Published in final edited form as:

AIDS. 2009 January 14; 23(2): 243–252. doi:10.1097/QAD.0b013e32831fb51a.

HIV risk reduction behaviours in gay men:

Unprotected anal intercourse, risk reduction behaviours, and subsequent HIV infection in a cohort of homosexual men

Fengyi Jin^a, June Crawford^b, Garrett P. Prestage^a, Iryna Zablotska^b, John Imrie^b, Susan C. Kippax^b, John M. Kaldor^a, and Andrew E. Grulich^a

^aNational Centre in HIV Epidemiology and Clinical Research

^bNational Centre in HIV Social Research, University of New South Wales, New South Wales, Australia

Abstract

Objective—A range of risk reduction behaviours in which homosexual men practise unprotected anal intercourse (UAI) has been described. We aimed to assess the extent of any reduction in HIV risk associated with these behaviours.

Design—A prospective cohort study of HIV-negative homosexual men in Sydney, Australia.

Methods—Men were followed up with 6-monthly detailed behavioural interviews and annual testing for HIV. The four risk reduction behaviours (behaviourally defined) examined were serosorting, negotiated safety, strategic positioning, and withdrawal during receptive UAI (UAI-R).

Results—In 88% of follow-up periods in which UAI was reported, it occurred in the context of consistent risk reduction behaviours. Compared with those who reported no UAI, the risk of HIV infection was not raised in negotiated safety [hazard ratio = 1.67, 95% confidence interval (CI) 0.59–4.76] and strategic positioning (hazard ratio = 1.54, 95% CI 0.45–5.26). Serosorting outside negotiated safety was associated with an intermediate rate of HIV infection (hazard ratio = 3.11, 95% CI 1.09–8.88). Withdrawal was associated with a higher risk than no UAI (hazard ratio = 5.00, 95% CI 1.94–12.92). Patterns of UAI differed greatly according to partner's serostatus. Men who reported serosorting were less likely to report either strategic positioning or withdrawal.

Conclusion—Each behaviour examined was associated with an intermediate HIV incidence between the lowest and highest risk sexual behaviours. The inverse association between individual behaviours suggests that men who practise serosorting rely on this protection. The high prevalence of these behaviours demands that researchers address the contexts and risks associated with specific types of UAI.

Keywords

Australia; cohort study; HIV; homosexuality; male; risk factor; risk reduction

Introduction

Soon after the onset of the HIV epidemic in homosexually active men, unprotected anal intercourse (UAI) was identified as the main mode of HIV acquisition [1–3]. In response, gay

communities in developed countries embraced the concept of 'safe sex', and there were dramatic reductions in UAI [4–7] and HIV transmission [8–10].

Approximately 25 years later, homosexual men's behavioural response to the risk of HIV transmission has evolved considerably. In general, the proportion of men reporting 'unsafe sex', often measured as UAI with casual partners, has increased since the mid-1990s [7,11], but at the same time recognition of a range of so-called 'risk reduction behaviours' has emerged. The risk is 'reduced' in that it is perceived to be lower than the highest risk activity (receptive UAI with an HIV-positive partner) but higher than having no UAI. From an HIV-negative man's perspective, there are at least four patterns of UAI behaviour in which he may believe he lowers his risk of HIV acquisition. First, in serosorting, UAI is practised only with partners believed to be HIV negative [12–14]. Second, in negotiated safety, a particular form of serosorting, UAI is restricted to an HIV-negative partner with whom a steady regular relationship is formed [15,16]. Third, in strategic positioning, the HIV-negative man takes only the insertive role in UAI [17]. Fourth, in withdrawal, the HIV-negative man engages in receptive UAI (UAI-R) only where ejaculation inside his rectum does not occur [18].

Despite the relatively widespread and increasing practice of some risk reduction behaviours [12,19,20], there is no published information from prospective studies on the risk of these behaviours. In this report, we describe the relationship between specific types of UAI, risk reduction behaviours, and HIV infection in a cohort of homosexual men in Sydney, Australia.

Methods

Participants

Participants were recruited from a wide range of community-based settings in Sydney between June 2001 and December 2004, as described in detail elsewhere [21]. Men were eligible if they met the following criteria: reported having sex with other men within the previous 5 years, lived in Sydney or participated regularly in its gay community, and tested HIV negative at baseline. Signed informed consent was obtained. Participants were followed to the end of June 2007. Ethics approval was granted by the Ethics Committee at the University of New South Wales.

Data collection

All eligible men willing to participate underwent annual face-to-face interviews, with 6-monthly telephone interviews between these visits. At each interview, detailed quantitative data on the number of episodes of UAI in the 6 months prior were collected. Participants reported the number of episodes of UAI separately for regular and for casual partners (defined by the participants), for the insertive and receptive positions, by HIV status of these partners (negative, positive or unknown). In addition, for UAI-R, they reported episodes separately by whether or not ejaculation occurred inside their rectum.

Ascertainment of HIV seroconversion and estimation of date of HIV infection

Methods of ascertainment of HIV seroconversion and estimation of the date of HIV infection have been described in detail elsewhere [22]. Briefly, incident HIV infections were identified through two sources. First, HIV diagnoses at the annual study visit were identified ($n = 31$). Second, identifiers were matched against the national HIV register to identify infections in people who tested outside the study ($n = 22$). The final match and the final study interviews occurred in June 2007.

In 36 HIV seroconverters who had no data on seroconversion symptoms, the midpoint between the last negative and first positive HIV tests was used to estimate the date of infection. Data

on the completeness of the western blot and the occurrence of seroconversion symptoms were available from another study in 17 HIV seroconverters [23,24]. In these participants, if the western blot was incomplete, the later of the midpoint or 2 weeks prior to symptom onset was used as the estimated infection date ($n = 9$). If the western blot was complete, the earlier the two was used ($n = 8$).

Definitions of risk reduction behaviours

Risk reduction behaviours were derived from participants' reports about modes of UAI. With the exception of negotiated safety, intent to engage in such behaviours was not assessed. The terms 'serosorting', 'negotiated safety' and 'strategic positioning' were not used in the study questionnaire.

Serosorting

Serosorting between interviews was defined as reporting UAI in that period and reporting that all this UAI was with partners who were reported by study participants to be HIV negative. This was regardless of whether the UAI was with regular or casual partners, or was insertive or receptive. Negotiated safety was defined as a form of serosorting with regular partners in which the following seven criteria were met, as previously defined in Australian community-based research [15,16]: they identified a primary regular partner; the relationship was of more than 6 months duration; the result of the primary regular partner's last HIV test was HIV negative; there was a clear spoken agreement that UAI was allowed within the relationship; there was a clear spoken agreement that there was to be no UAI outside the relationship; the participant and his partner had mutually disclosed their most recent HIV test result; and UAI was reported exclusively with the primary regular partner.

Strategic positioning (insertive only unprotected anal intercourse)

Strategic positioning was defined as reporting UAI in a study period and reporting that all this UAI was insertive. This was regardless of whether the UAI was with regular or casual partners and the HIV status of partners.

Withdrawal

Withdrawal was defined as reporting UAI-R in a study period, and that none of the UAI-R had involved ejaculation inside the rectum. This was regardless of whether UAI-R was with regular or casual partners, and the HIV status of partners.

Statistical analysis

Statistical analyses were performed using STATA 10.0 (STATA Corporation, College Station, Texas, USA). The HIV incidence was calculated as the number of seroconversions divided by the person-years followed. Total person-years were calculated from study entry to the time of HIV infection, to the last study interview, or to the end of June 2007 for those who remained HIV negative. The exact binomial method was used to calculate 95% confidence intervals (CIs).

In 13 participants whose seroconversions were identified through matching, the estimated date of infection was later than their last interview due to loss to follow-up. In these individuals, there were no behavioural data available at the time of estimated infection. Information obtained from the last interview was carried forward for risk factor analysis in seven participants in whom the estimated date of infection was less than 12 months after the last interview. Six participants whose estimated dates of infection were more than 12 months later were excluded from risk factor analysis.

Univariate and multivariate Cox regression models were developed to examine the number of episodes of different modes of UAI as risk factors and hazard ratios were calculated. The association between UAI and HIV seroconversion was examined according to three categories of sexual position (insertive, receptive with withdrawal and receptive with ejaculation), three categories of partner type (regular, casual, and combined regular and casual), and three categories of partners' reported HIV status (negative, positive and unknown). This led to the creation of 27 separate risk behaviours (e.g. insertive UAI with HIV-negative regular partners). In each of these analyses, we examined the effect of number of episodes of that type of UAI in the last 6 months, grouped as 0, one to five, and more than five episodes. Modes of UAI with regular and casual partners combined that were significantly related with HIV infection were entered into a multivariate model using forward stepwise regression.

For risk reduction behaviours, mutually exclusive categories were created for serosorting, strategic positioning and withdrawal. Negotiated safety was examined as a type of serosorting for those who reported a regular partner. Associations between reporting serosorting and each of the other risk reduction behaviours on each study visit occasion were examined using logistic regression, after adjustment for interparticipant correlation [25], and graphically displayed using pie diagrams. To assess confounding between behaviours, stratified analyses of HIV risk were performed among men who reported UAI with HIV-positive partners, and among those who reported UAI only with HIV-negative partners.

Results

A total of 1427 participants were enrolled between June 2001 and December 2004. The median age at enrolment was 35 years, ranging from 18 to 75 years. The great majority (95.2%) of participants self-identified as gay or homosexual. Follow-up interviews at 1 and 2 years were attended by 87 and 81% of participants, respectively, and the main reason for loss to follow-up was participants relocating from Sydney ($n = 139$, 9.74%).

HIV incidence

There were 53 HIV seroconversions, an overall HIV incidence of 0.78 per 100 person-years (95% CI 0.59–1.02). The median age at HIV seroconversion was 37 years (range 22–63). The total follow-up time for risk factor analysis was 5161 person-years, and the median was 3.9 years per participant. Risk factor analysis was performed on 47 HIV seroconverters for whom sexual behaviour data were available within 12 months of seroconversion.

None of the demographic factors examined, including age (P trend = 0.825), education (P trend = 0.336), current income (P trend = 0.700) and occupational level ($P = 0.253$) were related to the risk of HIV infection.

In univariate analysis, all nine modes of UAI with regular and casual partners combined were significantly related to HIV acquisition (Table 1). Similar patterns were observed when these analyses were separated by partner type (Appendix Table A1). There were seven seroconversions in men who reported no UAI in the seroconversion interval, but in each participant, UAI was reported in the 6-month period immediately prior. In the multivariate model, only UAI-R with withdrawal with HIV status unknown partners and UAI-R with ejaculation with HIV-positive partners remained significantly associated with HIV infection (Table 1).

HIV risk reduction behaviours

Serosorting—Overall, 38.0% of total follow-up and 29.8% of all infections ($n = 14$) occurred in men who reported that all their UAI was with partners they believed were HIV negative.

Compared with men who reported no UAI, these men were at more than twice the risk of HIV infection, but this did not reach statistical significance (Table 2). However, compared with those who reported UAI with HIV-positive partners, they were at significantly reduced risk of HIV infection (hazard ratio = 0.13, 95% CI 0.06–0.29).

Men who were classified as serosorters were classified into three mutually exclusive categories as outlined in Table 3. The first category was men who met the criteria for negotiated safety. Overall, 24.7% of total follow-up and 14.9% of all infections ($n = 7$) occurred in these men. Their risk of HIV infection was not significantly greater than those who reported no UAI. The second category was men who reported UAI with an HIV-negative regular partner that could not be classified as negotiated safety, but no UAI with casual partners. Overall, 9.0% of total follow-up and 10.6% of all infections ($n = 5$) occurred in men in this category, and these men were at significantly higher risk than those who reported no UAI. The third category was men who reported UAI with casual partners who were reported to be HIV negative. Overall, 4.2% of total follow-up and 4.3% of all infections ($n = 2$) occurred in men in this category. Compared with men who reported no UAI, these men were at three-fold increased risk, but this did not reach statistical significance.

Strategic positioning—Overall, 15.3% of total follow-up and 8.5% of all infections ($n = 4$) occurred in men who reported their highest risk behaviour was insertive UAI. Compared with men who reported no UAI, these men were not at significantly increased risk of HIV infection (Table 2). Overall, men who reported insertive UAI only were at significantly lower risk of HIV infection than men who reported any receptive UAI (hazard ratio = 0.32, 95% CI 0.12–0.91).

Withdrawal—Overall, 36 infections (76.5% of all infections) were in men who reported receptive UAI. A substantial proportion of these were in men who reported their highest risk behaviour was receptive UAI with withdrawal ($n = 11$, 23.4% of all infections and 12.8% of total follow-up). Compared with men who reported no UAI, men who reported withdrawal were at five-fold significantly increased risk of HIV infection (Table 2).

Combined HIV risk reduction behaviours—Overall, men who reported any risk reduction behaviour were about three times more likely to seroconvert to HIV than men who reported no UAI, but they were much less likely to become infected than men who reported UAI without risk reduction (Table 2). Patterns of sexual positioning were clearly different depending on the reported serostatus of partners (Fig. 1). Men who reported UAI with HIV-negative partners only were much less likely to report UAI-R with withdrawal [odds ratio OR = 0.52, 95% CI 0.43–0.63] or strategic positioning (OR = 0.44, 95% CI 0.36–0.54). Among men who reported that all their UAI partners were HIV negative, most (64%) risk periods included UAI-R with ejaculation. UAI-R with ejaculation with HIV-negative partners was associated with a higher risk of HIV infection compared with men who reported no UAI (hazard ratio = 2.87, 95% CI 1.13–7.29; Table 4). On the contrary, in men who reported UAI with HIV-positive partners, most (56%) risk periods were of insertive only UAI and only 11% included any UAI-R with ejaculation.

Among those men who reported any UAI with HIV-positive partners (Table 4), both insertive only UAI and withdrawal were associated with reduced risks of HIV infection compared with UAI-R with ejaculation (hazard ratio = 0.14, 95% CI 0.04–0.50; and hazard ratio = 0.16, 95% CI 0.04–0.63, respectively), although in both cases, incidence of HIV was significantly higher than no UAI (hazard ratio = 9.09, 95% CI 2.65–31.22 for insertive only UAI, and hazard ratio = 10.22, 95% CI 2.64–39.61 for withdrawal).

Discussion

Receptive UAI remains the main mode of HIV transmission in homosexual men. UAI was very common in this cohort, being reported during 60% of total follow-up periods. However, in only 7% of total follow-up, did this UAI occur where consistent risk reduction behaviour was not observed. Two of the four HIV risk reduction behaviours examined, negotiated safety and strategic positioning, were not associated with significantly increased HIV incidence compared with no UAI. The other two were somewhat less effective. First, serosorting with regular partners outside of negotiated safety, or with casual partners, was associated with HIV infection rates about three-fold higher than those who reported no UAI. Second, withdrawal was associated with a five-fold increased risk of HIV seroconversion, but this was confounded by the fact that it was commonly practiced with HIV-positive partners. Among those whose UAI partners were HIV positive, withdrawal was associated with a lower risk than UAI-R with ejaculation. Thus, each of the risk reduction behaviours examined was associated with a HIV incidence that was intermediate between that in those who reported no UAI, and UAI without that form of risk reduction behaviour.

Serosorting was described initially as a risk reduction strategy in HIV-positive homosexual men [13,14]. In HIV-negative men, the effectiveness of this strategy in HIV prevention will be compromised in any setting where there is uncertainty about the actual HIV status of the sexual partner. Negotiated safety is likely to be a setting where there is relative certainty of the HIV-negative status of the partner [15,16], and this strategy is commonly practiced among homosexual men in established relationships [26–28]. The Health in Men (HIM) study has confirmed that negotiated safety, applied consistently, can substantially protect men from becoming HIV infected. On the contrary, HIV incidence was higher in those men who practised serosorting outside of a negotiated safety agreement. This is not surprising, as accurate knowledge of partner's HIV status is less likely in casual sex or within a recently formed relationship [29]. It is uncertain to what extent these results may apply in other gay community settings. In Sydney, the rate of HIV testing in homosexual men is among the highest in the world, and testing is most frequent in higher risk individuals [30,31]. At screening for entry into the HIM study, only 0.6% of 1435 potential participants wrongly perceived that they were HIV negative [22]. In contrast to this accurate knowledge of HIV-negative status, almost half of men diagnosed with HIV in one US study were unaware they were infected [32]. Knowledge of current HIV status in Sydney appears to be more accurate than in many other settings [33].

The per-contact probability of HIV transmission of insertive UAI is an order of magnitude lower than for receptive UAI [34]. There is clear evidence that sexual positioning strategies have been adopted by some homosexual men, both HIV negative and HIV positive, when negotiating UAI [17,35]. The term strategic positioning was originally defined as occurring only in nonseroconcordant UAI [17], but we consider any report of consistent insertive only UAI as strategic positioning. The HIM study has demonstrated that overall, the incidence of HIV in men consistently practising only insertive UAI was no greater than the HIV incidence in those practising no UAI. However, insertive UAI was still associated with a substantial HIV incidence, of almost 3% per year, in those men who practised it with HIV-positive partners. In interpreting these results, it should be noted that the HIM population was predominantly (66%) circumcised [36], and thus may have been at relatively low risk from insertive sex.

Withdrawal during intercourse is a fallible but common method of birth control in heterosexual couples [37,38]. Among homosexual men, the practice is common [7], and there is a perception that it is at least partially efficacious in reducing HIV risk [39]. The HIM study has confirmed that there remains a substantial risk of HIV infection in those who consistently practise withdrawal. Nevertheless, among those who reported UAI with HIV-positive partners, the risk of HIV infection was lower than that among those who engaged in UAI-R with ejaculation.

We found that men who reported serosorting were much less likely to report both strategic positioning and withdrawal and were more likely to report UAI-R with ejaculation. In some ways, it is only common sense that strategic positioning be uncommon with HIV-negative partners, as in this setting, UAI will always involve one insertive and one receptive HIV-negative partner. However, the finding that they were less likely to practise withdrawal suggests that they felt they were adequately protected against HIV by serosorting when engaging in UAI-R. In fact, our data showed that serosorters who practised UAI-R with ejaculation were at significantly increased risk of HIV infection compared with those who had no UAI.

A key feature of the analyses we have performed is that we have examined consistent practise of risk reduction behaviours and not conscious intent. Given the direct link between sexual risk behaviour and HIV infection and the complexity of the relationship between intention and behaviour, we believe it is appropriate to examine the association with behaviour. In the future, studies of intent are needed to elucidate the contexts of this decision making. Our definition of risk reduction behaviours was based on exclusive practice. For example, if a man reported multiple episodes of insertive UAI and a single episode of UAI-R during a 6-month period, he was classified as not reporting strategic positioning in that period. Thus, our results can only be generalized to those who successfully apply any intentional strategy. In examining such complex and multilayered behaviours, small subgroups were inevitably created, with consequent limited power. This also prevented us from using a multivariate approach to incorporate other known risk factors. Nevertheless, the HIM study is the first prospective study to report on the effectiveness of the practice of risk reduction behaviours.

This study has demonstrated that consistent practice of risk reduction behaviours is common among homosexual men in Australia, and suggests that each of the risk reduction behaviours examined offered substantial but incomplete protection against HIV infection compared with other patterns of UAI. Having said that, consistent condom use (no UAI) was reported in 40% of the follow-up periods, and this remains the most effective risk reduction behaviour. Our results strongly suggest that policy makers, educators and researchers need to engage with the realities under which UAI is occurring, as well as targeting UAI itself. The relatively low incidence rates of HIV observed in this cohort, despite high overall levels of UAI, and the fact that Sydney is one of very few places in the developed world that has not recently seen an increase in HIV notifications in gay men [33] suggest that risk reduction behaviours can be associated with some success in containing HIV at the population level.

Acknowledgments

The authors thank all the participants, the dedicated HIM study team and the participating doctors and clinics.

The National Centre in HIV Epidemiology and Clinical Research and the National Centre in HIV Social Research are funded by the Australian Government Department of Health and Ageing. The Health in Men Cohort study was funded by the National Institutes of Health, a component of the U.S. Department of Health and Human Services (NIH/NIAID/DAIDS: HVDDT Award N01-AI-05395), the National Health and Medical Research Council in Australia (Project grant 400944), the Australian Government Department of Health and Ageing (Canberra), and the New South Wales Health Department (Sydney).

F.J. performed the analyses and drafted the manuscript; A.E.G. took overall responsibility for the project, drafted the analysis plan and assisted in the analyses and drafting of the manuscript; J.C., G.P.P., I.Z., J.I., S.C.K., and J.M.K. assisted in formulating the analyses and drafting the manuscript. All authors have read and approved the submission version of the manuscript.

F.J. is supported by the Dean's Fellowship provided by the Faculty of Medicine, University of New South Wales.

Appendix

Table A1

Univariate analysis of modes of unprotected anal intercourse as risk factors for HIV seroconversion with regular and casual partners in the Health in Men cohort study

	Person-years	N	Incidence (per 100 person-years)	Hazard ratio	95% CI	P trend value
[0,1-7]UAI with regular partners						
No UAI (reference category)	1166.0	4	0.34	1	—	
[0,1-7] Insertive UAI						<i>P</i> = 0.097
With HIV negative partners						
1–5 episodes	358.1	3	0.84	2.61	0.58-11.70	
>5 episodes	1476.3	13	0.88	2.64	0.86-8.12	
[0,1-6] With status unknown partners						<i>P</i> = 0.008
1–5 episodes	88.8	1	1.13	3.32	0.36-30.24	
>5 episodes	117.8	3	2.55	7.51	1.67-33.71	
[0,1-6] With HIV positive partners						<i>P</i> < 0.001
1-5 episodes	58.4	2	3.43	10.55	1.91-58.34	
>5 episodes	95.7	6	6.27	18.36	5.27-65.25	
[0,1-7]Receptive UAI with withdrawal						<i>P</i> = 0.030
[0,1-6] With HIV negative partners						
1–5 episodes	552.8	5	0.90	2.86	0.77-10.70	
>5 episodes	765.7	9	1.18	3.63	1.11-11.80	
[0,1-6] With status unknown partners						<i>P</i> = 0.082
1–5 episodes	84.5	1	1.18	3.58	0.39-32.50	
>5 episodes	56.3	1	1.78	5.49	0.61-49.77	
[0,1-6] With HIV positive partners						<i>P</i> < 0.001
1–5 episodes	38.8	1	2.58	8.82	0.97-79.93	
>5 episodes	34.6	3	8.67	23.82	5.27-107.64	
[0,1-7]Receptive UAI with ejaculation						<i>P</i> = 0.054
[0,1-6] With HIV negative partners						
1–5 episodes	450.3	6	1.33	4.11	1.16-14.60	
>5 episodes	923.6	10	1.08	3.21	1.00-10.26	
[0,1-6] With status unknown partners						<i>P</i> = 0.037
1–5 episodes	57.3	1	1.74	5.90	0.65-53.19	
>5 episodes	51.5	1	1.94	6.95	0.77-63.01	
[0,1-6] With HIV positive partners						<i>P</i> < 0.001
1–5 episodes	10.6	3	28.20	107.5	21.08-548.2	
>5 episodes	12.7	2	15.81	40.74	7.29-227.70	
[0,1-7]UAI with casual partners						
No UAI (reference category)	2616.3	18	0.69	1	---	
[0,1-7]Insertive UAI						<i>P</i> = 0.006
[0,1-6] With HIV negative partners						
1–5 episodes	223.1	7	3.14	4.93	2.05-11.88	
>5 episodes	75.4	1	1.33	2.04	0.27-15.33	
[0,1-6] With status unknown partners						<i>P</i> < 0.001
1–5 episodes	473.0	5	1.06	1.55	0.58-4.20	
>5 episodes	145.6	7	4.81	7.16	2.98-17.21	

	Person-years	N	Incidence (per 100 person-years)	Hazard ratio	95% CI	P trend value
[0,1-6] With HIV positive partners						<i>P</i> = 0.001
1-5 episodes	60.0	5	8.33	14.03	5.15-38.23	
>5 episodes	25.5	0	0.00	—	—	
[0,1-7]Receptive UAI with withdrawal						<i>P</i> = 0.028
[0,1-6] With HIV negative partners						
1-5 episodes	170.8	3	1.76	2.88	0.84-9.84	
>5 episodes	27.1	1	3.69	4.75	0.63-35.75	
[0,1-6] With status unknown partners						<i>P</i> < 0.001
1-5 episodes	297.7	4	1.34	1.93	0.65-5.71	
>5 episodes	43.6	7	16.06	23.60	9.80-56.82	
[0,1-6] With HIV positive partners						<i>P</i> < 0.001
1-5 episodes	34.5	4	11.59	15.87	5.34-47.17	
>5 episodes	4.0	0	0.00	—	—	
[0,1-7]Receptive UAI with ejaculation						<i>P</i> = 0.284
[0,1-6] With HIV negative partners						
1-5 episodes	78.3	0	0.00	—	—	
>5 episodes	18.3	0	0.00	—	—	
[0,1-6] With status unknown partners						<i>P</i> = 0.001
1-5 episodes	91.9	5	5.44	7.99	2.96-21.59	
>5 episodes	12.1	0	0.00	—	—	
[0,1-6] With HIV positive partners						<i>P</i> = 0.006
1-5 episodes	7.0	1	14.27	17.81	2.29-138.66	
>5 episodes	0.0	0	—	—	—	

References

1. Darrow WW, Jaffe HW, Curran JW. Passive anal intercourse as a risk factor for AIDS in homosexual men. *Lancet* 1983;2:160. [PubMed: 6135002]
2. Detels R, Fahey JL, Schwartz K, Greene RS, Visscher BR, Gottlieb MS. Relation between sexual practices and T-cell subsets in homosexually active men. *Lancet* 1983;1:609–611. [PubMed: 6131299]
3. Mayer KH, Ayotte D, Groopman JE, Stoddard AM, Sarngadharan M, Gallo R. Association of human T lymphotropic virus type III antibodies with sexual and other behaviors in a cohort of homosexual men from Boston with and without generalized lymphadenopathy. *Am J Med* 1986;80:357–363. [PubMed: 3006486]
4. McKusick L, Horstman W, Coates TJ. AIDS and sexual behavior reported by gay men in San Francisco. *Am J Public Health* 1985;75:493–496. [PubMed: 3985236]
5. McKusick L, Wiley JA, Coates TJ, Stall R, Saika G, Morin S, et al. Reported changes in the sexual behavior of men at risk for AIDS, San Francisco, 1982–84: the AIDS Behavioral Research Project. *Public Health Rep* 1985;100:622–629. [PubMed: 3934697]
6. Centers for Disease Control and Prevention. Self-reported behavioral change among gay and bisexual men: San Francisco. *MMWR* 1985;34:613–615. [PubMed: 3930938]
7. Prestage G, Mao L, Fogarty A, Van de Ven P, Kippax S, Crawford J, et al. How has the sexual behaviour of gay men changed since the onset of AIDS: 1986–2003. *Aust N Z J Public Health* 2005;29:530–535. [PubMed: 16370050]
8. van Griensven GJ, de Vroome EM, Goudsmit J, Coutinho RA. Changes in sexual behaviour and the fall in incidence of HIV infection among homosexual men. *BMJ* 1989;298:218–221. [PubMed: 2493866]
9. Kingsley LA, Zhou SY, Bacellar H, Rinaldo CR Jr, Chmiel J, Detels R, et al. Temporal trends in human immunodeficiency virus type 1 seroconversion 1984–1989. A report from the Multicenter AIDS Cohort Study (MACS). *Am J Epidemiol* 1991;134:331–339. [PubMed: 1877593]

10. NCHECR (National Centre in HIV Epidemiology and Clinical Research). HIV/AIDS, viral hepatitis and sexually transmissible infections in Australia: Annual Surveillance Report 2007. Sydney, Australia: National Centre in HIV Epidemiology and Clinical Research. Australian Institute of Health and Welfare; Sydney, NSW: 2007. Canberra, ACT
11. Grulich A. HIV risk behaviour in gay men: on the rise? *BMJ* 2000;320:1487–1488. [PubMed: 10834872]
12. Mao L, Crawford JM, Hospers HJ, Prestage GP, Grulich AE, Kaldor JM, et al. 'Serosorting' in casual anal sex of HIV-negative gay men is noteworthy and is increasing in Sydney, Australia. *AIDS* 2006;20:1204–1206. [PubMed: 16691075]
13. Suarez T, Miller J. Negotiating risks in context: a perspective on unprotected anal intercourse and barebacking among men who have sex with men: where do we go from here? *Arch Sex Behav* 2001;30:287–300. [PubMed: 11330118]
14. Suarez TP, Kelly JA, Pinkerton SD, Stevenson YL, Hayat M, Smith MD, et al. Influence of a partner's HIV serostatus, use of highly active antiretroviral therapy, and viral load on perceptions of sexual risk behavior in a community sample of men who have sex with men. *J Acquir Immune Defic Syndr* 2001;28:471–477. [PubMed: 11744837]
15. Kippax S, Crawford J, Davis M, Rodden P, Dowsett G. Sustaining safe sex: a longitudinal study of a sample of homosexual men. *AIDS* 1993;7:257–263. [PubMed: 8466689]
16. Kippax S, Noble J, Prestage G, Crawford JM, Campbell D, Baxter D, et al. Sexual negotiation in the AIDS era: negotiated safety revisited. *AIDS* 1997;11:191–197. [PubMed: 9030366]
17. Van de Ven P, Kippax S, Crawford J, Rawstone P, Prestage G, Grulich A, et al. In a minority of gay men, sexual risk practice indicates strategic positioning for perceived risk reduction rather than unbridled sex. *AIDS Care* 2002;14:471–480. [PubMed: 12204150]
18. Tindall B, Swanson C, Donovan B, Cooper DA. Sexual practices and condom usage in a cohort of homosexual men in relation to human immunodeficiency virus status. *Med J Aust* 1989;151:318–322. [PubMed: 2593942]
19. Elford J. Changing patterns of sexual behaviour in the era of highly active antiretroviral therapy. *Curr Opin Infect Dis* 2006;19:26–32. [PubMed: 16374214]
20. Xia Q, Molitor F, Osmond DH, Tholandi M, Pollack LM, Ruiz JD, et al. Knowledge of sexual partner's HIV serostatus and serosorting practices in a California population-based sample of men who have sex with men. *AIDS* 2006;20:2081–2089. [PubMed: 17053354]
21. Jin F, Prestage GP, Mao L, Kippax SC, Pell CM, Donovan B, et al. Transmission of herpes simplex virus types 1 and 2 in a prospective cohort of HIV-negative gay men: the Health in Men study. *J Infect Dis* 2006;194:561–570. [PubMed: 16897652]
22. Jin F, Prestage GP, McDonald A, Ramacciotti T, Imrie JC, Kippax SC, et al. Trend in HIV incidence in a cohort of homosexual men in Sydney: data from the Health in Men Study. *Sexual Health* 2008;5:109–112. [PubMed: 18588774]
23. Jin F, Prestage GP, Ellard J, Kippax SC, Kaldor JM, Grulich AE. How homosexual men believe they became infected with HIV: the role of risk-reduction behaviors. *J Acquir Immune Defic Syndr* 2007;46:245–247. [PubMed: 17721400]
24. Volk JE, Prestage G, Jin F, Kaldor J, Ellard J, Kippax S, et al. Risk factors for HIV seroconversion in homosexual men in Australia. *Sexual Health* 2006;3:45–51. [PubMed: 16607974]
25. Morris SR, Klausner JD, Buchbinder SP, Wheeler SL, Koblin B, Coates T, et al. Prevalence and incidence of pharyngeal gonorrhea in a longitudinal sample of men who have sex with men: the EXPLORE study. *Clin Infect Dis* 2006;43:1284–1289. [PubMed: 17051493]
26. Crawford JM, Rodden P, Kippax S, Van de Ven P. Negotiated safety and other agreements between men in relationships: risk practice redefined. *Int J STD AIDS* 2001;12:164–170. [PubMed: 11231869]
27. Elford J, Bolding G, Maguire M, Sherr L. Sexual risk behaviour among gay men in a relationship. *AIDS* 1999;13:1407–1411. [PubMed: 10449295]
28. Guzman R, Colfax GN, Wheeler S, Mansergh G, Marks G, Rader M, et al. Negotiated safety relationships and sexual behavior among a diverse sample of HIV-negative men who have sex with men. *J Acquir Immune Defic Syndr* 2005;38:82–86. [PubMed: 15608530]

29. Butler DM, Smith DM. Serosorting can potentially increase HIV transmissions. *AIDS* 2007;21:1218–1220. [PubMed: 17502737]
30. Jin FY, Prestage G, Law MG, Kippax S, Van d V, Rawsthorne P, et al. Predictors of recent HIV testing in homosexual men in Australia. *HIV Med* 2002;3:271–276. [PubMed: 12444945]
31. Prestage GP, Jin F, Zablotska IB, Imrie J, Grulich AE, Pitts M. Trends in HIV testing among homosexual and bisexual men in eastern Australian states. *Sexual Health* 2008;5:119–123. [PubMed: 18588776]
32. Centers for Disease Control and Prevention. HIV prevalence, unrecognized infection, and HIV testing among men who have sex with men: five U.S. cities, June 2004—April 2005. *MMWR* 2005;54:597–601. [PubMed: 15973239]
33. Grulich AE, Kaldor JM. Trends in HIV incidence in homosexual men in developed countries. *Sexual Health* 2008;5:113–118. [PubMed: 18588775]
34. Vittinghoff E, Douglas J, Judson F, McKirnan D, MacQueen K, Buchbinder SP. Per-contact risk of human immunodeficiency virus transmission between male sexual partners. *Am J Epidemiol* 1999;150:306–311. [PubMed: 10430236]
35. Grov C, DeBusk JA, Bimbi DS, Golub SA, Nanin JE, Parsons JT. Barebacking, the Internet, and harm reduction: an intercept survey with gay and bisexual men in Los Angeles and New York City. *AIDS Behav* 2007;11:527–536. [PubMed: 17431756]
36. Templeton DJ, Mao L, Prestage G, Kaldor JM, Kippax S, Grulich AE. Demographic predictors of circumcision status in a community-based sample of homosexual men in Sydney, Australia. *Sexual Health* 2006;3:191–193. [PubMed: 17044227]
37. Fu H, Darroch JE, Haas T, Ranjit N. Contraceptive failure rates: new estimates from the 1995 National Survey of Family Growth. *Fam Plann Perspect* 1999;31:56–63. [PubMed: 10224543]
38. Young V. Withdrawal: said to be unreliable yet it remains popular. *Popul Forum* 1981;7:16–17. [PubMed: 12263977]
39. Gold RS, Skinner MJ. Gay men's estimates of the likelihood of HIV transmission in sexual behaviours. *Int J STD AIDS* 2001;12:245–255. [PubMed: 11319976]

1a. Stratified by reported HIV status of sexual partners

1b. Stratified by sexual positioning during UAI

Fig. 1. Distribution of sexual position during unprotected anal intercourse and reported HIV status of sexual partners (percentage of person-years at risk in each category)

Categories were defined as follows: HIV status of sexual partners: HIV negative = all unprotected anal intercourse (UAI) during a follow-up interval was with sexual partners reported to be HIV negative; HIV status unknown = at least one episode of UAI during a follow-up interval was with a sexual partner reported to be of unknown HIV status, but no episodes were with an HIV-positive partner; HIV positive = at least one episode of UAI during a follow-up interval was with a sexual partner reported to be HIV positive. Sexual position: Insertive only = all UAI during a follow-up interval was in the insertive position; receptive with withdrawal = at least one episode of UAI during a follow-up interval was in the receptive

position, with withdrawal before ejaculation, and none was in the receptive position with ejaculation inside the rectum; receptive with ejaculation = at least one episode of UAI during a follow-up interval was in the receptive position with ejaculation in the rectum. (a) Stratified by reported HIV status of sexual partners. (b) Stratified by sexual positioning during UAI.

Table 1

Number of episodes of unprotected anal intercourse and risk of HIV seroconversion by sexual position, reported HIV status of partners, and by whether or not ejaculation occurred inside the rectum, in the Health in Men cohort study

Sexual position	HIV status of partners	Episodes (n)	[0,4-9]Univariate results					[10,10-12]Multivariate results			
			Person-years	N	Incidence (per 100 person-years)	Hazard ratio	95% CI	P trend ^d	Adjusted hazard ratio	95% CI	P trend
No UAI referent category) Insertive UAI ^b	NA	n/a	2071.4	7	0.34	1	–				
	Negative	1–5	504.3	6	1.19	3.65	1.23–10.90	0.031			N/A
		>5	1534.5	14	0.91	2.74	1.10–6.79				
		>5	257.4	9	3.50	10.27	3.80–27.77				
	Positive	1–5	101.2	6	5.93	18.83	6.28–56.43	<0.001	6.29	2.50–15.83	0.061
Receptive UAI, withdrawal before ejaculation ^b		>5	118.3	6	5.07	15.01	5.04–44.75		1.88	0.52–6.88	
	Negative	1–5	662.7	5	0.75	2.31	0.73–7.31	0.006			N/A
		>5	797.0	10	1.25	3.80	1.44–9.98				
	Unknown	1–5	355.8	5	1.41	4.25	1.34–13.48	0.001	1.40	0.53–3.72	0.001
		>5	102.3	8	7.82	24.32	8.77–67.44		7.74	3.38–17.74	
Receptive UAI, ejaculation inside the rectum ^b	Positive	1–5	64.0	3	4.69	13.10	3.36–51.04	0.001			0.213
		>5	38.5	3	7.79	23.69	6.09–92.18				
	Negative	1–5	506.3	6	1.19	3.64	1.22–10.85	0.016			N/A
		>5	940.4	10	1.06	3.16	1.20–8.30				
	Unknown	1–5	138.9	4	2.88	8.59	2.49–29.61	0.002			0.804
Positive		>5	63.9	1	1.57	5.34	0.65–43.86				
		1–5	14.9	4	26.94	88.76	25.01–315.0	0.001	10.95	2.92–41.01	0.011
		>5	12.7	2	15.82	43.16	8.81–211.46		5.87	0.92–37.64	

Sexual position	HIV status of partners	Episodes (<i>n</i>)	[0,4-9]Univariate results			[0,10-12]Multivariate results			
			Person-years	N	Incidence (per 100 person-years)	Hazard ratio	95% CI	<i>P</i> trend ^a	Adjusted hazard ratio

CI, confidence interval; UAI, unprotected anal intercourse.

^a*P* value for the trend in hazard ratios between reporting no UAI, and reporting this mode of UAI one to five and more than five times.

^bNumbers are not mutually exclusive, participants could report 0, one or more than one of these behaviours.

Table 2

Risk reduction behaviours and HIV infection in the Health in Men study

	Person-years	[0.3–4]HIV infections		Hazard ratio	95% CI	P
		N	Incidence (per 100 person-years)			
No UAI (referent category)	2071.4	7	0.34	1	—	
[0.1–6]UAI by reported HIV status of sexual partners						
UAI with HIV negative only	1958.7	14	0.71	2.17	0.88–5.39	<0.001
(serosorting)						
UAI with some unknown HIV status	879.8	13	1.48	4.44	1.77–11.16	
UAI with any HIV positive	246.3	13	5.28	16.12	6.42–40.46	
[0.1–6]UAI by sexual position						
Insertive UAI only (strategic positioning)	792.1	4	0.51	1.54	0.45–5.26	<0.001
Any receptive UAI	2289.2	36	1.57	4.75	2.11–10.69	
Receptive with withdrawal	662.0	11	1.66	5.00	1.94–12.92	
Receptive with ejaculation	1627.2	25	1.54	4.65	2.01–10.76	
[0.1–6]Any risk reduction behaviour ^a						
UAI suggesting risk reduction behaviour	2717.6	27	0.99	3.01	1.31–6.92	<0.001
Other patterns of UAI	364.69	13	3.56	10.8	4.31–27.2	

CI, confidence interval; UAI, unprotected anal intercourse.

^a UAI with HIV-negative partners only ('serosorting'), insertive UAI only ('strategic positioning'), or reporting that all receptive UAI occurred with withdrawal ('withdrawal').

Serosorting and negotiated safety and risk of HIV infection in the Health in Men study

Table 3

	Person-years	[0,3-4]HIV infections		Hazard ratio	95% CI	P
		N	Incidence (per 100 person-years)			
No UAI	2071.4	7	0.34	1	—	
[0,1-7]Serosorting ^a						
Negotiated safety ^b	1275.6	7	0.55	1.67	0.59–4.76	0.338
UAI with HIV negative regular partner, no UAI with casual partners	466.8	5	1.07	3.17	1.01–10.00	0.040
UAI with HIV negative casual partners	216.3	2	0.92	2.98	0.62–14.34	0.174

CI, confidence interval; UAI, unprotected anal intercourse.

^a Defined as reporting UAI, and that all UAI in a risk period was with HIV- negative partners.

^b For definition, see Methods section.

Table 4

Sexual position and receptive unprotected anal intercourse with withdrawal as risk factors for HIV infection among men reporting unprotected anal intercourse with HIV-negative and HIV-positive partners in the Health in Men study

	Person-years	[0,3-4]HIV infections		Hazard ratio	95% CI
		N	Incidence (per 100 person-years)		
No UAI	2071.4	7	0.34	1	—
UAI with HIV-negative only	1958.7	14	0.71	2.17	0.88–5.39
Insertive only	369.4	0	0.00	n/a	
Receptive with withdrawal	325.7	2	0.61	1.88	0.39–9.05
Receptive with ejaculation	1261.2	12	0.95	2.87	1.13–7.29
UAI with any HIV -positive	246.3	13	5.28	16.12	6.42–40.46
Insertive only	136.4	4	2.93	9.09	2.65–31.22
Receptive with withdrawal	82.1	3	3.66	10.22	2.64–39.61
Receptive with ejaculation	27.9	6	21.52	65.78	21.98–196.8

CI, confidence interval; UAI, unprotected anal intercourse.