



Characteristics of sexual partnerships, not just of individuals, are associated with condom use and recent HIV infection in rural South Africa

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Abstract

Characteristics of sexual partnerships, as well as those of the individuals involved, might influence the use of condoms and risk of HIV transmission. We set out to identify characteristics of non-spousal sexual partnerships associated with condom use at last sex and recent HIV infection among sexually-active young people in rural South Africa. We conducted an analysis of follow-up data (collected in 2004) from a cohort of 14-35 year old men and women recruited to a cluster-randomised trial in 2001. Data on 1647 non-spousal sexual partnerships during the previous year were reported in 2004 and analysed alongside HIV incidence over the previous three years among 762 individuals who were HIV negative in 2001. Structured interviews elicited information on sexual behaviour while HIV serostatus was assessed through an oral-fluid ELISA in both years. Condom use at last sex was reported for 615/1647 non-spousal sexual partnerships (37.3%) and was more commonly reported by individuals who were themselves married, more educated and aware of their HIV status. Condom use was more common in casual partnerships, those where the male partner was younger, where sex was less frequent and where the respondent believed the partner to have other sexual contacts. New HIV infection in the last three years was identified for 87/762 individuals (11.4%) and was more common among females and those out of school. Infections were less common among individuals reporting less frequent intercourse and for whom the oldest male partner was 20-25 years. Characteristics of sexual partnerships, as well as those of individuals, are important determinants of condom use and risk of HIV infection. Male characteristics are particularly important, perhaps because of their increased capacity to make decisions about HIV prevention. Established sexual partnerships are an increasingly important site of HIV transmission.

Introduction

HIV incidence remains high in much of sub-Saharan Africa. The bulk of HIV transmission among young adults occurs during unprotected heterosexual intercourse (UNAIDS, 2006). Condom use can prevent HIV transmission, yet remains lower than is necessary to curb infection in many places, despite extensive health promotion efforts..

Previous research has identified individual attributes associated with condom use and risk of HIV infection, including education (Fylkesnes et al., 1997; Grosskurth et al., 1995; Kilian et al., 1999; Smith et al., 1999), mobility (Morris, Wawer, Makumbi, Zavisca, & Sewankambo, 2000), attitudes and behavioural self-efficacy (J. Catania, Kegeles, & Coates, 1990; Fishbein, 2000; Flisher, Reddy, Muller, & Lombard, 2003; Norman, 2003). Characteristics of sexual partnerships such as their duration, level of trust, power dynamics and partners' perception of each other's behaviour might themselves influence condom use, and thus affect the partners' risk of infection.

Wide age differences between male and female sexual partners have been noted in sub-Saharan Africa, and partly attributed to social and economic inequalities between the sexes. (Anderson, May, Boily, Garnett, & Rowley, 1991; Gregson, Nyamukapa et al., 2002; Kelly et al., 2003; Luke, 2003) These unequal power dynamics influence cultural norms around sexual negotiation and behaviour, including condom use. Resources exchanged between sexual partners can also implicitly or explicitly influence condom use. These characteristics can combine in ways that potentially accelerate HIV transmission (Hallett, Gregson, Lewis, Lopman, & Garnett, 2007).

Qualitative studies have explored the relationship between partnership-level traits and condom use, highlighting age and economic status (C. Kaufman & Stavrou, 2002), and type of sexual relationships, including their perceived stability. Young people report using condoms with partners not considered trustworthy, and then reduce use as trust develops (C. E. Kaufman, Clark, Manzini, & May, 2004). The wishes of men may prevail over those of female partners (Luke, 2003; MacPhail & Campbell, 2001). While these dynamics have been widely discussed, there have been few attempts to quantify the relative importance of partnership-level characteristics in influencing condom use and HIV risk among African populations.

We set out to identify characteristics of non-spousal sexual partnerships associated with the use of condoms among young people in a region of rural South Africa. We then assessed whether these characteristics were associated with HIV acquisition over the last three years.

Methods

The data came from the IMAGE study, an eight village, cluster-randomised-trial conducted in rural South Africa. The results of the trial have been reported in detail elsewhere (Kim et al., 2007; Pronyk et al., 2006), and we have documented high HIV incidence among the study population (Hargreaves, Bonell et al., 2007).

For the analysis presented here, we used data collected from individuals interviewed in 2004 who had been recruited by random household selection in villages and were aged 14-35 years in 2001. These individuals were drawn from study communities but had little or no direct contact with the intervention (Pronyk et al., 2006). We used follow-up data from 2004 since more information was collected on sexual partnerships during the previous year than at baseline, and because data were available on new HIV infection following a negative test at baseline (2001). We restricted the analysis to individuals reporting at least one non-spousal partner in the previous year. Both married and unmarried individuals were included, although only non-spousal partnerships were considered, these being partnerships where the partners were not married to each other.

Individual socio-demographic and partnership data were collected in structured interviews conducted in the local language (Sepedi). Data on household wealth came from a participatory wealth ranking exercise conducted in 2001, with households classified as “very poor”, “poor but a bit better off” or “doing OK” (Hargreaves, Morison, Gear, Porter, Makhubele, Kim, Busza et al., 2007; Hargreaves, Morison, Gear, Porter, Makhubele, Kim, Watts et al., 2007). Data were collected on the total number of sexual partnerships throughout life and during the last year. Following this, more detailed information was collected on up to the three most recent non-spousal sexual

partnerships during the previous year. HIV status was determined through analysis of oral-fluid samples collected using the OraSure collection device (UCB group, Belgium) and analysed with the Vironostika HIV Uni-Form II assay (bioMerieux, France).

Following descriptive analysis we used logistic regression to identify characteristics associated with condom use at last sex within each sexual partnership. A dataset of non-spousal partnerships was constructed grouping together all partnerships reported by both men and women. Some 20 explanatory variables were included in the analysis representing characteristics of both the individual reporting the partnership (10 variables) and the partnership itself (10 variables). Respondents described each partnership as with a “boy/girlfriend” (we considered these to be more established partnerships) or could use colloquial terms for more casual partnerships, e.g. “hit and run”, “take-away” or “roll-on”. Other partnership characteristics on which data were available included the marital status of the partner, duration of relationship, frequency of sex during the last year (less than five times or five times or more), age of both partners, exchange of resources within the relationship and perception of the partner’s behaviour and risk of HIV infection. Adjustment was made for the fact that more than one partnership was reported by many individuals by calculating confidence intervals on the basis of robust standard errors.

In the first stage of the analysis a regression model was constructed for each of the 20 individual or partnership level characteristics, where these were the independent variable of interest and where only the sex of the reporting individual and the matched village-pair from the IMAGE trial were adjusted for. The results of these analyses are labelled “model 1”. A further two models were constructed including age, village-pair, and either all 10 individual or all 10 partnership characteristics together as independent

variables. A backward stepwise procedure was run retaining factors associated with the outcome at a level of $p < 0.10$ (model 2). Finally, a summary model was constructed incorporating both the individual and partnership-level characteristics retained in model 2 and these were included together in a final backward stepwise procedure (model 3).

Subsequently, a dataset of all individuals contributing information to the partnerships dataset was constructed. Logistic regression analysis was then used to identify characteristics associated with the individual-level outcome of new HIV infection within the previous three years. To provide an individual-level summary of each partnership characteristic for this analysis, variables were constructed summarising information on all sexual partnerships reported by each individual (for example, the *largest* age difference among all partnerships reported; see Table 4). A comparable analysis strategy to that for condom use was adopted, resulting in three sets of results from regression models.

Results

Interviews were conducted with 2325/3881 individuals at follow up in 2004, representing 59.9% of those eligible at baseline. Of these 153 had never been sexually active, while 190 reported no sexual activity during the previous year. A further 107 males and 293 females were married, and reported sexual activity with a spousal partner but no non-spousal partners. Some 26 individuals had all key data missing. The analysis therefore focused on the population of 678 males and 878 females who reported at least one non-spousal partnership during the previous year.

All recruited individuals were aged 14-35 years in 2001 and thus over 16 years by 2004 (Table 1). The majority were unmarried, had attended secondary school and were currently still students. More females than males reported being aware of their HIV-status from a recent HIV test (22.5% vs 10.8%, $p < 0.01$). Males reported a higher number of non-spousal partners than females. Despite this, similar numbers of males and females reported that they perceived themselves to be at medium or high risk of infection. Females were much more likely than males to have been newly HIV-infected in the past 3 years (16.4% vs 6.7%, $p < 0.01$).

Males included in the analysis reported a total of 1051 non-spousal partnerships during the previous year, while females reported 994. Some 19 males (2.8%) and 2 females (0.2%) reported more than three non-spousal partners in the previous year and detailed data on only the most recent three were collected. Consequently, descriptive data were available on 1000 partnerships (95.1%) reported by males and 988 partnerships (99.4%) reported by females (Table 2). Most partners were described as a "boy/girlfriend", though males reported more casual relationships than females (15.0% vs 3.7%). More

females than males reported partnerships involving a married partner (10.9% vs 6.6%, $p < 0.01$), although in both cases the male was more likely to be the married partner. Males more often reported partnerships lasting only a single day, while females more often reported partnerships that had lasted over three years. Males reported slightly more partnerships where sex occurred less than five times during the previous year (28.4% vs 24.3%, $p = 0.04$). Females reported 9.0% of partnerships with males over 40 years old. In the majority of partnerships the male partner was more than three years older than the female partner. However for both sexes, the most common source of missing exposure data was on partner's age. Females more often reported partnerships where the net resource flow was from male to female, whereas males more often reported no net exchange of resources. Similar numbers of males and females reported that their partners had other sexual partners or were at medium / high risk of HIV infection. Males reported higher rates of condom use at last sex than females (41.8% vs 34.7%, $p < 0.01$).

Risk factors for condom use at last sex

Risk factor analysis focused only on individuals with data available for all individual and partnership characteristics meaning that 1647/1988 (82.8%) partnerships were included in the analysis.

Condom use at last sex was less commonly reported by females than males after adjustment for individual-level factors and village-pair (adjusted odds ratio, aOR, 0.78 95% CI 0.61-0.90; model 2, Table 3) and decreased with increasing age of the respondent. Condom use at last sex with a non-spousal partner was more often reported by individuals who had themselves been married, especially after other individual

characteristics were adjusted for (aOR 1.59 95% CI 0.93-2.71). The most educated individuals were also the most likely to report condom use (aOR completed secondary vs did not attend secondary 1.64 95% CI 1.26-2.15). Employment status and household wealth were not associated with condom use at last sex. Individuals who did not know their HIV status were less likely to report condom use than those who did (aOR 0.74 95% CI 0.53-0.99). Individuals reporting more than one non-spousal partner in the last year were more likely to report condom use at last sex after adjustment for individual, but not partnership-level, characteristics (aOR 1.29 95% CI 1.00-1.67).

Partnership characteristics were also associated with condom use at last sex. Condom use was more commonly reported for casual partnerships (aOR 1.57 95% CI 1.05-2.36). In analyses adjusted only for sex and village-pair, increasing partnership duration was also strongly associated with decreasing condom use at last sex. However, this factor was not retained in the model adjusting for all partnership characteristics. Condom use was more common in partnerships where sex was less frequent (aOR 1.34 95% CI 1.04-1.75). Age of the male partner, but not of the female partner or their age-difference, was approximately linearly associated with use of condoms (aOR per additional year of age 0.98 95% CI 0.96-1.00). Resource exchange patterns and perception of partner's risk of HIV infection were not associated with condom use. Individuals reporting that their partner did not have other sexual partners, however, were less likely to report condom use (aOR 0.72 95% CI 0.58-0.89).

When individual-level and partnership characteristics were included in the model together (Table 3, model 3) most odds ratio changed only slightly. There were three exceptions where individual-level characteristics were not retained in the model after adjustment for partnership variables. These comprised sex and age of the reporting

partner and the number of partners an individual reported for the previous year. The age of the male partner was retained and was more strongly associated with condom use (aOR per additional year of age 0.96 95% CI 0.95-0.98).

Risk factors for new HIV infection in the last three years

There were data available on all exposure and outcome variables for 762 individuals reporting a non-spousal partnership who had been HIV-negative at baseline. Of these 87 (11.4%) had become HIV-positive since 2001.

New HIV infections in the last three years were more frequent among women than men (aOR 2.51 95% CI 1.50-4.20; Table 4, model 2). New infections were also more common among individuals aged 26-30 years than other age groups. Students experienced significantly fewer infections than individuals out of school (aOR 0.53 95% CI 0.32-0.87), while those in the middle wealth group also experienced a lower risk of infection than other groups (aOR vs very poor 0.66 95% CI 0.41-1.05). None of the other measured individual characteristics were significantly associated with new HIV infection in the last three years.

Few partnership-level characteristics were associated with new HIV infection in the last three years. Only two factors were retained in the stepwise analysis when all partnership factors were included together. Individuals reporting only partnerships with a low frequency of sex were at lower risk of infection (aOR 0.44 95% CI 0.21-0.91). Women reporting greatest age of any male partner as 20-25 years experienced the lowest risk of infection (aOR compared to <19 years 0.30 95% CI 0.17-0.52).

When individual and partnership characteristics were included in the model together most odds ratios remained stable. However, the age of the reporting individual was no longer retained in the model although the age of the oldest male partner was included (aOR comparing 20-25 years with <19 years 0.33 95% CI 0.19-0.58).

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Discussion

Unprotected sex and new HIV infection in the last three years were common among a population of sexually-active young people in rural South Africa in 2004. While condom use within non-spousal sexual partnerships was associated with individual characteristics such as education, marital status and knowledge of HIV status, it was also associated with a number of partnership characteristics. Specifically, condom use was more common in relationships where sex was less frequent and with casual partners. Interestingly, the age of the male partner was more strongly associated with condom use than the age of the female – with younger men more likely to use condoms. New HIV infection in the last three years was most common among sexually-active young women, those not attending school and those living in households of medium wealth. Infections were least common where the age of the male partner(s) was relatively low (20-25 years) and where sex was relatively infrequent. Characteristics of sexual partnerships, as well as those of individuals, are important determinants of condom use and HIV transmission.

There were limitations to this analysis. Despite extensive efforts to limit reporting bias, sexual behaviour is likely to have been misreported, a common difficulty faced in studies of this kind (J. A. Catania et al., 1996; Gregson, Zhuwau, Ndlovu, & Nyamukapa, 2002). As elsewhere, using sexual partnerships as the unit of analysis posed additional sampling challenges (Morris, 2004). Our sampling frame was based on the characteristics of individuals rather than those of partnerships. Thus, sexual partnerships were reported by both men and women aged 14-35 years. However, these partnerships are unlikely to be representative of all partnerships involving individuals in this age group. In particular, while young women reported many sexual partnerships involving

men aged over 40 years of age, these data were not collected from men (since men over 40 years were not interviewed). Thus, these partnerships were under-represented in the grouped data used for risk analyses. Under-sampling was less likely for partnerships involving women who were older than the male partner or for partnerships involving women under 14 years since these were relatively rare. Since we did not identify individuals by name it is also likely that some relationships were reported by both partners and appeared twice in our data.

We did not collect detailed data on socio-demographic or HIV risk characteristics of all the sexual partners reported in our study. The degree of similarity in sociodemographic characteristics between sexual partners may be an important determinant of condom use patterns in African settings that warrants further study (Doherty, Padian, Marlow, & Aral, 2005; Konde-Lule, Sewankambo, & Morris, 1997; Morris, 1997). However, the data we collected on sexual partners (notably age) highlighted the difficulties in this. This information was often unknown and potentially reported inaccurately. More detailed data, for example on the educational or economic status of sexual partners, would have been additionally prone to such errors. Future studies of this type are essential but will need to develop methods to overcome these complexities.

These results re-enforce the importance of considering characteristics of sexual partnerships when documenting key influences on the uptake of condom use and risk of infection in more mature HIV epidemics. Previous research has pointed to the important role that age asymmetry plays in HIV transmission (Kelly et al., 2003; Luke, 2003). Our findings largely complement this body of work, although in our analyses the age of the male partner was more important than the age of the female partner or the age difference between partners in determining condom use and HIV risk. Age and economic

power imbalances between male and female sexual partners may mean that the wishes of the older, more powerful male partner prevail, and thus their characteristics are stronger determinants of HIV-related outcomes. This hypothesis should be further examined through the design and testing of interventions that support women to establish sexual relationships in which such imbalances are less pronounced, and thus enhance their capacity to make decisions about the timing and frequency of sex and condom use. Such interventions may be more likely to arise from the education, development or legal sectors than from the health sector alone (Blakenship, Bray, & Merson, 2000; Sumartojo, 2000; Sweat & Denison, 1995). Another interesting finding from this study was that individuals of the highest educational level were more likely to report condom use, while those in school were the least likely to be HIV-infected; this supports our conclusions from earlier studies (Hargreaves, Bonell et al., 2007; Hargreaves, Morison et al., 2007), as well as a wider body of literature identifying low education as increasingly associated with sexual risk taking and risk of HIV infection as epidemics mature (de Walque, Nakiyingi-Miir, Busingye, & Whitworth, 2005; Michelo, Sandoy, & Fylkesnes, 2006; Wojcicki, 2005).

Finally, our findings point to the increasing importance of established sexual partnerships in HIV transmission. Early in HIV epidemics the bulk of transmission occurred within casual partnerships, and HIV prevention campaigns to date may have been most successful in increasing condom use within such partnerships. In our study, partnerships where sex was less frequent and those perceived as casual saw higher levels of condom use. In turn, individuals reporting only these partnerships were less likely to become HIV-infected (although reported condom use in partnerships was not associated with recent HIV infection). As partnership duration and intercourse frequency increase, condom use may be dropped as trust develops between partners. However,

this dynamic means that established partnerships may become an increasingly important site of HIV transmission. Unless the decision to forego condom use is accompanied by HIV testing in both partners this trend may increase the risk of infection. Marital status has been found to be associated with HIV infection risk and condom use in other settings (Lewis et al., 2007; Maharaj & Cleland, 2004) and although not the focus of this paper it was noted that condom use was lowest in spousal partnerships in our setting (13.7% use of condoms at last sex). Our findings highlight the continued importance of campaigns that encourage voluntary counselling and testing and condom promotion, both for individuals and for couples in trust-relationships, in sub-Saharan African settings.

Tables

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Table 1: Characteristics of males and females reporting at least one non-spousal sexual partnership during the previous year in rural South Africa in 2004

		Males		Females		p (Chi ²)
N		678		878		
Age	<16 y	178	26.3%	210	23.9%	0.72
	20-25	292	43.1%	381	43.4%	
	26-30	119	17.6%	165	18.8%	
	30+	89	10.5%	122	11.1%	
Marital Status	Never	636	94.9%	798	91.6%	0.01
	Ever	34	5.1%	73	8.4%	
Education	Not attended secondary	86	12.7%	111	12.6%	0.38
	Attended Secondary	436	64.3%	590	67.2%	
	Completed secondary	156	23.0%	177	20.2%	
Employment status	Unemployed	140	21.8%	306	37.5%	<0.01
	Employed / Self employed	132	20.6%	91	11.2%	
	Student	369	57.6%	419	51.3%	
Household wealth	Very poor	206	30.5%	273	31.4%	0.92
	Poor, but a bit better off	378	55.9%	481	55.4%	
	Doing OK	92	13.6%	115	13.2%	
IMAGE trial village allocation	Control	337	49.7%	439	56.4%	0.91
	Intervention	341	50.3%	339	43.6%	
Knows HIV Status	Yes	73	10.8%	197	22.5%	<0.01
	No	605	89.2%	679	77.5%	
Perception of risk	Low	369	54.7%	421	48.6%	0.02
	High	305	45.3%	445	51.4%	
Total number of sexual partners during lifetime	[Median, (IQ Range)]	5 (3,10)		3 (2,4)		<0.01
Number of partners in the last year	One non-spousal only	408	60.2%	765	87.1%	<0.01
	More than one (including spouses)	270	39.8%	113	12.9%	
HIV seroconverted*		26/387	6.7%	82/501	16.4%	<0.01

There were missing data on a number of exposure variables: Males – marital status (8), employment status (37), household wealth (2), risk perception (4). Female – marital status (7), employment status (62), household wealth (9), knows HIV status (2), risk perception (12). * Measured only among individuals with a negative HIV test at baseline. Results from one interviewer were excluded.

Table 2: Characteristics of non-spousal sexual partnerships reported by males and females in rural South Africa, 2004

		Males		Females		p (Chi ²)
N		1000		988		
Partner type description	"Boyfriend / Girlfriend"	833	85.0%	929	96.3%	<0.01
	Casual	147	15.0%	36	3.7%	
Extramarital partnership	Both partners unmarried	930	93.4%	879	89.1%	<0.01
	Either partner married	66	6.6%	108	10.9%	
Duration of partnership	1 day	68	7.0%	13	1.3%	<0.01
	1 day – 1 year	329	33.6%	204	21.2%	
	1-3 years	183	18.7%	148	15.4%	
	> 3 years	398	23.9%	598	36.2%	
Frequency of sex in last year	5 or more times	716	71.6%	748	75.7%	0.04
	< 5 times	284	28.4%	240	24.3%	
Age of male partner	16-19	265	26.5%	67	7.2%	<0.01
	20-25	442	44.2%	357	38.5%	
	26-30	170	17.0%	219	23.6%	
	31-40	123	12.3%	201	21.7%	
	>40	0	0.0%	83	9.0%	
Age of female partner	<19	611	65.3%	255	25.8%	<0.01
	20-25	261	27.9%	421	42.6%	
	26-30	52	5.6%	178	18.0%	
	31-40	11	1.0%	134	11.9%	
Age difference	Similar or female older	397	42.5%	368	39.7%	0.23
	Male > 3 year older	538	57.5%	559	60.3%	
Resource exchange	No exchange / similar level	182	18.3%	64	6.5%	<0.01
	Net male-female flow	697	70.0%	810	82.2%	
	Net female-male flow	117	11.7%	112	11.4%	
Thinks partner has other partners	Yes	455	45.7%	466	47.2%	0.51
	No	541	54.3%	522	52.8%	
Partner's perceived risk of infection	No / Low	435	43.7%	420	42.5%	0.60
	Medium / High	561	56.3%	568	57.5%	
Condom use at last sex	No	567	58.2%	635	65.3%	<0.01
	Yes	407	41.8%	338	34.7%	

There were missing data on a number of exposure variables: Males – partnership type (20), extramarital partnership (4), duration (22), age of female partner (65), resource exchange (4), partner's partners (4), perceived partner risk (4), condom use (4). Females - partnership type (23), extramarital partnership (1), duration (25), age of male partner (61), resource exchange (2).

Table 3: The association between individual and partnership-level characteristics and condom use at last sex in non-spousal partnerships in rural South Africa (615/1647, 37.3%)

n		Condom use at last sex		Model 1	Model 2	Model 3
		n/N	%	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Individual Characteristics						
Sex	Male	346/848	40.8%	1	1	nr
	Female	269/799	33.7%	0.73 (0.59-0.91)	0.78 (0.61-0.99)	nr
Age	<16 y	175/450	38.4%	1	Linear term 0.96 (0.94-1.99) per year	nr
	20-25	283/722	39.2%	0.99 (0.76-1.31)		
	26-30	97/282	34.4%	0.80 (0.56-1.14)		
	30+	60/193	31.1%	0.71 (0.48-1.05)		
Marital Status	Never	582/1564	37.2%	1	1	1
	Ever	33/83	39.8%	1.25 (0.77-2.01)	1.59 (0.93-2.71)	1.64 (0.99-2.72)
Education	Not attended secondary	55/188	28.2%	1	1	1
	Attended Secondary	396/1092	36.3%	1.34 (0.91-1.95)	nr	nr
	Completed secondary	164/367	44.7%	1.97 (1.30-3.00)	1.64 (1.26-2.15)	1.59 (1.24-2.03)
Employment status	Unemployed	149/456	32.7%	1	nr	
	Employed / Self employed	94/256	36.7%	1.14 (0.79-1.63)	nr	
	Student	372/935	39.8%	1.32 (1.02-1.72)	nr	
Household wealth	Very poor	187/529	35.3%	1	nr	
	Poor, but a bit better off	342/889	38.5%	1.08 (0.83-1.39)	nr	
	Doing OK	86/229	37.6%	1.07 (0.75-1.53)	nr	
IMAGE trial village allocation	Control	304/862	35.3%	1	nr	
	Intervention	311/785	39.6%	1.12 (0.90-1.41)	nr	
Knows HIV Status	Yes	107/256	41.8%	1	1	1
	No	508/1391	36.5%	0.73 (0.54-1.00)	0.72 (0.53-0.99)	0.74 (0.55-0.98)
Perception of risk	Low	325/853	38.1%	1	nr	
	High	290/794	36.5%	0.98 (0.78-1.22)	nr	
Number of partners in last yr	One non-spousal only	338/991	34.1%	1	1	nr
	More than one	277/656	42.2%	1.35 (1.05-1.73)	1.29 (1.00-1.67)	nr
Partnership Characteristics						
Partner type description	"Boyfriend / Girlfriend"	545/1517	35.9%	1	1	1
	Casual	70/130	53.8%	2.00 (1.35-2.96)	1.57 (1.05-2.36)	1.58 (1.07-2.34)
Extramarital affair	Both partners unmarried	563/1524	36.9%	1	nr	
	Either partner married	52/123	42.3%	1.32 (0.89-1.97)	nr	
Duration of partnership	1 day	35/57	61.4%	1	nr	
	1 day – 1 year	173/425	40.7%	0.41 (0.23-0.74)	nr	
	1-3 years	113/287	39.4%	0.40 (0.22-0.73)	nr	
	> 3 years	294/878	33.5%	0.32 (0.18-0.58)	nr	
Frequency of sex in last year	5 or more times	429/1231	34.4%	1	1	1
	< 5 times	186/416	44.7%	1.60 (1.25-2.06)	1.34 (1.04-1.75)	1.32 (1.03-1.69)
Age of male partner	16-19	122/299	40.8%	1	Linear term 0.98 (0.96-1.00) per year	Linear term 0.96 (0.95-0.98) per year
	20-25	272/682	39.9%	1.03 (0.74-1.42)		
	26-30	117/334	35.0%	0.84 (0.57-1.23)		
	31-40	87/265	32.8%	0.80 (0.54-1.18)		
	>40	17/67	25.4%	0.57 (0.30-1.08)		
Age of female partner	<19	312/767	40.7%	1	nr	
	20-25	211/590	35.8%	0.85 (0.66-1.10)	nr	
	26-30	60/186	32.3%	0.77 (0.53-1.12)	nr	
	31-40	32/104	30.8%	0.72 (0.44-1.17)	nr	
Age difference	Similar or female older	255/681	37.4%	1	nr	
	Male > 3 year older	360/966	37.3%	1.08 (0.81-1.25)	nr	
Resource exchange	No exchange / similar level	123/302	40.7%	1	nr	
	Net female-male flow	41/90	45.6%	1.17 (0.72-1.92)	nr	
	Net male-female flow	451/1255	35.9%	0.89 (0.68-1.17)	nr	
Thinks partner has other partner	Yes	316/744	42.4%	1	1	1
	No	299/903	33.1%	0.68 (0.54-0.82)	0.72 (0.58-0.89)	0.72 (0.59-0.89)
Partner's risk of infection	No / Low	277/687	40.3%	1	nr	
	Medium / High	338/960	35.2%	0.80 (0.65-0.99)	nr	

Model 1 adjusted for sex and matched village-pair. Model 2 including all individual or partnership characteristics, adjusted for sex, village pair and terms retained in a backward stepwise regression procedure (removal threshold $p < 0.10$). Age

terms were included as linear terms. Model 3, as model 2 but including both partnership and individual-level characteristics retained in model 2. **nr** = not retained in stepwise model.

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Table 4: The association between individual and partnership-level characteristics and HIV seroconversion in rural South Africa (n=87/762, 11.4%)

		New HIV infection in the last three years		Model 1	Model 2	Model 3
n		n/N	%	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Individual Characteristics						
Sex	Male	23/346	6.7%	1	1	1
	Female	64/416	15.4%	2.43 (1.47-4.02)	2.51 (1.50-4.20)	2.37 (1.42-3.97)
Age	<16 y	20/246	8.1%	1	1	1
	20-25	35/344	10.2%	1.27 (0.71-2.28)	nr	nr
	26-30	25/101	24.8%	3.92 (2.04-7.57)	2.43 (1.34-4.41)	nr
	30+	7/71	9.9%	1.27 (0.51-3.18)	nr	0.34 (0.14-0.82)
Marital Status	Never	80/728	11.0%	1	nr	
	Ever	7/34	20.6%	1.94 (0.80-4.69)	nr	
Education	Not attended secondary	13/80	16.3%	1	nr	
	Attended Secondary	58/517	11.2%	0.60 (0.31-1.17)	nr	
	Completed secondary	16/165	9.7%	0.56 (0.25-1.24)	nr	
Employment status	Unemployed	33/180	18.3%	1	1	1
	Employed / Self employed	15/92	16.3%	1.08 (0.54-2.16)	nr	nr
	Student	39/490	8.0%	0.41 (0.25-0.68)	0.53 (0.32-0.87)	0.46 (0.28-0.77)
Household wealth	Very poor	30/228	13.2%	1	1	nr
	Poor, but a bit better off	41/412	10.0%	0.68 (0.41-1.13)	0.66 (0.41-1.05)	nr
	Doing OK	16/122	13.1%	1.01 (0.52-1.97)	X	nr
IMAGE trial village allocation	Control	45/392	11.5%	1	nr	
	Intervention	42/370	11.4%	1.02 (0.64-1.62)	nr	
Knows HIV Status	Yes	13/112	11.6%	1	nr	
	No	74/650	11.4%	1.19 (0.63-2.26)	nr	
Perception of risk	Low	39/408	9.6%	1	nr	
	High	48/354	13.6%	1.41 (0.90-2.23)	nr	
Number of partners in last yr	One non-spousal only	75/573	13.1%	1	nr	
	More than one	12/189	6.4%	0.62 (0.32-1.20)	nr	
Summary of partnership characteristics						
Partner type description	"Boyfriend / Girlfriend"	84/692	12.1%	1	nr	
	Any casual	3/70	4.3%	0.45 (0.13-1.52)	nr	
Extramarital affair	Both partners unmarried	79/713	11.1%	1	nr	
	Any partner married	8/49	11.6%	1.62 (0.72-3.65)	nr	
Shortest duration of partnership	1 day	3/40	7.5%	1	nr	
	1 day – 1 year	14/192	7.3%	0.82 (0.22-3.04)	nr	
	1-3 years	14/116	12.1%	1.19 (0.31-4.56)	nr	
	> 3 years	56/414	13.5%	1.22 (0.35-4.31)	nr	
Lowest frequency of sex in last year	5 or more times	77/614	12.5%	1	1	1
	< 5 times	10/148	6.8%	0.46 (0.23-0.92)	0.44 (0.21-0.91)	0.52 (0.26-1.07)
Highest age of any male partner	<19	14/152	9.2%	1	1	1
	20-25	18/328	5.5%	0.45 (0.21-0.96)	0.30 (0.17-0.52)	0.33 (0.19-0.58)
	26-30	33/151	21.9%	2.04 (0.99-4.19)	nr	nr
	31-40	15/112	13.4%	1.13 (0.50-2.57)	nr *	nr *
	>40	7/19	36.8%	3.41 (1.08-10.78)		
Highest age of any female partner	16-19	24/365	6.6%	1	nr	
	20-25	38/279	13.6%	1.82 (1.03-3.21)	nr	
	26-30	20/78	25.6%	4.00 (2.03-3.86)	nr *	
	31-40	5/40	12.5%	1.41 (0.49-4.05)		
Largest Age difference	Similar or female older	27/290	9.3%	1	nr	
	Male > 3 year older	60/472	12.7%	1.47 (0.90-2.38)	nr	
Resource exchange	No exchange / similar level	13/124	10.5%	1	nr	
	Net female-male flow	2/24	8.3%	0.90 (0.19-4.39)	nr	
	Any net male-female flow	72/614	11.7%	1.03 (0.55-1.95)	nr	
Any partner has other partners	Yes	45/360	12.5%	1	nr	
	No	42/402	10.5%	0.75 (0.48-1.19)	nr	
Any partner's highest	No / Low	31/244	12.7%	1	nr	

risk of infection	Medium / High	56/518	10.8%	0.95 (0.59-1.53)	nr
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Model 1 adjusted for sex and matched village-pair. Model 2 including all individual or partnership characteristics, adjusted for sex, village pair and terms retained in a backward stepwise regression procedure (removal threshold $p < 0.10$). Age terms were included as dummy terms with the two largest values to increase power. Model 3, as model 2 but including both partnership and individual-level characteristics retained in model 2. **nr** = not retained in stepwise model. * bottom two categories combined owing to small number of infection events.

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