Sexual risk behaviours among circumcised and uncircumcised men before and after implementation of the safe male circumcision programme in Uganda

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Background

Heterosexual transmission of HIV is still the biggest contributor to the HIV epidemic in sub Saharan Africa where over 70% of the estimated global 35 million HIV positive people live [1, 2]. Male circumcision reduces HIV heterosexual transmission risk from infected women to men [3-8], prevalence of high risk human papilloma virus and incidence of Herpes simplex virus 2 in men and, genital ulcers in female partners of circumcised HIV negative men [9-12]. In 2007, male circumcision was recommended in 14 sub Saharan African countries with high HIV prevalence but low levels of male circumcision [13, 14].

The Ministry of Health and partners in Uganda have scaled up circumcision through the national safe male circumcision (SMC) programme since 2007. Local and religious leaders, health workers and the general public were educated through radio and television talk shows, and educational materials such as brochures and question-answer booklets [15]. A national policy guiding the programme was launched in 2010 [16] together with a national communication strategy [17]. In 2011, there were further efforts to increase demand, such as the "stand proud, get circumcised" campaign using a unique approach that spoke to men through women. This was designed to convince men who had intentions of circumcision to get SMC services while encouraging women to support their partners to get circumcised and encouraging adherence to post circumcision practices that promote healing. The SMC intervention is implemented as an additional approach to the existing HIV prevention programmes, and its demand and service provision increased since 2010; over 1.4 million adult men were circumcised up to September 2013 [18, 19].

Male circumcision has the potential to reduce the HIV epidemic at population level with large scale benefits projected [20, 21]. There are concerns however that promoting such large scale population level interventions may also come with potential for behavioural risk compensation [22-25]. Circumcised men may as a result of reduced self-perceived risk to HIV and sexually transmitted infections increase sexual risk behaviours, including frequency of unprotected sex with multiple high risk partners [26-28].

Information from the three randomised controlled trials on which the WHO recommendation of the male circumcision intervention was mainly based, indicated both adjustments and

non-adjustments in the sexual behaviour of participants. In South Africa [8] circumcised men reported more sexual partners in the 4-21 month recall periods while in Kenya [7], inconsistent condom use declined in the control but not in intervention group after a 24 month period of repeated emphasis on comprehensive behaviour related counselling. In contrast, in Uganda there was no evidence of behavioural risk compensation reported even in follow up studies [29, 6].

Increases in sexual risk behaviours have been documented in Uganda among people living with HIV on antiretroviral therapy [30], in part due to reduced risk perception [31]. HIV vaccine trials have documented similar concerns with increases in sexual risk behaviours after vaccination among some groups [32-34]. Risk compensation may also occur in part due to misperceptions from social marketing about the 'partial' protective effect of male circumcision [35]. There are few studies [23, 36-38, 28] outside of the three trials that have examined the association between male circumcision and sexual risk behaviour. Our earlier analysis of differences in sexual risk behaviours in the 2011 Uganda AIDS indicator survey (UAIS) alone, showed higher odds of engaging in sexual risk behaviours among circumcised men than the uncircumcised [39]. However, no comparison with the period before the implementation of the national SMC programme (2004 UAIS) has been done.

The objective of this paper was to establish the differences in the associations for sexual risk behaviours and circumcision status, between the 2004 and 2011 UAISs. We hypothesised an increase in the prevalence of sexual risk behaviours among circumcised men after information was made public that male circumcision offered partial protection from HIV.

Methods

Study Design and Sampling procedures

This study was based on data from two national surveys; the Uganda HIV/AIDS Sero-Behavioural Survey (UAIS) 2004 and the UAIS 2011. The 2004 UAIS was conducted before the implementation of the SMC programme while the 2011 UAIS was conducted after the SMC programme implementation was underway in the entire country. The two surveys have nationally representative samples obtained from stratified two-stage cluster sampling designs [40, 41]. In both surveys, clusters were selected from strata defined by urban/rural residence and geographical

regions at the first stage, while the second stage involved selecting households for interview to obtain eligible respondents. Clusters were from a list of enumeration areas obtained from the 2002 Uganda population census (for the 2004 UAIS) and from the 2010 Uganda National Household Survey update of the 2002 Uganda population census (for the 2011 UAIS). At the first stage, 417 clusters in 2004 and 470 in 2011 were selected. The second stage in both surveys involved systematically sampling 25 households for interview in each cluster. Out of 9,842 eligible households, 9,529 were interviewed in 2004 (response rate, 96.1%) and in these households 8,830 men completed individual interviews out of 9,905 eligible men (response rate, 89.1%). In the 2011 survey, out of 11,434 occupied households, 11,340 were interviewed, giving a response rate of 99.2%. In these households 9,588 men were interviewed out of the 9,983 eligible (response rate, 96%). In both surveys, eligible respondents were permanent residents of the households or visitors who had spent the survey night in the household. All men 15-59 years were requested to voluntarily provide a blood sample for HIV testing. The response rate for HIV testing was 83.4% in 2004, and 94.2% in 2011. This paper is based on information from 14,875 men (6,906 in 2004 and 7,969 in 2011 UAIS) who reported to ever have had sex.

Data collection and variables

Data were collected between August 2004 and January 2005 for the 2004 UAIS and between February and September 2011 for the 2011 UAIS. Both surveys were led by the Uganda Ministry of Health working with ICF international, USA and Uganda Bureau of Statistics. Individual male interviews obtained data on respondents' self-reported circumcision status, their reported sexual behaviours, personal perceived risk of HIV infection, and knowledge of the protection offered by male circumcision against HIV infection (for 2011 alone), and socio-demographic characteristics (age, marital status, highest education level, survey region, ethnicity, residence, religion). Information on wealth status was also obtained from the household interviews and thus reflects the state of the household in which individual men were interviewed. All male interviews were conducted by trained male research assistants.

The dependent variables were the following sexual risk behaviours among all circumcised and uncircumcised men: (a) having multiple sexual partners, (b) having had sex with non-marital partners, (c) non-use of condoms at the last non-marital sex, and (d) transactional sex (payment or

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receipt of money/gifts in exchange for sex). All these questions referred to behaviours that took place in the 12 months preceding each of the surveys. Condom use at last non-marital sex only included men who reported having such sex. The main independent variable was self-reported circumcision status, while other explanatory variables were socio-demographic characteristics, personal HIV risk perception as well as knowledge of the protection offered by male circumcision against HIV infection (for the 2011 UAIS).

Statistical analyses

Analyses were conducted using Stata version 13 (StataCorp 2013). Data from the two national surveys were appended to get one dataset with 14,875 observations so as to increase the power and precision of our estimates. A "survey" variable was generated to identify each of the surveys' datasets. All cases with missing data on circumcision were dropped from the analyses after the merge.

The measure of association used for these analyses were prevalence rate ratio (PRR) and their corresponding 95 % confidence intervals obtained via modified Poisson regression models using generalized linear models with family (Poisson) and link (log) [42-44]. The primary analyses were to estimate the associations between male circumcision and sexual risk behaviours. In the adjusted analyses, for circumcision and sexual risk behaviour, socio-demographic characteristics were controlled for.

In order to address the question "did the association between sexual risk behaviours and male circumcision vary between the two surveys?" we conducted a stratified analysis in the bivariate analysis to determine strata specific PRRs; strata were the by year of the survey. When the strata specific PRRs were significantly different, then an interaction term between male circumcision and year of the survey was introduced in the multivariable regression model. However, when the strata specific PRRs were similar, the year if the survey was adjusted for a potential confounder in the multivariable model. Sample weights were used in the analyses.

Ethical considerations

Informed consent was obtained before conducting interviews. Each survey protocol was reviewed and approved by the Science and Ethics Committee of the Uganda Virus Research Institute, ICF International's Institutional Review Board, and a review committee at the Centers for Disease Control and Prevention in Atlanta, USA. They were also cleared by the Ethics Committee of the Uganda National Council of Science and Technology. Permission to use both surveys' data was obtained from ICF international, USA, and the Ministry of Health, Uganda.

Results:

Characteristics of respondents

We analysed 14,875 cases for the two surveys. We eliminated 531 cases from the analysis for this study. In total 1,792 (26%) and 2,228 (28%) men reported that they were circumcised in 2004 and 2011, respectively. In 2004, two thirds (67%) of men were married and 86% lived in rural areas, while in 2011, 72% were married and 81% lived in rural areas. The majority (61% in 2004 and 57% in 2011) of the men had completed primary education but a higher proportion in 2011 (36%) had completed secondary or higher education than in 2004 (29%). In both surveys, 44% were from households in the top two wealth quintiles, and the largest ethnic groups were Baganda, Banyankore and Langi/Acholi. Two thirds (65%) in 2011 perceived themselves as being at high risk for HIV and 50% knew that male circumcision reduced the risk of HIV infection to a man.

In 2004, over half of circumcised men (53%) were from households in the top two wealth quintiles compared to only 44% of the uncircumcised. Circumcised men were also more educated and more likely to be from urban areas than their uncircumcised counterparts in both surveys. In 2011, a larger proportion of circumcised than uncircumcised men knew that circumcision was protective (62% against 46%), but the personal perception for HIV risk was similar across both groups (64% among circumcised, 66% among the uncircumcised) (Table 1).

Prevalence of sexual risk behaviours

The prevalence of sexual risk behaviours varied over the two survey periods. In the 2004 survey, 25% of men reported sex with multiple partners while in 2011, 22% reported this behaviour. Thirty five percent of men reported sex with a non-marital partner in 2004 compared to 33% in 2011. The percentage of men who reported non-use of condoms at the last such sexual intercourse was higher

in the 2011 survey (55% compared to 48% in 2004) (Table 2).

Sexual risk behaviour differences between circumcised and uncircumcised men

The prevalence of all sexual risk behaviour was higher among the circumcised than the uncircumcised men in both survey periods (Table 2). When we adjusted for socio-demographic variables, circumcision status was significantly associated with two of the four sexual risk behaviours in the 2004 survey. Circumcised men were 1.38 times more likely to report having multiple sexual partners, and more likely to report having had sex with non-marital sexual partners (adjusted PRR 1.12; CI 1.06 - 1.20) in the 12 months preceding the 2004 survey than uncircumcised men. There was no difference in 2004 between the two groups regarding condom use at last non-marital sex. In 2011, similar associations were observed regarding multiple sexual partnerships (adjusted PRR 1.23; CI 1.11 - 1.36). However, unlike in the 2004 survey, circumcised men were less likely to report use of condoms at the last sex with a non-marital partner in 2011 (adjusted PRR 0.85; CI 0.76 - 0.96). Male circumcision status was not significantly associated with transactional sex in any of the two surveys. Other factors independently associated with sexual risk behaviours were age, marital status, education level, region of residence and wealth quintile of the man's household (Table 3).

Differences in the associations between sexual risk behaviours in the 2004 and 2011 surveys

The models with pooled data from the two surveys with an interaction term for circumcision status and survey period indicate that non-use of condoms at the last non-marital sex among circumcised men varied by the survey. In 2004, circumcised men were slightly more likely to report condom use at the last non-marital sexual encounter than uncircumcised men, whereas in 2011 circumcised men were significantly less likely to report condom use. Reporting of sex with a non-marital partner and multiple sexual partners, did not vary between 2004 and 2011 (Table 4).

Discussion

This study indicates significant differences in some of the sexual risk behaviours between circumcised and uncircumcised men in both the 2004 and the 2011 UAIS. Circumcised men reported higher prevalence of all sexual risk behaviours examined, except for transactional sex. Non-use of condoms with non-marital sexual partners increased between 2004 and 2011,

suggesting a possible change in this risk behaviour among circumcised men, in line with our hypothesis that promotion of male circumcision as a HIV protective measure since 2007 could result in risk compensation. However, there was no significant change in the prevalence of other sexual risk behaviours between the two survey periods. Thus we conclude that there is limited evidence to support our hypothesis from the two UAISs for other behaviours.

Unlike in the 2004 survey, circumcised men were more likely to report non-use of condoms at the last non-marital sex in the 2011 survey. It is plausible that the clear reduction in condoms use in this group could be linked to risk compensation due to higher awareness in 2011 that circumcision was protective, since a similar reduction in reported condom use at the last non-marital sex was not found among uncircumcised men. However, since condoms are even more effective against heterosexual HIV infection than circumcision [45, 46], a reduction in their use because of male circumcision [47] would be a dangerous 'trade off'. Inconsistent condom use after circumcision has been associated with increased risk of HIV infection among young men in eastern Uganda [48]. This could significantly reduce the beneficial effect of circumcision against HIV infection, even with its reported high efficacy levels [49, 21].

Circumcised men reported higher prevalence of multiple sexual partners in both 2004 and 2011 than the uncircumcised. Although there were no significant differences in the association over time, i.e. indicating that any risk compensation due to the SMC campaign was limited at this early stage of the campaign, multiple sexual partnerships coupled with higher prevalence of non-use of condoms in 2011 is a potentially dangerous situation if it continues uncontrolled. If persons who have multiple sexual relationships also have concurrent partners, non-use of condoms is particularly risky because HIV infection can easily spread to several persons in the sexual network if one of the concurrent partners are newly infected (and thus more infectious) [50]. Concurrency has been one of the main drivers of new heterosexual HIV infections in Uganda in the last decade [1, 51].

Further, because of the early stages of the SMC campaign, it is possible that some previously circumcised men may not have fully understood partial risk reduction as opposed to eliminating the entire risk of HIV infection, leading to a misguided sense of sexual freedom [47]. These two

concepts may still be hard for the population to understand fully even in the current stage of the campaign, a challenge that could further be complicated by appropriate translation into all local dialects for diverse populations [52, p.26]. It may be hard to convince all circumcised men at the population level as well as their sexual partners to continue using both interventions (condoms and circumcision), even when engaging in high risk behaviours such as multiple sexual partnerships. However, if such behaviour continues unabated in the current 'mature' period of the SMC programme, this should have implications for circumcision-related social marketing messages that mainly focus on those intending to circumcise, and less specific on behaviours of men already circumcised.

The study has several limitations. First, the cross sectional nature of both surveys means inability to ascertain temporality and causation between circumcision, sexual behaviour. Second, both circumcision status and the sexual risk behaviours were obtained using individual men's self-reports in face-to-face interviews which can be liable to social desirability [42] as well as recall biases when reporting for a 12 months periods. However, individual sexual behaviour reports are not likely to be linked with reports of male circumcision status; therefore biases are likely to be non-differential if they exist. All the individual interviews were conducted by well-trained male interviewers using standardised questionnaires. The results from this study are from nationally representative samples of men with a high response rate and can be generalised to the general adult male population in Uganda. The surveys are also drawn using the same standard sampling methodology from a similar target population five years apart. Even though they are not panel surveys, they can be comparable across the time points.

Conclusions

This study indicates higher prevalence of sexual risk behaviours among circumcised men in each survey and a reduction in use of condoms with non-marital sexual partners among circumcised men from 2004 to 2011, suggesting that promotion of male circumcision could result in risk compensation. Considering the high levels of sexual risk behaviours among men who are already circumcised observed in this study, the Ministry of Health and partners need to continue sensitising the sexually active population to use condoms even when a man is circumcised. These messages should target both circumcised men and their sexual partners. Educating men

undergoing circumcision also needs to be strengthened to avoid sexual risk taking post circumcision.

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Table 1. Characteristics of circumcised and uncircumcised men 15-59 years, Uganda 2004 and 2011

Variables		2004 UAIS, n (%)				2011 UAIS, n (%)			
	Circumcised	Uncircumcised	P-values	All men		Circumcised	Uncircumcised	P-values	All men
Age									
15-24	492 (27.4)	1,318 (25.8)	0.491	1,809 (26.2)		610 (27.4)	1,331 (23.2)	0.046	1,941 (24.4)
25-34	549 (30.6)	1,664 (32.6)	0.384	2,213 (32.1)		708 (31.8)	1,751 (30.5)	0.528	2,460 (30.9)
35-44	434 (24.2)	1,162 (22.7)	0.527	1,596 (23.1)		508 (22.8)	1,492 (26.0)	0.151	2,000 (25.1)
45-59	317 (17.7)	970 (19.0)	0.606	1,288 (18.6)		402 (18.0)	1,166 (20.3)	0.318	1,568 (19.7)
Marital status									
Never married	418 (23.3)	1,170 (22.9)	0.866	1,589 (23.0)		523 (23.5)	1,127 (19.6)	0.070	1,649 (20.7)
Married	1,183 (66.0)	3,438 (67.2)	0.449	4,621 (66.9)		1,534 (68.9)	4,176 (72.7)	0.005	5,710 (71.7)
Divorced/Widowed	191 (10.6)	506 (9.9)	0.784	696 (10.1)		171 (7.7)	438 (7.6)	0.943	609 (7.7)
Residence									
Urban	352 (19.6)	605 (11.8)	0.001	957 (13.9)		604 (27.1)	916 (16.0)	<0.001	1,520 (19.1)
Rural	1,440 (80.4)	4,509 (88.2)	<0.001	5,949 (86.2)		1,624 (72.9)	4,825 (84.1)	<0.001	6,449 (80.9)
Region									
Central	468 (26.1)	1,213 (23.7)	0.304	1,681 (24.4)		491 (22.0)	1,293 (22.5)	0.821	1,784 (22.4)
Kampala	332 (18.6)	645 (12.6)	0.012	978 (14.2)		215 (9.7)	353 (6.2)	0.125	568 (7.1)
Eastern	465 (25.9)	817 (16.0)	<0.001	1,282 (18.6)		882 (39.6)	819 (14.3)	<0.001	1,701 (21.4)
Northern	458 (25.6)	1,712 (33.5)	0.001	2,171 (31.4)		201 (9.0)	1,798 (31.3)	<0.001	1,999 (25.1)
Western	69 (3.8)	725 (14.2)	0.015	794 (11.5)		439 (19.7)	1,477 (25.7)	0.010	1,916 (24.1)
Highest Education Level									
No Education	164 (9.1)	529 (10.4)	0.629	693 (10.1)		143 (6.4)	427 (7.4)	0.688	570 (7.2)
Primary	1,058 (59.1)	3,167 (62.0)	0.094	4,225 (61.3)		1,166 (52.3)	3,360 (58.5)	<0.001	4,526 (56.8)
Secondary	442 (24.7)	1,066 (20.9)	0.105	1,509 (21.9)		697 (31.3)	1,458 (25.4)	0.004	2,155 (27.0)
Tertiary	125 (7.0)	342 (6.7)	0.909	468 (6.8)		222 (10.0)	496 (8.6)	0.545	718 (9.0)

Wealth level								
Low	496 (27.7)	1,999 (39.1)	<0.001	2,495 (36.1)	654 (29.4)	2,297 (40.0)	<0.001	2,952 (37.0)
Middle	347 (19.4)	1,012 (19.8)	0.872	1,359 (19.7)	428 (19.2)	1,103 (19.2)	<0.001	1,531 (19.2)
High	949 (52.9)	2,103 (41.1)	<0.001	3,052 (44.2)	1,146 (51.4)	2,341 (40.8)	<0.001	3,486 (43.8)
Ethnicity								
Baganda	357 (19.9)	785 (15.4)	0.059	1,142 (16.6)	400 (18.0)	921 (16.1)	0.395	1,321 (16.6)
Banyakore	68 (3.8)	606 (11.9)	0.044	674 (9.8)	109 (4.9)	685 (11.9)	0.029	793 (10.0)
Iteso/Karimojong	47 (2.6)	621 (12.2)	0.047	668 (9.7)	64 (2.9)	667 (11.6)	0.033	730 (9.2)
Lugbara/Madi	184 (10.3)	292 (5.7)	0.063	477 (6.9)	113 (5.1)	282 (4.9)	0.934	396 (5.0)
Basoga	217 (12.1)	416 (8.1)	0.103	632 (9.2)	314 (14.1)	401 (7.0)	0.002	716 (9.0)
Langi/Acholi	21 (1.2)	765 (15.0)	0.078	786 (11.4)	19 (0.9)	877 (15.3)	0.511	896 (11.2)
Bakiga/Bafumbira	45 (2.5)	434 (8.5)	0.156	479 (7.0)	66 (2.9)	526 (9.2)	0.084	592 (7.4)
Bagisu/Sabiny/Bakonzo	395 (22.0)	54 (1.1)	<0.001	449 (6.5)	646 (29.0)	34 (0.6)	0.004	680 (8.5)
Alur/Japadhola	76 (4.2)	321 (6.3)	0.485	397 (5.8)	73 (3.3)	315 (5.5)	0.441	387 (4.9)
Banyoro/Batooro	81 (4.5)	323 (6.3)	0.540	404 (5.9)	164 (7.4)	516 (9.0)	0.525	680 (8.5)
Others	300 (16.8)	488 (9.6)	0.003	788 (11.4)	261 (11.7)	516 (9.0)	0.234	777 (9.8)
Religion								
Non Moslem	931 (52.0)	5,085 (99.8)	<0.001	6,016 (87.4)	1,202 (54.0)	5,729 (99.8)	<0.001	6,931 (87.0)
Moslem	858 (48.0)	12 (0.2)	0.002	870 (12.6)	1,026 (46.1)	12 (0.2)	0.002	1,038 (13.0)
Perceived HIV risk								
Low risk					743 (33.4)	1,721 (30.0)	0.094	2465 (30.9)
High risk/not sure					1,431 (64.2)	3,772 (65.7)	0.310	5202 (65.3)
Missing					54 (2.4)	248 (4.3)	0.517	302 (3.8)
Knows SMC reduces HIV risk								
No					826 (37.1)	3,029 (52.8)	<0.001	3855 (48.4)
Yes					1,389 (62.4)	2,634 (45.9)	<0.001	4023 (50.5)
Missing					13 (0.6)	78 (1.4)	0.2794	91 (1.1)
HIV sero-status								

Negative	1,716 (95.7)	4,767 (93.2)	<0.001	6,482 (93.9)	2,120 (95.2)	5,296 (92.3)	<0.001	7,416 (93.1)
Positive	76 (4.3)	347 (6.8)	0.418	424 (6.1)	108 (4.8)	445 (7.8)	0.279	553 (6.9)
Total	**1,792 (100)**	**5,114 (100)**		**6,906 (100)**	**2,228 (100)**	**5,741 (100)**		**7,969 (100)**

Table 2. Prevalence of Sexual risk behaviours among circumcised and uncircumcised men, Uganda 2004 and 2011

Variables	2004 UAIS, n (%)			2011 UAIS, n (%)		
	Circumcised	Uncircumcised	All men	Circumcised	Uncircumcised	All men
Had multiple sexual partners						
No	1,201 (67.0)	3,996 (78.1)	5,196 (75.2)	1,615 (72.5)	4,572 (79.7)	6,187 (77.6)
Yes	592 (33.0)	1,118 (21.9)	1,710 (24.8)	613 (27.5)	1,168 (20.4)	1,781 (22.4)
Total	1,792 (100)	5,114 (100)	6,906 (100)	2,228 (100)	5,741 (100)	7,969 (100)
Had transactional sex						
No	1,761 (98.2)	5,063 (99.0)	6,824 (98.8)	2,154 (96.7)	5,601 (97.6)	7,755 (97.3)
Yes	31 (1.8)	51 (1.0)	82 (1.2)	74 (3.3)	139 (2.4)	214 (2.7)
Total	1,792 (100)	5,114 (100)	6,906 (100)	2,228 (100)	5,741 (100)	7,969 (100)
Sex with a non-marital partner						
No	926 (59.3)	2,951 (67.8)	3,878 (65.5)	1,229 (61.6)	3,569 (69.8)	4,798 (67.5)
Yes	636 (40.7)	1,404 (32.2)	2,040 (34.5)	768 (38.5)	1,547 (30.2)	2,315 (32.6)
Total	1,562 (100)	4,355 (100)	5,918 (100)	1,997 (100)	5,116 (100)	7,114 (100)
Used a condom at last non marital sex						
No	290 (45.6)	692 (49.3)	983 (48.2)	448 (58.4)	819 (52.9)	1,267 (54.7)
Yes	346 (54.4)	711 (50.7)	1,057 (51.8)	320 (41.6)	728 (47.1)	1,048 (45.3)
Total	636 (100)	1,404 (100)	2,040 (100)	768 (100)	1,547 (100)	2,315 (100)

Table 3. Generalised linear models showing unadjusted and adjusted associations between sexual risk behaviours and circumcision status among men age 15-59 years, Uganda 2004 and 2011

	Had multiple sexual partners in last 12 months, PRR [95% CI]		Had sex with non-marital partner in last 12 months, PRR [95% CI]		Used a condom at last non marital sex, PRR [95% CI]		Transactional sex in last 12 months, PRR [95% CI]	
	2004	**2011**	**2004**	**2011**	**2004**	**2011**	**2004**	**2011**
Unadjusted: **Circumcised**								
No	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Yes	1.51* [1.38,1.65]	1.35* [1.23,1.49]	1.26* [1.17,1.37]	1.27* [1.17,1.38]	1.07 [0.98,1.18]	0.88* [0.79,0.99]	1.72 [1.06,2.81]	1.36 [0.99,1.88]
Adjusted: **Circumcised**								
No	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Yes	1.38* [1.26,1.51]	1.23* [1.11,1.36]	1.12* [1.06,1.20]	1.05 [0.99,1.13]	1.00 [0.92,1.10]	0.85* [0.76,0.96]	1.56 [0.92,2.62]	1.23 [0.85,1.76]
Age								
15-24	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
25-34	1.04 [0.89,1.20]	1.03 [0.88,1.20]	0.90* [0.83,0.97]	0.91* [0.85,0.99]	0.93 [0.84,1.04]	0.90 [0.79,1.03]	0.76 [0.38,1.51]	0.65 [0.41,1.05]
35-44	0.94 [0.81,1.10]	1.10 [0.93,1.28]	0.73* [0.65,0.83]	0.80* [0.71,0.92]	0.76* [0.64,0.90]	0.79* [0.66,0.95]	0.34* [0.15,0.79]	0.58* [0.34,0.97]
45-59	0.68* [0.57,0.81]	0.85 [0.72,1.02]	0.54* [0.46,0.64]	0.55* [0.46,0.64]	0.49* [0.36,0.66]	0.53* [0.40,0.71]	0.28* [0.11,0.74]	0.19* [0.09,0.39]
Highest Education level								
No education	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Primary	1.33* [1.12,1.59]	1.21 [0.99,1.49]	1.26* [1.06,1.49]	1.11 [0.93,1.34]	1.28 [0.95,1.73]	1.75* [1.09,2.82]	1.51 [0.61,3.76]	0.96 [0.46,2.01]
Secondary	1.30* [1.07,1.57]	1.12 [0.90,1.41]	1.31* [1.10,1.55]	1.11 [0.92,1.33]	1.62* [1.20,2.19]	2.08* [1.29,3.37]	0.55 [0.18,1.70]	0.69 [0.31,1.51]
Higher	1.22	1.28	1.27*	1.21	1.80*	2.19*	0.43	0.44

	[0.96,1.56]	[0.98,1.67]	[1.05,1.54]	[0.98,1.49]	[1.32,2.46]	[1.34,3.59]	[0.07,2.52]	[0.15,1.26]
Marital status								
Never married	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Married	2.16*	1.75*	0.25*	0.22*	1.08	1.17*	1.58	1.11
	[1.81,2.56]	[1.47,2.08]	[0.23,0.27]	[0.20,0.25]	[0.97,1.21]	[1.02,1.34]	[0.73,3.43]	[0.66,1.89]
Divorced/Widowed	1.54*	1.10	0.86*	0.88*	0.92	1.07	2.49*	2.62*
	[1.23,1.94]	[0.84,1.45]	[0.79,0.93]	[0.81,0.96]	[0.79,1.07]	[0.89,1.29]	[1.02,6.05]	[1.43,4.79]
Residence								
Urban	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Rural	1.09	0.99	1.04	0.92	1.00	1.03	0.56	0.68
	[0.95,1.26]	[0.82,1.19]	[0.95,1.13]	[0.82,1.03]	[0.89,1.11]	[0.87,1.21]	[0.25,1.28]	[0.40,1.16]
Survey region								
Central	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Kampala	1.06	0.67*	0.94	0.87*	0.85*	1.12	0.93	0.84
	[0.93,1.22]	[0.52,0.87]	[0.85,1.05]	[0.77,0.98]	[0.74,0.97]	[0.95,1.32]	[0.48,1.80]	[0.39,1.83]
Eastern	0.76*	1.39*	0.85*	1.01	0.67*	0.66*	0.29*	0.85
	[0.66,0.88]	[1.21,1.60]	[0.78,0.93]	[0.92,1.10]	[0.58,0.78]	[0.56,0.78]	[0.12,0.69]	[0.53,1.35]
Northern	0.71*	0.97	0.74*	0.75*	0.68*	0.88	0.27*	0.43*
	[0.62,0.81]	[0.82,1.13]	[0.67,0.80]	[0.67,0.83]	[0.59,0.77]	[0.75,1.03]	[0.13,0.57]	[0.24,0.78]
Western	0.53*	1.15	0.62*	1.02	0.45*	0.67*	0.13*	1.32
	[0.43,0.65]	[0.99,1.33]	[0.54,0.73]	[0.94,1.12]	[0.33,0.61]	[0.57,0.79]	[0.03,0.53]	[0.86,2.03]
Wealth quintile								
Lowest	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Second	1.02	1.07	1.11	1.10	1.07	1.06	0.73	0.97
	[0.87,1.19]	[0.92,1.26]	[0.99,1.24]	[0.98,1.24]	[0.87,1.33]	[0.83,1.34]	[0.28,1.95]	[0.53,1.78]
Middle	1.15	1.23*	1.21*	1.23*	1.07	1.19	1.01	1.83*
	[0.98,1.34]	[1.05,1.45]	[1.07,1.36]	[1.09,1.38]	[0.86,1.32]	[0.95,1.50]	[0.41,2.50]	[1.01,3.29]
Fourth	1.21*	1.32*	1.21*	1.35*	1.07	1.37*	1.28	1.38
	[1.04,1.42]	[1.12,1.56]	[1.08,1.36]	[1.20,1.52]	[0.87,1.31]	[1.10,1.70]	[0.51,3.21]	[0.75,2.54]
Highest	1.36*	1.47*	1.28*	1.31*	1.37*	1.55*	0.57	1.17
	[1.15,1.61]	[1.20,1.80]	[1.13,1.44]	[1.14,1.50]	[1.12,1.67]	[1.22,1.96]	[0.17,1.87]	[0.56,2.48]
Number of men	**6886**	**7857**	**5919**	**6996**	**1945**	**2233**	**6886**	**7857**

Table 4: Models of the associations between sexual risk behaviours and circumcision status with combined data from the 2004 and 2011 UAIS

	Had multiple sexual partners in last 12 months		Had sex with non-marital partner in last 12 months		Used a condom at last non marital sex	
	Unadjusted, PRR [95%CI]	**Adjusted, PRR [95%CI]**	**Unadjusted, PRR [95%CI]**	**Adjusted, PRR [95%CI]**	**Unadjusted, PRR [95%CI]**	**Adjusted, PRR [95%CI]**
Circumcised						
No	1.0	1.0	1.0	1.0	1.0	1.0
Yes	1.51* [1.37,1.66]	1.42* [1.29,1.56]	1.26* [1.15,1.38]	1.14* [1.07,1.22]	1.07 [0.96,1.20]	1.02 [0.93,1.12]
Survey						
2004 UAIS	1.0	1.0	1.0	1.0	1.0	1.0
2011 UAIS	0.93 [0.84,1.03]	0.92 [0.83,1.02]	0.94 [0.85,1.03]	1.00 [0.94,1.05]	0.93 [0.84,1.03]	0.99 [0.91,1.07]
Interaction term *(circumcision and survey)*	0.90 [0.77,1.04]	0.89 [0.77,1.03]	1.01 [0.88,1.14]	0.94 [0.86,1.03]	0.82* [0.70,0.97]	0.81* [0.71,0.93]
Age						
15-24		1.0		1.0		1.0
25-34		1.02 [0.92,1.13]		0.90* [0.86,0.95]		0.92 [0.84,1.01]
35-44		1.00 [0.90,1.11]		0.76* [0.70,0.84]		0.78* [0.69,0.89]
45-59		0.76* [0.66,0.86]		0.54* [0.48,0.61]		0.51* [0.42,0.63]
Education level						
No education		1.0		1.0		1.0
Primary		1.28* [1.11,1.48]		1.18* [1.04,1.34]		1.44* [1.09,1.90]
Secondary		1.22* [1.04,1.43]		1.20* [1.05,1.38]		1.78* [1.35,2.35]
Higher		1.28* [1.06,1.55]		1.25* [1.07,1.45]		1.96* [1.47,2.59]
Marital status						
Never married		1.0		1.0		1.0
Married		1.96* [1.72,2.23]		0.23* [0.22,0.25]		1.11* [1.02,1.21]

Divorced/widowed		1.31* [1.10,1.57]		0.86* [0.81,0.92]		0.98 [0.87,1.11]
Residence						
Urban		1.0		1.0		1.0
Rural		1.13 [0.99,1.28]		1.00 [0.94,1.06]		0.97 [0.90,1.06]
Survey region						
Central		1.0		1.0		1.0
Kampala		1.03 [0.90,1.17]		0.95 [0.88,1.02]		0.93 [0.85,1.02]
Eastern		1.04 [0.93,1.18]		0.93 [0.87,1.00]		0.66* [0.58,0.74]
Northern		0.82* [0.72,0.92]		0.75* [0.70,0.81]		0.75* [0.67,0.84]
Western		0.87 [0.75,1.01]		0.90* [0.83,0.98]		0.60* [0.53,0.68]
Wealth quintile						
Lowest		1.0		1.0		1.0
Second		1.05 [0.94,1.18]		1.11* [1.02,1.21]		1.06 [0.91,1.24]
Middle		1.20* [1.06,1.36]		1.22* [1.12,1.33]		1.10 [0.94,1.29]
Fourth		1.29* [1.14,1.45]		1.30* [1.19,1.41]		1.19* [1.02,1.38]
Highest		1.43* [1.23,1.66]		1.32* [1.19,1.45]		1.43* [1.23,1.67]
Number of men	**14757**	**14743**	**12927**	**12915**	**4181**	**4178**