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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 in the previous year and HIV infection in the previous three years 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. Data on 1647 non-spousal sexual partnerships during the previous year were reported in 2004 and analysed alongside new HIV infections over the previous three years among 762 individuals who were HIV-negative in 2001. Structured interviews elicited information on sexual behaviour. HIV serostatus was assessed through oral-fluid ELISA. 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 younger, 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. Infection risk was associated with the age of the partners and was less common among individuals reporting less frequent intercourse in the previous year. Characteristics of sexual partnerships, as well as those of individuals, are important determinants of condom use and risk of HIV infection. Male characteristics may be particularly important because of their greater capacity to make decisions about HIV prevention. Established non-spousal sexual partnerships are an increasingly important context for HIV transmission in this setting.

Introduction

High HIV incidence in sub-Saharan Africa is maintained primarily through unprotected heterosexual intercourse (UNAIDS, 2006). Condom use can prevent HIV transmission but remains low. Individual attributes associated with condom use and risk of HIV infection include education (Fylkesnes et al., 1997; Greig & Koopman, 2003; Grosskurth et al., 1995; Kilian et al., 1999; Smith et al., 1999), marital status (Dunkle et al., 2008; Glynn, Carael, Buve, Musonda, & Kahindo, 2003), mobility (Morris, Wawer, Makumbi, Zavisca, & Sewankambo, 2000) and attitudes and behavioural self-efficacy (J. Catania, Kegeles, & Coates, 1990; Fishbein, 2000; Flisher, Reddy, Muller, & Lombard, 2003; Norman, 2003). Since condom use is likely determined by sexual partners in negotiation, characteristics of sexual partnerships, as well as those of the individuals involved, might influence this.

Age-mixing in sexual partnerships influences HIV transmission (Anderson, May, Boily, Garnett, & Rowley, 1991; Gregson, Nyamukapa et al., 2002; Kelly et al., 2003; Luke, 2003). Age-asymmetry between older males and younger females may be partly attributed to socioeconomic and power inequalities between the sexes (Luke, 2003). Where unequal power dynamics exist these might influence sexual negotiation and condom use, for example because men's wishes may prevail (MacPhail & Campbell, 2001), because women have lower self-efficacy to suggest condom use (Coleman & Ingham, 1999; Meekers & Klein, 2002), or because resource exchange influences condom use decisions (C.E. Kaufman & Stavrou, 2002). Condom use may be reduced as trust develops over time (C. E. Kaufman, Clark, Manzini, & May, 2004). In Tanzania in 1995-97 and Nigeria in 1998 condom use was lowest within spousal and steady partnerships and most common in unsteady, occasional or commercial partnerships (Norman, 2003; Van Rossem, Meekers, & Akinyemi, 2001). We assessed whether

characteristics of non-spousal sexual partnerships were associated with condom use at last sex among young people in rural South Africa, where marriage occurs relatively late, and also with HIV acquisition during the previous three years.

Methods

Study Design

We report a secondary analysis of data from the Intervention with Microfinance for AIDS and Gender Equity study (IMAGE), a cluster-randomised-trial of a community-based microfinance and health intervention conducted in eight purposively selected and pair-matched villages in rural South Africa (Hargreaves, Bonell et al., 2007; Kim et al., 2007; Pronyk et al., 2006).

For the trial we first interviewed 14-35 year old residents of 1640 randomly selected households during 2001. From 2001-2004 these individuals had little contact with the intervention (Pronyk et al., 2006). All were eligible for follow-up interview in 2004. Here we present data collected from individuals who reported at least one non-spousal partner in the previous year at the follow-up interview. In a previous publication we have reported participation rates (Hargreaves, Bonell et al., 2007). Married and unmarried individuals were included although only non-spousal partnerships - where the partners were not married to each other - were considered. The definition of marital status included local marriage traditions such as the payment of *lobola* (bride-price) and cohabiting partnerships.

Data collection and study variables

Data were collected in structured interviews conducted in the local language (*Sepedi*) in 2004, except on household wealth which came from participatory wealth ranking conducted in 2001 (Hargreaves, Morison et al., 2007). Two outcome variables were considered. The first was condom use at last sexual intercourse. This information was collected for each of up to three partnerships during the previous year reported by each respondent. The second outcome variable was HIV status at follow-up determined through analysis of oral-fluid sample collected using the OraSure collection device (UCB group, Belgium) and analysed with the Vironostika HIV Uni-Form II assay (bioMerieux, France). We restricted this analysis to individuals who had tested HIV-negative at baseline: thus identifying individuals who had sero-converted during the previous three years. Thus, while sexual behaviour data related to the past year, HIV infections had occurred at any point during the previous three years.

Twenty explanatory variables were considered representing characteristics of both individuals (10 variables) and partners / partnerships (10 variables) (see Table 1). Respondents described partnerships as with a “boy/girlfriend” (we considered these 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 included the marital status of the partner, time since first sex, frequency of sex during the last year, age of both partners and the difference between these, exchange of resources within the partnership and perception of the partner’s risk behaviour and risk of HIV infection.

Data analysis

Analysis was conducted using Stata (version 10, Stata CORP). We constructed two datasets: the first (*“the partnerships dataset”*) contained details of all non-spousal sexual

partnerships reported for the previous year such that each individual could contribute data on up to three partnerships. The second dataset (*“the individual dataset”*) contained individual-level data for which we constructed summaries of partnership characteristics: for example, for a given individual, the *largest* age difference among all partnerships (see Table 1).

We first conducted descriptive analysis on the explanatory and outcome variables using Chi² tests to explore differences between males and females.

Following this we analysed the partnerships dataset. We used logistic regression to identify explanatory variables associated with condom use at last sex within each partnership. First, separate regression models were constructed for each of the 10 individual and 10 partnership-level characteristics (model 1). In these analyses we adjusted for the sex of the reporting individual and the matched village-pair from the IMAGE trial design in order to account for underlying geographic variation. Following this, models were fitted separately for all individual and all partnership-level characteristics with factors included in the model on the basis of a backward-stepwise procedure retaining factors associated with the outcome at a level of $p < 0.10$ (model 2). Finally, a model was fitted adjusting for individual and partnership-level characteristics together (model 3). Confidence intervals were adjusted to reflect the fact that individuals could report more than one partnership by calculating robust standard errors specifying individuals as the clustering factor in Stata.

Finally we analysed the individual dataset to identify factors associated with new HIV infection within the previous three years. A parallel analysis strategy to that for condom use was adopted resulting in three sets of results from regression models.

Results

Among 3881 eligible individuals enumerated at baseline, 2325 (59.9%) were interviewed at follow-up in 2004 . Of these, 153 (16.6%) had never been sexually active, while 190 (8.2%) reported no sexual activity during the previous year. A further 107 males (4.6%) and 293 females (12.6%) reported sexual activity only with a spousal partner. Some 26 individuals (1.1%) had all key data missing. Thus, the analysis focused on 678 males and 878 females reporting at least one non-spousal partnership during the previous year. The average time-period between baseline and follow-up was 3.1 years (inter-quartile range 3.1-3.2 years).

All individuals were 16 years or over by follow-up. The majority were unmarried, had attended secondary school and were currently still students (Table 2). More females than males reported being aware of their HIV-status (22.5% vs 10.8%, $p<0.01$). Males reported more sexual partners during their lifetime than females. However, more females reported that they perceived themselves to be at medium or high risk of infection (51.4% vs 45.3%, $p=0.02$). Females were more likely than males to have been newly HIV-infected in the past three years (16.4% vs 6.7%, $p<0.01$).

The 678 males reported 1051 non-spousal partnerships during the previous year, while 878 females reported 994 partnerships. Nineteen males (2.8%) and two females (0.2%) reported more than three partners but data on only the most recent three were collected. Consequently, data were available on 1000 partnerships reported by males (95.1%) and 988 partnerships (99.4%) reported by females (Table 3). Most males (64.9%) and females (89.0%) contributed data on a single partnership. Males reported more casual partnerships than females (15.0% vs 3.7%, $p<0.01$). More females reported partnerships

in which either partner was married (10.9% vs 6.6%, $p < 0.01$), although the male was more likely to be the married partner. More males reported partnerships of only one day's length (7.0% vs 1.3%, $p < 0.01$) and those where the cumulative frequency of sex in the last year was less than five times (28.4% vs 24.3%, $p = 0.04$). Males were generally older than female partners and net resource-flow was usually from male to female, although males more often reported no net-exchange of resources than females (21.6% vs 15.4%, $p < 0.01$). Males more frequently reported condom use at last sex than females (41.8% vs 34.7%, $p < 0.01$). Among 335 individuals providing data on more than one non-spousal partner (238 reported two partners, 97 three partners) a condom was not used at last sex in any partnership by 134 individuals (40.0%), was used in all partnerships by 91 (27.2%), while 110 individuals (32.8%) reported condom use at last sex with some but not all partners.

Risk factors for condom use at last sex (Table 4)

Risk factor analysis focused only on the 1647/1988 (82.8%) partnerships with data available for all individual and partnership characteristics. In analyses adjusted only for sex and village-pair (model 1) there was little evidence for an association between many factors and condom use at last sex. However, currently married individuals were most likely to report condom use though this was not statistically significant (odds ratio, OR, compared to never married 1.62 95% CI 0.83-3.15). Condom use was less commonly reported by females than males (OR 0.73 95% CI 0.59-0.91) and decreased linearly with increasing age of the respondent (OR per year of age 0.98 95% CI 0.96-1.00). Students were most likely to report condom use (OR compared to unemployed 1.97 95% CI 1.30-3.00). Individuals who were not aware of their HIV status reported less condom use (OR 0.73 95% CI 0.54-1.00), while those reporting more sexual partners reported more

condom use (OR 1.35 95% CI 1.05-1.73). Condom use was more common in casual partnerships compared to partnerships with a “boy/girlfriend” (OR 2.00 95% CI 1.35-2.96) and for partnerships where sex was less frequent (OR 1.60 95% CI 1.25-2.06), and decreased with time since first sex (OR comparing partnerships of >3 years with those of 1 day, 0.32 95% CI 0.18-0.58). Condom use also decreased approximately linearly with the age of the male partner (OR per year of age 0.98 95% CI 0.96-1.00) and of the female partner (OR per year of age 0.98 95% CI 0.96-1.00).

After adjustment for individual-level factors (model 2), employment status was no longer associated with condom use perhaps because of its close association with age. Among partnership-level factors, time since first sex, age of the female partner and perception of partners risk of infection were also no longer associated with condom use after adjustment. There were few changes to odds ratios in the final model (model 3) suggesting that individual and partnership characteristics were independently associated with condom use. One exception was that age of the reporting individual was no longer associated with condom use at last sex, though age of the male partner remained borderline associated (OR per year of age 0.97 95% CI 0.94-1.01).

Risk factors for new HIV infection in the last three years (Table 5)

Data were available on 762 individuals who were HIV-negative at baseline and reported a non-spousal partnership in 2004. Of these 87 (11.4%) had become HIV-positive since baseline. Adjusting for sex and village-pair, new HIV infections in the last three years were more frequent among women than men (OR 2.43 95% CI 1.47-4.02) and among individuals aged 26-30 years (OR compared to those under 19 years 3.92 95% CI 2.04-7.57). Students experienced the fewest infections (OR compared to unemployed 0.41

95% CI 0.25-0.68). No other individual characteristics were significantly associated with HIV infection. Most partnership-level characteristics were not associated with HIV infection, including condom use at last sex (OR 0.82 96% CI 0.50-1.33). However, individuals reporting only sexual partnerships with a low frequency of sex during the last year had experienced fewer infections during the previous three years (OR 0.46 95% CI 0.23-0.92). The highest age of the partners was also associated with risk of infection, though the patterns of association were non-linear.

Sex, age and employment status were associated with recent HIV infection after adjustment for individual-level characteristics with similar odds ratios (model 2). Among partnership characteristics, frequency of sex and the ages of the partners were still significant after adjustment although the odds ratios for age parameters varied. In the fully-adjusted model (model 3) these patterns were largely replicated though confidence intervals were wider because there were few outcomes in some groups and correlation between the age parameters.

Discussion

Unprotected sex with a non-spousal partner during the previous year and new HIV infection during the previous three years were common among sexually-active young people interviewed in rural South Africa during 2004. Condom use was more common in casual relationships and where sex had been less frequent. Interestingly, the age of the male partner was more strongly associated with condom use than the age of the female after adjustment, with younger men more likely to use condoms. New HIV infections in the previous three years were also least common among individuals who reported non-spousal partnerships during the previous year where sex was relatively infrequent.

There were limitations to this analysis. Despite efforts to limit reporting bias, sexual behaviours were likely misreported in some cases (J. A. Catania et al., 1996; Gregson, Zhuwau, Ndlovu, & Nyamukapa, 2002). Further, data were collected over different recall periods with sexual behaviour data relating to the previous year, while HIV infections might have occurred during the previous three years. Consequently, associations between these variables must be interpreted cautiously. The study was conducted in eight selected villages limiting the generalisability of the findings, and some individuals who were eligible to participate could not be included in the final analysis (Hargreaves, Bonell et al., 2007). Using sexual partnerships as the unit of analysis posed sampling challenges (Morris, 2004). Our sampling frame was based on the characteristics of individuals rather than of partnerships. Consequently, while young women reported many sexual partnerships involving men over 40 years, men could not report these since the oldest males interviewed were only 38 years old in 2004. Thus, these partnerships were under-represented. Under-sampling was less likely for partnerships involving women who were older than their male partner since these were relatively rare. Since we did not identify individuals by name it is also possible that some partnerships were reported by both partners and appeared twice in our data. It is difficult to predict the impact of these complex limitations on the estimates of effect we provide here.

We collected some data on characteristics of sexual partners. The degree of similarity in socio-demographic characteristics between sexual partners may be a determinant of condom use warranting further study (Doherty, Padian, Marlow, & Aral, 2005; Konde-Lule, Sewankambo, & Morris, 1997; Morris, 1997). However, our experience highlighted difficulties in studying this phenomenon. Partner information was often unknown and potentially reported inaccurately for relatively simple data such as age. Future studies

need to overcome these problems, perhaps by nesting studies within more completely enumerated population data so that socio-demographic data are reported by the partners themselves, or tracing network partners. However, ethical and logistical issues are complex.

Despite these limitations we describe characteristics of non-spousal sexual partnerships in eight South African villages in 2004. As expected, partnerships predominantly involved age imbalance between males and females, with males four years older than females on average. We noted other gender-based imbalances: for example, where a partner was married to someone else this was more likely to be the male, suggesting higher levels of extramarital partnership among men. Most partnerships saw a net-flow of resources from male-to-female. Females were most likely to report this dynamic, perhaps because of their greater perception of resource flows or because they reported partnerships with older males who may be most likely to provide resources.

We highlight the association between characteristics of sexual partnerships and condom use. Previous research has pointed to the important role that age asymmetry plays in HIV transmission, independent of condom use within partnerships (Kelly et al., 2003; Luke, 2003). Our findings suggest that age dynamics might also influence condom use within partnerships. The age of the male partner was more strongly associated with condom use than the age of the female partner or the age difference between partners. Age and/or economic power imbalances between male and female sexual partners may mean that the wishes of the older, more powerful male partner prevail (MacPhail & Campbell, 2001), and thus their characteristics may be stronger determinants of partnership behaviours.

Finally, condom use was reported most often for casual, shorter partnerships and those where sex had been less frequent. Although conclusions must be made tentatively because of the differences in recall periods involved, it was interesting that HIV infection in the past three years was also associated with frequency of sex with partners in the last year. As in other settings (Dunkle et al., 2008; Lewis et al., 2007; Maharaj & Cleland, 2004), condom use was much lower in spousal partnerships (13.7%, data not shown) than non-spousal ones (38.7%), though relatively few young people were married. As partnership duration and intercourse frequency increase condom use may be dropped. This might occur as trust develops between partners, as females become increasingly economically dependent on male partners or as a desire for pregnancy increases. HIV prevention campaigns may have increased condom use within casual partnerships and those perceived as “risky”, but established non-spousal partnerships may be an increasingly important context for HIV transmission in South Africa. The importance of spousal partnerships in HIV transmission in settings where marriage occurs at a younger age has also been reported (Dunkle et al., 2008). In high HIV prevalence settings the decision to forego condom use should be accompanied by HIV-testing, sharing of results between partners, discussion of the implications, and take-up of appropriate behavioural strategies by both partners. Consequently, our findings highlight the importance of voluntary counselling and testing and condom promotion for both individuals and couples, including unmarried couples, in South Africa.

Tables

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Table 1: Outcome and explanatory variables at the individual and sexual partnership-level included in the analysis

Individual-level characteristics		
<i>Variable</i>	<i>Categories used in the analysis</i>	
HIV seroconverted	Yes, No [among HIV-negatives at baseline]	
Sex	Male, Female	
Age (years)	<19, 20-25, 26-30, 31-40, >40	
Marital Status at follow-up	Never, Currently, Previously	
Education	Not attended secondary, Attended secondary, Completed secondary	
Employment status	Unemployed, Employed & Self employed, Student	
Household wealth*	“Very poor”, “Poor, but a bit better off”, “Doing OK”	
IMAGE trial village allocation	Control, Intervention	
Knows HIV Status	Yes, No	
Perception of own risk [†]	No or Low, Medium or High	
Number of sexual partners in last year	One, More than one	
Sexual partnership-level characteristics		
<i>Variable</i>	<i>Categories used in the analysis</i>	<i>Individual-level summary Variable</i>
Condom use at last sex	Yes, No	Condom use at last sex in <i>all partnerships</i>
Partner type description	Boyfriend or Girlfriend, Other (more casual)	<i>Most casual</i> partnership type
Partnership marital status	Both partners unmarried, Extramarital partnership	<i>Any</i> partnership an extramarital affair
Time since first sex with this partner	1 day, 1 day – 1 year, 1-3 years, >3 years	<i>Shortest</i> time since first sex
Frequency of sex in last year	5 or more times, < 5 times	<i>Lowest</i> frequency of sex in last year
Age of male partner (years)	<19, 20-25, 26-30, 31-40, >40	<i>Highest</i> age of any male partner
Age of female partner (years)	<19, 20-25, 26-30, 31-40, >40	<i>Highest</i> age of any female partner
Age difference	Similar or female older, Male >3 years older	<i>Largest</i> age difference with any partner
Resource exchange [^]	No exchange or similar level, Net male-female flow, Net female-male flow	<i>Most male-favouring</i> resource exchange balance of any partnership
Thinks partner has other partner	Yes, No	<i>Any</i> partner has other partners
Perception of partner’s risk of infection §	Not at risk, At risk	<i>Highest</i> perceived risk of any partner

* Data from participatory wealth ranking.

[†] Question wording: “If you were to consider your risk of HIV now would you consider yourself at high, medium, low or no risk at all of HIV/AIDS?”

[^] Composite response on the basis of answers to two questions: “Do you sometimes provide financial support to this person (Yes or No)?”, “Do you regularly receive financial support from this person (Yes or No)?”

§ Question wording: “In your opinion is this person at risk of HIV infection (Yes or No)?”

Table 2: Characteristics of 678 males and 878 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 (years) at follow-up	<19	178	26.2%	210	23.9%	0.72
	20-25	292	43.1%	381	43.4%	
	26-30	119	17.6%	165	18.8%	
	31-40	89	13.1%	122	13.9%	
	>40	0	0%	0	0%	
Marital Status at follow-up	Never	638	94.1%	819	93.3%	0.01
	Currently	34	5.0%	15	1.7%	
	Previously	6	0.9%	44	5.0%	
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	50.0%	0.91
	Intervention	341	50.3%	439	50.0%	
Knows HIV Status	Yes	73	10.8%	197	22.5%	<0.01
	No	605	89.2%	679	77.5%	
Perception of risk	No or Low	369	54.7%	421	48.6%	0.02
	Medium or 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 owing to incompleting items on the questionnaires: Males - employment status (37), household wealth (2), risk perception (4). Female - employment status (62), household wealth (9), knows HIV status (2), risk perception (12). * Measured only among individuals with a negative HIV test at baseline: 61 results from one interviewer (5.1% of the total) were excluded owing to concerns about data validity (Hargreaves, Bonell et al., 2007).

Table 3: Characteristics of non-spousal sexual partnerships reported by males (n=1000) and females (n=988) in rural South Africa, 2004

		Males		Females		p (Chi ²)
N		1000		988		
Partner-type	"Boyfriend / Girlfriend"	833	85.0%	929	96.3%	
	Casual	147	15.0%	36	3.7%	<0.01
Extramarital partnership	Both partners unmarried	930	93.4%	879	89.1%	
	Either partner married	66	6.6%	108	10.9%	<0.01
Time since first sex with this partner	1 day	68	7.0%	13	1.3%	
	1 day – 1 year	329	33.6%	204	21.2%	
	1-3 years	183	18.7%	148	15.4%	
	> 3 years	398	40.7%	598	62.1%	<0.01
Frequency of sex in last year	5 or more times	716	71.6%	748	75.7%	
	< 5 times	284	28.4%	240	24.3%	0.04
Age of male partner (years)	<19	265	26.5%	67	7.2%	
	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%	<0.01
Age of female partner (years)	<19	611	65.3%	255	25.8%	
	20-25	261	27.9%	421	42.6%	
	26-30	52	5.6%	178	18.0%	
	31-40	9	1.0%	134	13.6%	<0.01
	>40	2	0.2%	0	0.0%	<0.01
Age difference	Median years male older (IQ range)	3.5 (2.1, 5.8)		4.0 (1.9, 6.6)		
	Similar or female older	397	42.5%	368	39.7%	
	Male > 3 years older	538	57.5%	559	60.3%	0.23
Resource exchange	No exchange / similar level	215	21.6%	152	15.4%	
	Net female-male flow	86	8.4%	24	2.4%	
	Net male-female flow	697	70.0%	810	82.2%	<0.01
Thinks partner has other partners	Yes	455	45.7%	466	47.2%	
	No	541	54.3%	522	52.8%	0.51
Perception of partner's risk of infection	At risk	435	43.7%	420	42.5%	
	Not at risk	561	56.3%	568	57.5%	0.60
Condom use at last sex	No	567	58.2%	635	65.3%	
	Yes	407	41.8%	338	34.7%	<0.01

There were missing data on a number of exposure variables owing to incompleting items on the questionnaires: 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 4: The association between individual and partnership-level characteristics and condom use at last sex in 1647 non-spousal partnerships reported by males and females in rural South Africa (615/1647, 37.3%)

n		Condom use at last sex		Model 1	Model 2	Model 3
		n/N	%	OR (95% CI)	OR (95% CI)	OR (95% CI)
Individual Characteristics						
Sex	Male	346/848	40.8%	1	1	1
	Female	269/799	33.7%	0.73 (0.59-0.91)	0.79 (0.62-1.01)	0.88 (0.65-1.18)
Age at follow-up (years)	<19	175/450	38.4%	Linear term 0.98 (0.96-1.00) per year	Linear term 0.97 (0.95-0.99) per year	Linear term 1.00 (0.96-1.05) per year
	20-25	283/722	39.2%			
	26-30	97/282	34.4%			
	31-40	60/193	31.1%			
	>40	0/0	0.0%			
Marital Status at follow-up	Never	581/1564	37.2%	1	nr	
	Currently	23/47	48.9%	1.62 (0.83-3.15)		
	Previously	11/36	30.6%	0.86 (0.41-1.79)		
Education	Not attended secondary	55/188	28.2%	1	1	1
	Attended Secondary	396/1092	36.3%	1.34 (0.91-1.95)	1.26 (0.86-1.86)	1.26 (0.85-1.89)
	Completed secondary	164/367	44.7%	1.97 (1.30-3.00)	1.97 (1.28-3.03)	1.92 (1.23-2.99)
Employment status	Unemployed	149/456	32.7%	1	nr	
	Employed / Self employed	94/256	36.7%	1.14 (0.79-1.63)		
	Student	372/935	39.8%	1.32 (1.02-1.72)		
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)		
	Doing OK	86/229	37.6%	1.07 (0.75-1.53)		
IMAGE trial village allocation	Control	304/862	35.3%	1	nr	
	Intervention	311/785	39.6%	1.12 (0.90-1.41)		
Knows HIV Status	Yes	107/256	41.8%	1	1	1
	No	508/1391	36.5%	0.73 (0.54-1.00)	0.73 (0.53-1.00)	0.73 (0.54-1.00)
Perception of risk	No or Low	325/853	38.1%	1	nr	
	Medium or High	290/794	36.5%	0.98 (0.78-1.22)		
Number of partners in last yr	One non-spousal only	338/991	34.1%	1	1	1
	More than one	277/656	42.2%	1.35 (1.05-1.73)	1.33 (1.03-1.71)	1.10 (0.84-1.45)
Partnership Characteristics						
Partner type	"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)	1.47 (0.97-2.24)
Extramarital partnership	Both partners unmarried	563/1524	36.9%	1	nr	
	Either partner married	52/123	42.3%	1.32 (0.89-1.97)		
Time since first sex with this partner	1 day	35/57	61.4%	1	nr	
	1 day – 1 year	173/425	40.7%	0.41 (0.23-0.74)		
	1-3 years	113/287	39.4%	0.40 (0.22-0.73)		
	> 3 years	294/878	33.5%	0.32 (0.18-0.58)		
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)	1.34 (1.03-1.74)
Age of male partner (years)	<19	122/299	40.8%	Linear term 0.98 (0.96-1.00) per year	Linear term 0.98 (0.96-1.00) per year	Linear term 0.97 (0.94-1.01) per year
	20-25	272/682	39.9%			
	26-30	117/334	35.0%			
	31-40	87/265	32.8%			
	>40	17/67	25.4%			
Age of female partner (years)	<19	312/767	40.7%	Linear term 0.98 (0.96-1.00) per year	nr	
	20-25	211/590	35.8%			
	26-30	60/186	32.3%			
	31-40	32/104	30.8%			
	>40	0/0	0/0%			
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)		
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)		
	Net male-female flow	451/1255	35.9%	0.89 (0.68-1.17)		
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 (0.58-0.90)
Perception of partner's risk of infection	At risk	277/687	40.3%	1	nr	
	Not at risk	338/960	35.2%	0.80 (0.65-0.99)		

nr= not retained in adjusted model. Model 1 adjusted for sex and matched village-pair. Model 2 was adjusted for sex, village-pair and individual OR partnership level factors retained in a backward stepwise model-fitting procedure. At the individual level these factors were age, education, knowledge of HIV status and number of partners in the last year. At the partnership level these factors were partner-type, frequency of sex in last year, age of the male partner, age of the female partner and perception of whether the partner has other sexual partners. Age terms were included as linear terms. Model 3 was adjusted for sex, village-pair and both individual AND partnership-level factors from model 2. Confidence intervals were computed on the basis of robust standard errors accounting for reporting of multiple partnerships by the same individual.

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Table 5: The association between individual and partnership-level characteristics and HIV seroconversion among 762 individuals 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	%	OR (95% CI)	OR (95% CI)	OR (95% CI)
Individual Characteristics						
Sex	Male	23/346	6.7%	1	1	1
	Female	64/416	15.4%	2.43 (1.47-4.02)	2.59 (1.53-4.40)	2.46 (1.15-5.27)
Age at follow-up	<19	20/246	8.1%	1	1	1
	20-25	35/344	10.2%	1.27 (0.71-2.28)	1.00 (0.53-1.88)	0.99 (0.24-4.05)
	26-30	25/101	24.8%	3.92 (2.04-7.57)	2.13 (0.93-4.94)	1.15 (0.18-7.41)
	31-40	7/71	9.9%	1.27 (0.51-3.18)	0.59 (0.19-1.81)	0.04 (0.04-6.59)
	>40	0/0	0.0%	-	-	-
Marital Status at follow-up	Never	80/728	11.0%	1		
	Currently	7/34	20.6%	1.94 (0.80-4.69)	nr	
	Previously					
Education	Not attended secondary	13/80	16.3%	1		
	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)		
Employment status	Unemployed	33/180	18.3%	1	1	1
	Employed / Self employed	15/92	16.3%	1.08 (0.54-2.16)	1.31 (0.62-2.27)	1.46 (0.66-3.22)
	Student	39/490	8.0%	0.41 (0.25-0.68)	0.50 (0.25-0.95)	0.59 (0.30-1.16)
Household wealth	Very poor	30/228	13.2%	1	1	1
	Poor, but a bit better off	41/412	10.0%	0.68 (0.41-1.13)	0.70 (0.41-1.18)	0.66 (0.38-1.14)
	Doing OK	16/122	13.1%	1.01 (0.52-1.97)	1.15 (0.58-2.26)	1.08 (0.54-2.17)
IMAGE trial village allocation	Control	45/392	11.5%	1		
	Intervention	42/370	11.4%	1.02 (0.64-1.62)	nr	
Knows HIV Status	Yes	13/112	11.6%	1		
	No	74/650	11.4%	1.19 (0.63-2.26)	nr	
Perception of risk	No or Low	39/408	9.6%	1		
	Medium or 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		
	More than one	12/189	6.4%	0.62 (0.32-1.20)	nr	
Summary of partnership characteristics						
<i>Most casual</i> partnership type	"Boyfriend / Girlfriend"	84/692	12.1%	1		
	Any casual	3/70	4.3%	0.45 (0.13-1.52)	nr	
Any partnership an extramarital affair	All partners unmarried	79/713	11.1%	1		
	Any partner married	8/49	11.6%	1.62 (0.72-3.65)	nr	
<i>Shortest</i> time since first sex with this partner	1 day	3/40	7.5%	1		
	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)		
	> 3 years	56/414	13.5%	1.22 (0.35-4.31)		
<i>Lowest</i> 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)	0.47 (0.22-0.99)	0.48 (0.23-1.03)
<i>Highest</i> age of any male partner (years)	<19	14/152	9.2%	1	1	1
	20-25	18/328	5.5%	0.45 (0.21-0.96)	0.33 (0.14-0.78)	0.30 (0.11-0.85)
	26-30	33/151	21.9%	2.04 (0.99-4.19)	1.12 (0.44-2.85)	0.86 (0.27-2.78)
	31-40	15/112	13.4%	1.13 (0.50-2.57)	0.67 (0.22-2.00)	0.51 (0.13-2.07)
	>40	7/19	36.8%	3.41 (1.08-10.78)	8.45 (1.19-60.02)	6.61 (0.78-56.17)
<i>Highest</i> age of any female partner (years)	16-19	24/365	6.6%	1	1	1
	20-25	38/279	13.6%	1.82 (1.03-3.21)	1.62 (0.77-3.39)	1.44 (0.43-4.88)
	26-30	20/78	25.6%	4.00 (2.03-3.86)	2.69 (1.04-6.92)	1.85 (0.36-9.45)
	31-40	5/40	12.5%	1.41 (0.49-4.05)	0.24 (0.04-1.66)	0.28 (0.02-4.48)
<i>Largest</i> Age difference	Similar or female older	27/290	9.3%	1		
	Male > 3 year older	60/472	12.7%	1.47 (0.90-2.38)	nr	
<i>Most male-favouring</i> resource exchange balance of any partnership	No exchange / similar level	13/124	10.5%	1		
	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)		
Any partner has other partners	Yes	45/360	12.5%	1		
	No	42/402	10.5%	0.75 (0.48-1.19)	nr	

<i>Highest perceived risk of any partner</i>	At risk	31/244	12.7%	1	nr	
	Not at risk	56/518	10.8%	0.95 (0.59-1.53)		
<i>Condom use at last sex in all partnerships</i>	Yes	57/396	12.6%	1	nr	
	No	29/272	9.6%	0.82 (0.50-1.33)		

nr= not retained in adjusted model. Model 1 adjusted for sex and matched village-pair. Model 2 was adjusted for sex, village-pair and individual OR partnership level factors retained in a backward stepwise model-fitting procedure. At the individual level these factors were age, employment status and household wealth. At the partnership level these factors were frequency of sex in last and age of the male and female partners. Model 3 was adjusted for sex, village-pair and both individual AND partnership-level characteristics from model 2.

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