners, standardised for age, are shown in Table 2 for men and women in each dataset. The proportion reporting more than one lifetime partner ranges from 63% to 71% of men and from 25% to 57% for women. Men and women in South Africa were the least likely to report any lifetime partners. Women in Zimbabwe were by far the least likely to report more than one lifetime partner. The lowest proportions of men reporting more than one partner were in South Africa and Zimbabwe. In all countries, a greater proportion of men than women report more than one lifetime partner. This difference is most pronounced in Zimbabwe and least pronounced in the Masaka cohort and the Namibia DHS. Women were more likely than men to report just one lifetime partner.

COUNTRY AND DATA SOURCE	MEN		WOMEN	
	Number	Participation (%)	Number	Participation (%)
South Africa: ACDIS cohort 2003/4	5,689	44%	11,248	70%
Uganda: Masaka cohort	6,915	47%*	9,010	56%*
Zimbabwe: Manicaland cohort 2004/5	6,491	83%†	9,775	83%†
	Number	Response (%)	Number	Response (%)
Namibia 2006/7 DHS	3,915	88%	9,804	95%
Tanzania: 2007 AIS	6,975	88%	9,343	96%
Uganda 2006 DHS	2,503	91%	8,531	95%
Zambia 2007 DHS	6,500	91%	7,146	97%
Zimbabwe 2005 DHS	7,175	82%	8,907	90%

Table 1: Numbers of male and female respondents and levels of response (for the DHS & AIS [31-35]) and participation (for the cohorts). †Both sexes combined. *All survey rounds combined (1992/3, 1994/5, 1998/9, 2005/6 and 2006/7)

Country and data source	Men		Women		Sex difference
	Number	Percent	Number	Percent	
Namibia: 2007 DHS					
No partners	533	13.8	1590	16.7	-2.9
One only	556	14.9	3011	31.6	-16.7
More than one	2647	71.3	4966	51.7	19.6
South Africa: 2003/4 ACDIS					
No partners	1904	25.7	2754	22.9	2.8
One only	254	6.7	2491	32.8	-26.1
More than one	2123	67.7	3238	44.3	23.4
Tanzania: 2007/8 AIS					
No partners	1406	19.6	1231	14.4	5
One only	843	12.5	3290	35.2	-22.7
More than one	4598	67.9	4784	50.4	17.5
Uganda: 2006/7 Masaka					
No partners	663	23.2	548	18.3	5.1
One only	141	7.4	677	24.4	-17
More than one	1019	69.5	1291	57.4	12.1
Uganda: 2006 DHS					
No partners	447	18.2	1250	15	3.2
One only	264	11.4	3278	38.5	-27.1
More than one	1635	70.4	3955	46.5	24.1
Zambia: 2007 DHS					
No partners	969	16.4	952	14	2.4
One only	813	14	2909	40.7	-26.7
More than one	4081	69.7	3262	45.2	24.5
Zimbabwe: 2005 DHS					
No partners	1793	22.8	1848	19.9	2.9
One only	968	14.2	4652	52.8	-38.4
More than one	4007	63.1	2382	27.4	35.7
Zimbabwe: 2004/5 Manicaland					
No partners	1768	22.5	1916	20.6	1.9
One only	772	12.6	4889	54	-41.4
More than one	3538	65	2279	25.4	39.6

Table 2: Age-standardised percentage distribution of the number of lifetime partners by country and sex and the difference between the sexes (percentage points)

Table 3 shows the ages at which the proportion of respondents who reported having had a) any sexual partner and b) two or more partners first exceeded 50% in each dataset. This is not a true median age because it is based on the proportion reporting by single year of age, not the cumulative proportion that would be implied by a median age. Women take longer than men to acquire their second sexual partner but this is partly because women acquire their first partner at a younger age than men. There may be some regional difference; women in Southern Africa seem on average to have a longer interval between acquiring their first and their second partners.

Country and data source	MEN			WOMEN		
	Age at which 50% first report:			Age at which 50% first report:		
	At least 1 lifetime partner	At least 2 lifetime partners	Difference	At least 1 lifetime partner	At least 2 lifetime partners	Difference
Namibia						
DHS 2007	17	20	*3*	18	22	*4*
South Africa						
ACDIS 2003/4	19	21	*3*	19	24	*5*
Tanzania						
AIS 2007	19	21	*2*	17	22	*5*
Uganda						
DHS 2006	19	20	*1*	18	22	*4*
Masaka 1992/93	18	19	*1*	18	20	*2*
Masaka 1993/94	19	20	*1*	19	22	*3*
Masaka 1998/99	18	20	*2*	18	20	*2*
Masaka 2005/06	21	21	*0*	19	22	*3*
Masaka 2006/07	21	21	*0*	19	22	*3*
Zambia						
DHS 2007	18	19	*1*	17	24	*7*
Zimbabwe						
DHS 2005	20	22	*2*	19	-*	
Manicaland R1	18	20	*2*	19	-*	
Manicaland R2	19	21	*2*	18	-*	
Manicaland R3	20	21	*1*	19	-*	

Table 3: The ages at which at least 50% of respondents first report one sexual partner (1+), and two or more (2+). * Fewer than 50% of women ever report having had more than one lifetime partner.

Figure 1 shows the proportion who report more than one lifetime partner by single year of age and by sex and survey. Everywhere except Zimbabwe, the younger women showed a similar pattern with a steady increase in the proportion reporting more than one lifetime partner between 15 and 20 followed by a levelling off in the early 20s at around 50%. A different pattern is observed in Zimbabwe with a much slower increase in this proportion and a plateau at around 30%. For women, there is most heterogeneity between the countries at the older ages. There is less cross-country variation for men than women and this is observed at the youngest and oldest ages. Most men have had a second partner by the end of their twenties. After this age, the proportion reporting more than one lifetime partner increases little in most countries so although most men may continue to acquire new partners over their lifetime many of the men who have not had a second partner in their twenties are unlikely to acquire one later in life. In their late 20s men in all countries are remarkably similar, with around 80% reporting having had more than one lifetime partner. The variation in the older men may be party because fewer older men were surveyed.

In the youngest age groups, Namibia had higher proportions of men with more than one partner than other countries, but at ages over 35 Namibian m en reported lower proportions than in other countries. The proportion of men reporting more than one lifetime partner in Namibia increased rapidly in the teenage years, peaked around age 25 and then declined slightly between ages of 35 and 45. This implies that young Namibian men are behaving, or reporting their behaviour, differently to older men.

The opposite pattern was seen in the Zimbabwe datasets and the results from the most recent survey round in Masaka. These datasets had the lowest proportion of young men reporting more than one partner, a peak around age 25 at a similar level to the other countries and then a slow but steady increase in the proportion to around 80% in the late 40s, about 10-20 percentage points higher than Namibian men.

The graphs for men show a clear turning point: at younger ages there are rapid increases in the proportion reporting more than one partner and then the line flattens out. For men, this proportion does not increase much after the age of 27. The increase in the proportion of women reporting more than one partner slows around the age of 22 and has almost stopped by the age of 30 but in all countries there continues to be a small, steady increase in the proportion of respondents reporting more than one partner at the older ages.

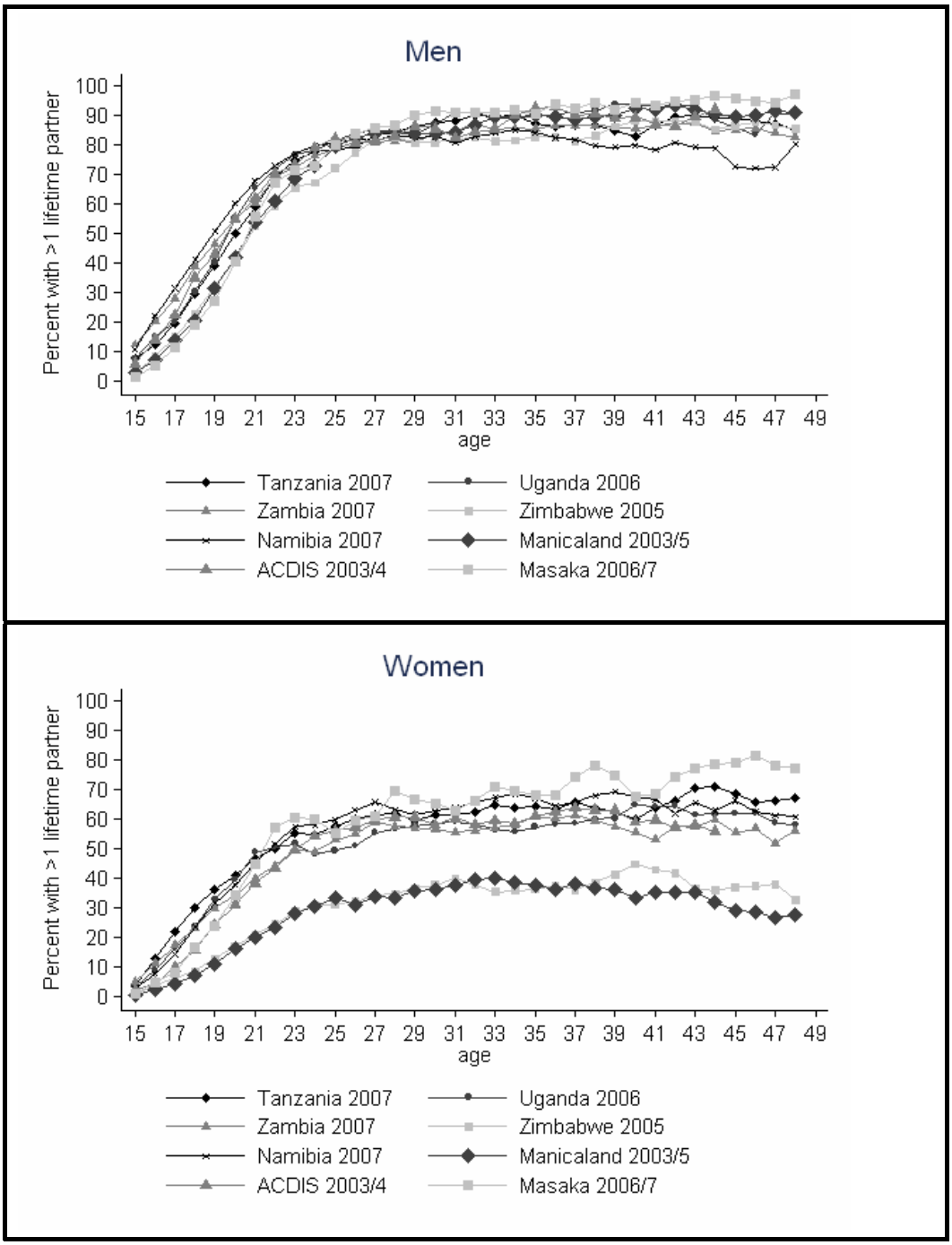

Figure 1: Proportion who have had more than one lifetime partner by single year of age (three year moving average). Most recent round only for cohort studies.

There is no evidence for a trend across rounds in the proportion reporting more than one lifetime partner in either the Manicaland or Masaka data (not shown). Both cohorts show close agreement with the DHS data.

Figure 2 shows the distribution of number of lifetime partners by five-year age group for men and women from each data set. The graphs illustrate the timing of the transitions from zero to one to more than one partner and show how population size may interact with partnership behaviour to determine the availability of partners. In all datasets there is asymmetry between men and women in every age group: more men that women have had multiple lifetime partners which suggests that at every age some of the men with multiple partners will be in partnerships with women who have had only one partner. This asymmetry may be further exacerbated by age differences between partners (typically 5-7 years between spouses) that means men's female partners are likely to come from a younger age group where the proportion with only one partner is higher than among women of their own age.

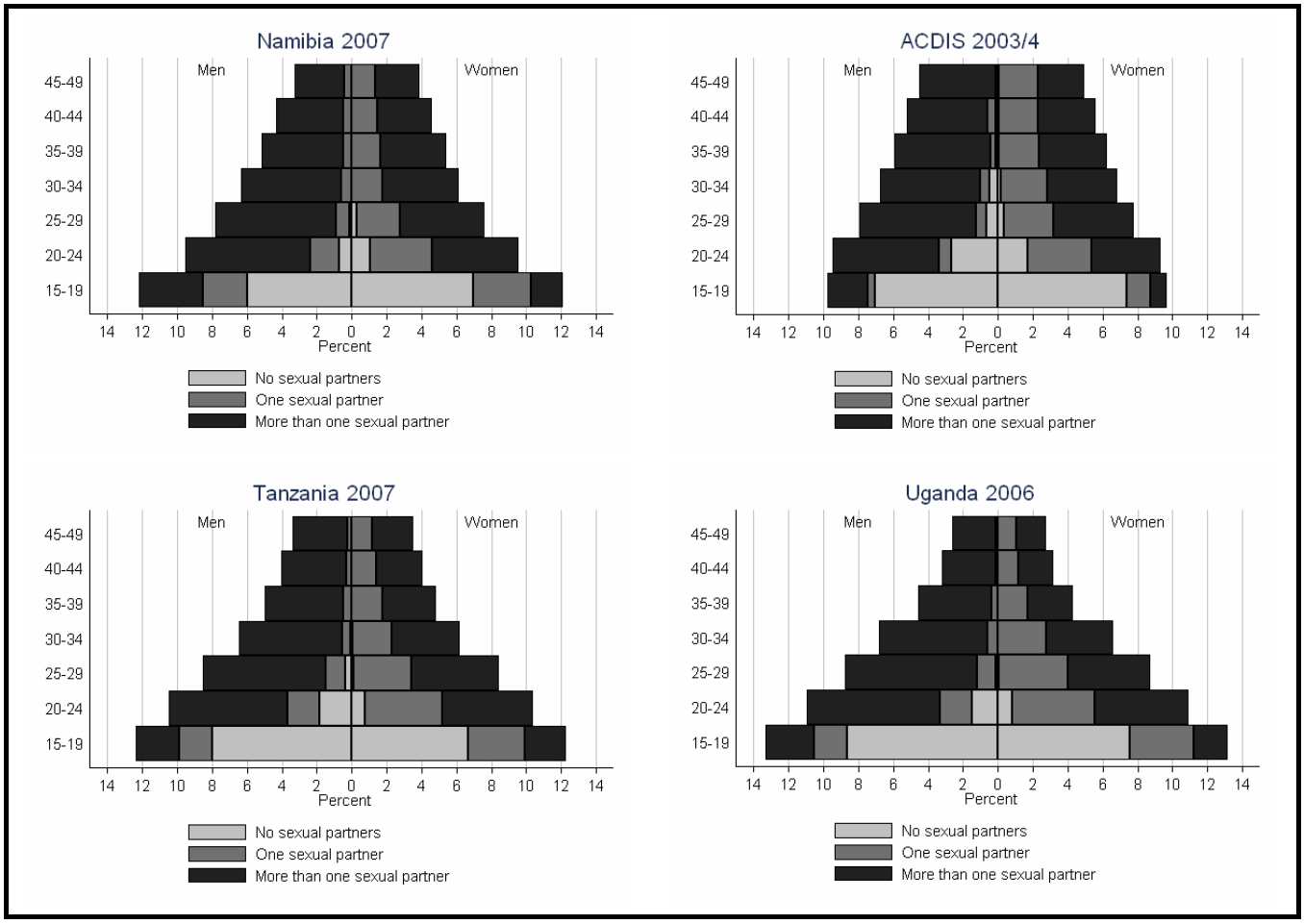

Figure 2: Population pyramids showing the distribution of the grouped number of lifetime partners by five-year age group. The most recent round is used for cohort studies.

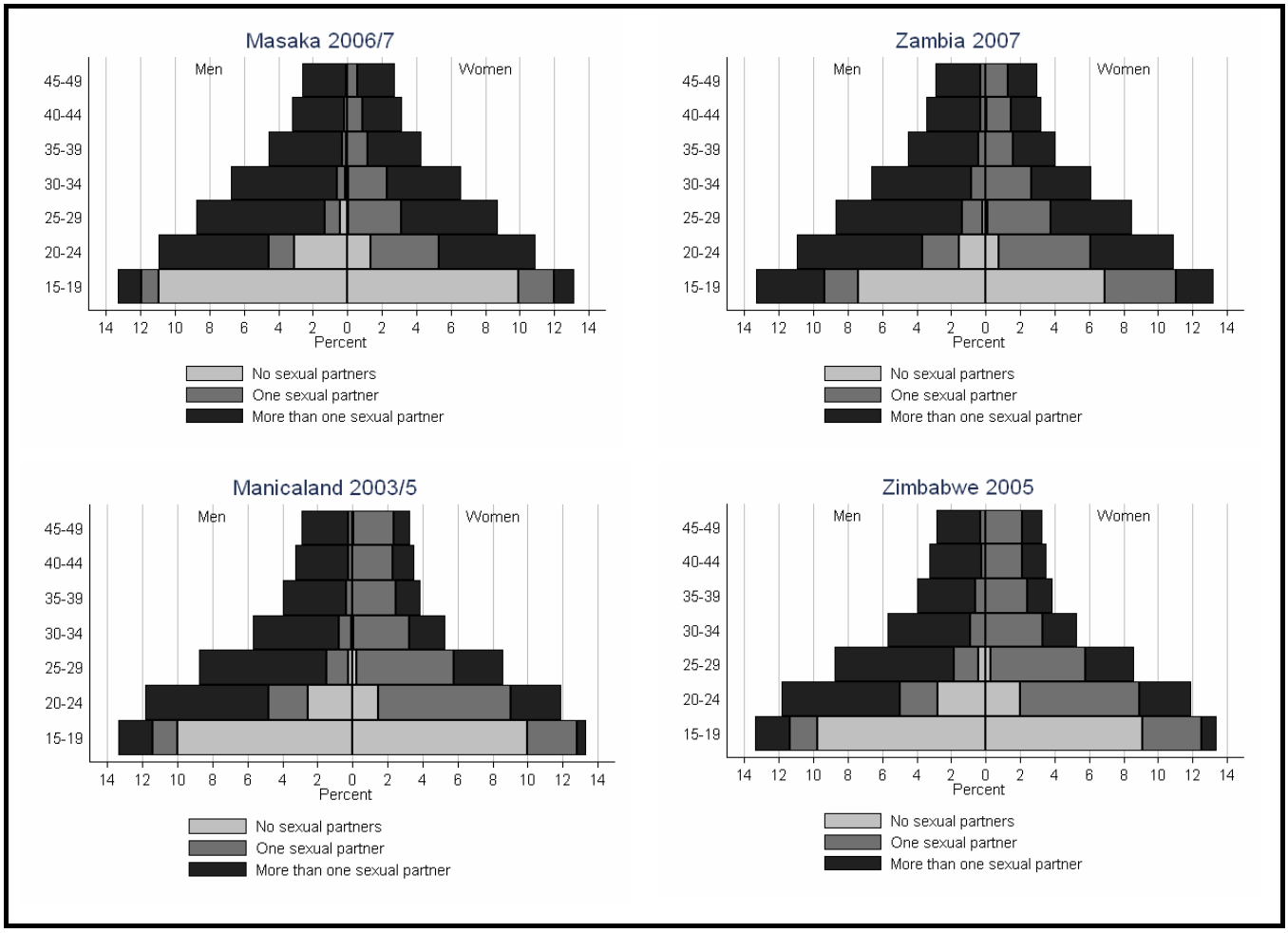

Figure 2 continued: Population pyramids showing the distribution of the grouped number of lifetime partners by five-year age group. The most recent round is used for cohort studies.

Table 4 shows the marital status of respondents reporting one and more than one lifetime partners by sex and survey. Men who report only one lifetime partner are evenly distributed between those who are single or currently married with the exception of Namibian men. Namibians of both sexes are very likely to be single which reflects a late age at first marriage. Almost all the women who report only one partner are married and many report their first sex and marriage at the same age. Women who report more than one partner are mostly ex-married or in second marriages. With the exception of Namibia, women who report multiple partners are less likely to be single than men.

Women's reports of only one lifetime partner are more convincing if they are married and first sex coincided with first marriage. Most women are married, but in all countries the proportion reporting first sex and marriage at the same time is smaller than the proportion currently married. First sex may have been with their future husband but have occurred some time before the marriage. However, first sex may have been with a different, undisclosed partner. The difference between the proportion reporting first sex and marriage to be the same age, and the proportion currently married ranges from 12 to 25 percentage points. The discrepancy is greatest in Zimbabwe and Uganda.

Country and data source	Lifetime partners	Distribution of Marital Status (%)				AFS = AFM*	AFS > AFM*	Median AFM
		Never married	Currently married	Re-married	Formerly married	(Percent)	(Percent)	
MEN								
Namibia								
DHS 2007	1	75	20	3	2	5	5	32
	>1	57	29	9	5	3	3	32
Tanzania								
AIS 2007	1	54	45	0	1	31	4	24
	>1	23	53	17	7	8	4	24
Uganda								
DHS 2006	1	48	48	1	2	10	7	23
	>1	20	52	21	7	8	3	23
Zambia								
DHS 2007	1	47	50	1	2	33	7	24
	>1	26	49	19	6	8	4	24
Zimbabwe								
DHS 2005	1	48	49	1	3	22	14	24
	>1	26	54	13	7	13	7	24
WOMEN								
Namibia								
DHS 2007	1	52	43	0	6	18	10	26
	>1	49	33	9	10	7	5	26
Tanzania								
AIS 2007	1	13	81	0	6	61	3	18
	>1	12	45	24	20	27	5	18
Uganda								
DHS 2006	1	13	78	0	9	54	11	17
	>1	9	42	28	22	30	7	17
Zambia								
DHS 2007	1	16	76	0	8	63	7	18
	>1	13	42	25	20	31	6	18
Zimbabwe								
DHS 2005	1	7	78	2	14	54	17	18
	>1	10	35	26	29	31	12	18

Table 4: Marital status and proportion whose age at first sex (AFS) was the same as age at first marriage (AFM) by reported number of lifetime partners. *Current age for never married respondents.

Discussion

In all countries there are substantial differences between men and women with respect to acquiring a second partner. Fewer women than men acquire a second partner and, on average, women are older when they do make the transition. Men in all countries seem to acquire second partners at a similar rate although the age at which these partners are acquired varies between countries. By their late twenties around 80% of men have had a second partner and this is remarkably similar across the different sources of data. There is more difference between countries in the pattern of second partner acquisition for women and Zimbabwean women are markedly different from those in the other countries.

In South Africa a very small proportion of men report having had only one lifetime partner. Age at first sex is later than the other countries but the proportion reporting two or more lifetime partners (Figure 1) resembles that of the other countries which implies that the interval between first and second partners must be shorter for men in South Africa compared to the other countries. The difference between young men in Zimbabwe and Namibia may be partly due to differences in age at first sex: the median age at first sex reported by 15-24 year old men in Namibia was 17.3 compared to 18.0 in Zimbabwe.

There are fundamental problems with trying to estimate age at second sexual partnership based on the number of lifetime partners reported at the time of the survey. Current status data are likely to over-estimate the age at the transition. Survival analysis based on the retrospectively reported age would be a better measure if the data were available [36]. We have probably over-estimated the average age in this analysis; the ages for those reporting at least one partner in Table 3 are between 0.5 and 1 year older than the median ages at first sex obtained from rigorous analysis of the data in South Africa [17] and Zimbabwe [15] and considerably higher for Masaka [19]. This implies that the age at second partner may be slightly younger than estimated here.

Reporting bias is an ever-present problem with sexual behaviour data and is likely to have affected these results. The generally high levels of response to surveys and to the question on lifetime partners suggests that non-response bias is not important in these data, with the possible exception of the ACDIS cohort where around a quarter of respondents did not answer the question. However, this does not mean that the reported data are necessarily valid. We may have observed a difference between men and women because women have not truthfully reported their number of lifetime partners and may be particularly reticent to report having had more than one partner. Men may have exaggerated their numbers of partners. Although the results in Table 4 suggest that most of the women who reported only one partner gave a plausible account, in that they were married and first sex occurred at the same age as first marriage, between 12% and 25% of married women who reported only one partner also reported first sex before their first marriage. The first sexual partner may have become a spouse following a period of pre-marital sexual activity, but this may also represent a failure to disclose pre-marital partnerships. If all women whose age at first sex preceded first marriage by one year of more had all had more than one lifetime partner the estimates for South Africa and Namibia would have been the most affected since age at marriage is highest in those countries.

A study of partnerships in Mwanza region in Tanzania found a 16% deficit in the number of partners reported by women compared to men and attributed this to selective under-reporting by women of short-term and low status male partners combined with some exaggeration in the numbers of partners reported by young single men[37]. If the data presented here are subject to reporting errors of the same magnitude and direction then the differences between young men and women may be smaller than they appear. In the Mwanza study and a sexual network study on Likoma Island in Malawi [38], married respondents were found to report their partnerships more accurately than unmarried respondents. The Likoma study found that partnerships of longer duration were more likely to be reported by both partners than short-term partnerships. Single women in the Likoma study appeared to report only 70% of their partnerships[39].

If women in these data have failed to report a proportion of their short-term partners, and if under-reporting is particularly acute among younger women, we may have over-estimated the age at which women acquired their second partner. As the under-reporting in the other studies varied by age, the shape of the curves in Figure 1 may be inaccurate and the slower increase in the proportion of women with more than one partner compared to men may be an artefact of reporting bias.

Although the Tanzanian and Malawian studies found, respectively, that 16% and 30% of all partners are not reported, we do not know the extent to which the under-reporting affects reporting of one versus more than one lifetime partner. This distinction is important both epidemiologically and socially since it is socially desirable for women in particular to report only one lifetime partner.

Despite the limitations of the analysis, the results presented here suggest some important areas for further research. It is likely that marriage patterns have an important effect on the acquisition of a second partner. We cannot examine this directly in these data because we do not know the age at which a second partner was acquired but the distribution of current marital status is different for respondents with only one lifetime partner and those with more than one lifetime partner. Marriage, or remarriage, may be the point at which a respondent acquires a second partner. Respondents who are married may not acquire new partners during their marriage.

The timing of the acquisition of second partners (Figure 1) suggests that most men acquire their second partner before first marriage as the median age at first marriage is 23 or above (Table 4). Many women will also make this transition before first marriage but, with a median age at first marriage around 18, others may acquire second partners after first marriage. The breakdown of a first marriage may be the point at which many women acquire a second sexual partner.

The timing of first sex and first marriage has been shown to be associated with marital status and number of partners later in life in Tanzania[40], number of partners and condom use in Zimbabwe[16] and with marital status and HIV infection among ever-married women in Malawi[41]. In the Malawi study, women who married their first sexual partner and remained married were the least likely to be HIV positive, but amongst these women those whose first sex was younger than 15 the benefit was offset by the increased likelihood of marital breakdown. Having experienced the ending of a marriage increased the odds of being HIV positive in this sample. Many women (68%) married their first sexual partner, half had had only one lifetime partner and very few married women reported having had extra-marital partners. In this context, acquisition of the second partner may prove a risk for both acquisition of HIV and for potential transmission of infection. The highest prevalence in this study (40%) was found amongst women who married their first partner at a young age and were subsequently widowed. This group may be small but the potential for onward spread of infection would be very high were these women to acquire a second sexual partner.

The potential importance of widows and widowers in the spread of HIV has been demonstrated by Lopman et al. [42] in Manicaland, Zimbabwe. HIV prevalence was high among widows and widowers and they estimated that between 8 and 17% of new infections over a 20 year period may be ascribed to their sexual activity. Death of a spouse was not a risk for acquiring HIV infection.

Although, the inception and termination of marriages may be a risk for acquisition and transmission of HIV infection irrespective of the number of lifetime partners, the difference between 1 and 2 lifetime partners is greater, from the point of view of transmission, than the difference between 2 and 3 partners or so on.

Based on mathematical modelling, Hallett et al [43] suggest that in Manicaland, delays in age at first sex and reductions in age mixing in sexual partnerships have less potential to slow the spread of HIV infection than condom use. The difference in the age at which men and women acquire their second sexual partners suggests that the higher proportion, of women relative to men, who have had only one partner during their twenties could act to slow the further spread of infection by delaying onward transmission. The proportion with only one partner may offset the effects of age mixing, at least temporarily.

A limitation of using the cumulative lifetime number of partners, by age, to describe the age at which people acquire their second sexual partner is that the observed results may be the product of either lifecourse changes, or secular trends or both. Both effects are interesting but it would be more useful to be able to distinguish them. To do this requires data on the reported age at which the respondent acquired their second partner, analysed by birth cohort. Alternatively, cohort data could be used to approximate this age if the number of lifetime partners is collected annually. Such data could be used to approximate the age at which the second partner is acquired, though this approach would require about 10 years of data to permit observation of this event for a reasonable number of respondents because only those who acquire their second partner during the study will contribute data for such analysis.

Despite the limitations in the available data on the acquisition of the second sexual partner, this analysis has revealed some differences between countries and between men and women which merit further investigation.

References

1. Ghani AC, Garnett G. Risks of Acquiring and Transmitting Sexually Transmitted Diseases in Sexual Partner Networks. *Sexually Transmitted Diseases* 2000;27(10):579-587.
2. Lopman BA, Nyamukapa C, Mushati P, Mupambireyi Z, Mason P, Garnett G, et al. HIV incidence in 3 years of follow-up of a Zimbabwe cohort - 1998-2000 to 2001-03: contributions of proximate and underlying determinants to transmission. *Int J Epidemiol* 2008;37:88-105.
3. Anderson RM, May RM. *Infectious Diseases of Humans*. Oxford: Oxford University Press, 1991.
4. Nordvik MK, Liljeros F. Number of sexual encounters involving intercourse and the transmission of sexually transmitted infections. *Sex Transm Dis* 2006;33(6):342-349.
5. Ward H. Prevention strategies for sexually transmitted infections: importance of sexual network structure and epidemic phase. *Sex Transm Infect* 2007;83(Suppl 1):i43-i49.
6. Morris M, Kretzschmar M. Concurrent partnerships and the spread of HIV. *Aids* 1997;11(5):641-648.
7. Potterat JJB, Muth SQB, Brody SP. Evidence Undermining the Adequacy of the HIV Reproduction Number Formula. *Sexually Transmitted Diseases* 2000;27(10):644-645 <6>.
8. Malamba SS, Wagner HU, Maude G, Okongo M, Nunn AJ, Kengeyakayondo JF, et al. Risk-Factors For HIV-1 Infection In Adults In A Rural Ugandan Community - A Case-Control Study. *Aids* 1994;8(2):253-257.
9. Gregson S, Nyamukapa CA, Garnett GP, Mason PR, Zhuwau T, Carael M, et al. Sexual mixing patterns and sex-differentials in teenage exposure to HIV infection in rural Zimbabwe. *Lancet* 2002;359(9321):1896-1903.
10. Kelly RJ, Gray RH, Sewankambo NK, Serwadda D, Wabwire-Mangen F, Lutalo T, et al. Age differences in sexual partners and risk of HIV-1 infection in rural Uganda. *J Acquir Immune Defic Syndr* 2003;32(4):446-51.
11. Quigley M, Munguti K, Grosskurth H, Todd J, Mosha F, Senkoro K, et al. Sexual behaviour patterns and other risk factors for HIV infection in rural Tanzania: a case-control study. *AIDS* 1997;11(2):237-48.
12. Auvert B, Buve A, Ferry B, Carael M, Morison L, Lagarde E, et al. Ecological and individual level analysis of risk factors for HIV infection in four urban populations in sub-Saharan Africa with different levels of HIV infection. *AIDS* 2001;15(suppl 4):S15-S30.
13. Todd J, Cremin I, McGrath N, Bwanika JB, Wringe A, Marston M, et al. Reported number of sexual partners: comparison of data from four African longitudinal studies. *Sexually Transmitted Infections* 2009;85 Suppl 1:i72-80.
14. Wellings K, Collumbien M, Slaymaker E, Singh S, Hodges Z, Patel D, et al. Sexual behaviour in context: a global perspective. *The Lancet* 2006;368(9548):1706-1728.
15. Cremin I, Mushati P, Hallett T, Mupambireyi Z, Nyamukapa C, Garnett GP, et al. Measuring trends in age at first sex and age at marriage in Manicaland, Zimbabwe. *Sexually Transmitted Infections* 2009;85 Suppl 1:i34-40.
16. Hallett T, Lewis J, Lopman BA, Nyamukapa C, Mushati P, Wambe M, et al. Age at First Sex and HIV Infection in Rural Zimbabwe. *Stud Fam Plann* 2007;38(1):1-10.
17. McGrath N, Nyirenda M, Hosegood V, Newell ML. Age at first sex in rural South Africa. *Sexually Transmitted Infections* 2009;85 Suppl 1:i49-55.
18. Pettifor AE, van der Straten A, Dunbar MS, Shiboski SC, Padian NS. Early age of first sex: a risk factor for HIV infection among women in Zimbabwe. *Aids* 2004;18(10):1435-1442.
19. Slaymaker E, Bwanika JB, Kasamba I, Lutalo T, Maher D, Todd J. Trends in age at first sex in Uganda: evidence from Demographic and Health Survey data and longitudinal cohorts in Masaka and Rakai. *Sex Transm Infect* 2009;85(Suppl_1):i12-19.
20. Ferry B, Carael M, Buve A, Auvert B, Laourou M, Kanhonou L, et al. Comparison of key parameters of sexual behaviour in four African urban populations with different levels of HIV infection. *Aids* 2001;15(Supplement 4):S41-S50.
21. Giesecke J, Scalia-Tomba G, Gothberg M, Tull P. Sexual behaviour related to the spread of sexually transmitted diseases- a population based survey. *Int J STD AIDS* 1992;3(4):255-260.
22. Hosegood V, Benzler J, Solarsh G. Population mobility and household dynamics in rural South Africa: implications for demographic and health research.

. *S Afr J Demogr* 2005;10:43-67.

23. Tanser F, Hosegood V, Barnighausen T, et al. Cohort Profile: Africa Centre Demographic Information System (ACDIS) and population-based HIV survey. *Int J Epidemiol* 2008;37:956-62.
24. Gregson S, Mushati P, White PJ, Mlilo M, Mundandi C, Nyamukapa C. Informal confidential voting interview methods and temporal changes in reported sexual risk behaviour for HIV transmission in sub-Saharan Africa. *Sex Transm Infect* 2004;80 Suppl 2:ii36-42.
25. Mulder D, Nunn A, Wagner H, Kamali A, Kengeya-Kayondo J. HIV-1 incidence and HIV-1-associated mortality in a rural Ugandan population cohort. *AIDS* 1994;8(1):87-92.
26. Gregson S, Garnett G, Nyamukapa C, Hallett TB, Lewis JJC, Mason PR, et al. HIV Decline Associated with Behavior Change in Eastern Zimbabwe. *Science* 2006;311:664-666.
27. United Nations Population Division. World Population Prospects: The 2006 Revision Population Database: UN, 2006.
28. United Nations Population Division. World Population Prospects: The 2004 Revision Population Database: UN, 2004.
29. Stata/SE 10.0 for Windows [program]. 10.0 version. College Station, USA: Stata Corporation, 2006.
30. MEASURE DHS. Demographic and Health Surveys, 2008.
31. Central Statistical Office (CSO), Inc. MI. Zimbabwe Demographic and Health Survey 2005-06. Calverton, Maryland, USA: CSO and Macro International Inc., 2007.
32. Central Statistical Office (CSO) Z, Ministry of Health (MOH) Z, Tropical Diseases Research Centre (TDRC) UoZ, Macro International Inc. Zambia Demographic and Health Survey 2007. Calverton, Maryland, USA: CSO and Macro International Inc., 2009.
33. Ministry of Health and Social Services (MoHSS) N, Macro International Inc. Namibia Demographic and Health Survey 2006-07. . Windhoek, Namibia and Calverton, Maryland, USA: MoHSS and Macro International Inc. , 2008.
34. Tanzania Commission for AIDS (TACAIDS), Zanzibar AIDS Commission (ZAC), National Bureau of Statistics (NBS), Office of the Chief Government Statistician (OCGS), Macro, Inc. I. Tanzania HIV/AIDS and Malaria Indicator Survey 2007-08. . Dar es

Salaam, Tanzania: TACAIDS, ZAC, NBS, OCGS, and Macro International Inc., 2008.

35. Uganda Bureau of Statistics (UBOS), Macro International Inc. Uganda Demographic and Health Survey 2006. Calverton, Maryland, USA: UBOS and Macro International Inc., 2007.
36. Zaba B, Pisani E, Slaymaker E, Boerma T. Age at first sex: understanding recent trends in African demographic surveys. *Sexually Transmitted Infections* 2004; 80(Supplement II):ii28-ii35.
37. Nnko S, Boerma JT, Urassa M, Mwaluko G, Zaba B. Secretive females or swaggering males? An assessment of the quality of sexual partnership reporting in rural Tanzania. *Social Science and Medicine* 2004;59:299-310.
38. Helleringer S, kohler HP. Sexual network structure and the spread of HIV in Africa: evidence from Likoma Island, Malawi. *AIDS* 2007;21(17):2323-2332.
39. Helleringer S, Kohler HP, Chimbiri A, Chatonda P, Mkandawire J. The Likoma Network Study: context, data collection and initial results. . *PSCWorking Paper Series*: University of Pennsylvania, Population Studies Center, 2007.
40. Zaba B, Isingo R, Wringe A, Marston M, Slaymaker E, Urassa M. Influence of timing of sexual debut and first marriage on sexual behaviour in later life: findings from four survey rounds in the Kisesa cohort in northern Tanzania. *Sexually Transmitted Infections* 2009;85 Suppl 1:i20-6.
41. Boileau C, Clark S, Bignami-Van Assche S, Poulin M, Reniers G, Watkins SC, et al. Sexual and marital trajectories and HIV infection among ever-married women in rural Malawi. *Sexually Transmitted Infections* 2009;85 Suppl 1:i27-33.
42. Lopman BA, Nyamukapa C, Hallett TB, Mushati P, Spark-du Preez N, Kurwa F, et al. Role of widows in the heterosexual transmission of HIV in Manicaland, Zimbabwe, 1998-2003. *Sexually Transmitted Infections* 2009;85 Suppl 1:i41-8.
43. Hallett TB, Gregson S, Lewis JJC, Lopman BA, Garnett G. Behaviour change in generalised HIV epidemics: impact of reducing cross-generational sex and increasing age at sexual debut. *STI* 2007;83(Supplement 1):i50-i54.