AIDS Care

Psychological and Socio-medical Aspects of AIDS/HIV

ISSN: 0954-0121 (Print) 1360-0451 (Online) Journal homepage: http://www.tandfonline.com/loi/caic20

Sexual risk behaviors following circumcision among HIV-positive men in Rakai, Uganda

Edward Nelson Kankaka, Joseph Ssekasanvu, Jessica Prodger, Dorean Nabukalu, Hadijja Nakawooya, Anthony Ndyanabo, Godfrey Kigozi & Ronald Gray

To cite this article: Edward Nelson Kankaka, Joseph Ssekasanvu, Jessica Prodger, Dorean Nabukalu, Hadijja Nakawooya, Anthony Ndyanabo, Godfrey Kigozi & Ronald Gray (2018): Sexual risk behaviors following circumcision among HIV-positive men in Rakai, Uganda, AIDS Care, DOI: 10.1080/09540121.2018.1437253

To link to this article: https://doi.org/10.1080/09540121.2018.1437253

AIDS CARE, 2018
https://doi.org/10.1080/09540121.2018.1437253

Routledge
Taylor & Francis Group

Sexual risk behaviors following circumcision among HIV-positive men in Rakai, Uganda

Edward Nelson Kankaka[a,b], Joseph Ssekasanvu[a,b], Jessica Prodger[b], Dorean Nabukalu[a], Hadijja Nakawooya[a], Anthony Ndyanabo[a], Godfrey Kigozi[a] and Ronald Gray[a,b]

[a]Rakai Health Sciences Program, Rakai, Uganda; [b]Department of Epidemiology, Bloomberg School of Public Health, Johns Hopkins University, Baltimore, MD, USA

ABSTRACT

Objective: To determine whether circumcision of HIV-positive men is associated with increased subsequent sexual risk behaviors which may place their female partners at risk.

Methods: Newly circumcised and uncircumcised HIV-positive men in the Rakai Community Cohort Study were followed from baseline (July 2013–January 2015) to determine trend in sexual risk behaviors and association of circumcision with subsequent sexual risk behaviors at follow up (February 2015–September 2016). Risk behaviors included sexual activity, alcohol before sex, transactional sex, multiple sex partners, casual sex partners, and inconsistent condom use with casual partners. The association was evaluated using modified Poisson regression, and sensitivity analyses were performed after multiple imputation with chained equations for missing data.

Results: We identified 538 eligible men, of whom 113(21.0%) were circumcised at baseline and 425 (79.0%) were uncircumcised. Men in fishing communities were more likely to be circumcised ($p = 0.032$) as well as those exposed to targeted HIV messaging ($p < 0.001$). Overall, 188(34.9%) men were lost to follow up and most were uncircumcised ($p = 0.020$). Among those followed up, behaviors remained largely unchanged with no differences by circumcision status. Transactional sex appeared to be associated with circumcision in unadjusted analyses (PR = 1.58, 95%CI = 1.01,2.48; $p = 0.045$, $p = 0.05$) and adjusted analyses (adj.PR = 1.54, 95%CI = 1.06,2.23; $p = 0.022$). However, the association was no longer significant in sensitivity analyses after accounting for loss to follow up (adj.PR = 1.43, 95%CI = 0.98,2.08; $p = 0.066$). No association with circumcision was observed for other sexual risk behaviors.

Conclusion: We found no association between circumcision of HIV-positive men and subsequent sexual risk behavior.

ARTICLE HISTORY
Received 2 August 2017
Accepted 1 February 2018

KEYWORDS
HIV-positive; male circumcision; risk compensation; risky sexual behavior; Rakai

Introduction

Three Randomized trials demonstrated that male circumcision (MC) reduces male HIV acquisition by up to 60% (Auvert et al., 2005; Bailey et al., 2007; Gray et al., 2007). Following recommendations by the WHO and UNAIDS (WHO/UNAIDS, 2007), male circumcision is now an integral component of HIV prevention strategies in 14 priority countries in Sub-Saharan Africa. However, there were early warnings that the benefits of circumcision could be jeopardized if scale up was not accompanied by efforts to change risky behavior (Cassell, Halperin, Shelton, & Stanton, 2017). While some studies suggest minimal or no risk compensation following male circumcision in HIV-negative men (Gray et al., 2012; Kong et al., 2012; Mattson et al., 2008; Westercamp, Agot, Jaoko, & Bailey, 2014), others have reported higher sexual risk behaviors, re-emphasizing need for prevention of risk compensation following circumcision (Kibira, Nansubuga, Tumwesigye, Atuyambe, & Makumbi, 2014; Kibira, Sandøy, Daniel, Atuyambe, & Makumbi, 2015; Mukudu, 2016; Wang, Feng, & Lau, 2016). Qualitative studies suggest that male circumcision accompanied by HIV counseling and testing can foster positive behavior change and reduce risk compensation (Grund & Hennink, 2012; Riess et al., 2010).

Some of the studies above included a minority of HIV-positive men but the analyses did not explicitly assess post-circumcision risk behavior in HIV-positive men. For example, a cross-sectional study that reported higher prevalence of sexual risk behavior in circumcised men only observed that majority of these circumcised men were HIV negative (Kibira, Sandøy, et al., 2015). The WHO recommended that HIV-positive men should not be denied circumcision unless medically contraindicated (WHO, 2007), since there are several benefits for them including reduction in human papillomavirus

CONTACT Edward Nelson Kankaka ken1edd@gmail.com Rakai Health Sciences Program, P.O.Box 279, Old Bukoba Road, Kalisizo, Uganda
Supplemental data for this article can be accessed http://dx.doi.org/10.1080/09540121.2018.1437253

infection, genital ulceration, and foreskin pathologies (Awad et al., 2017; Tobian et al., 2015). Recent mathematical modeling has also projected that greater inclusion of HIV positive men could significantly increase effectiveness of male circumcision programs (Awad et al., 2017). However, reports of a transient increase in post-circumcision penile HIV shedding (Tobian et al., 2015), and a seemingly higher rate of HIV acquisition in female partners of circumcised HIV-positive men (though non-significant) (Wawer et al., 2009), warrant specific assessment of whether circumcision of HIV-positive men is associated with increased sexual risk behaviors.

Methods

Data source

Data are from the Rakai Community Cohort Study (RCCS) in Rakai, South-central Uganda (Rakai Community Cohort Study, 2017). Initiated in 1994, the RCCS is an open population-based cohort which enrolls consenting residents aged 15–49 in up to 50 communities. Some of these communities are on the shores of lake Victoria and are heavily populated although with large migrations, some are along major highways and some are inland. Eligible participants are identified through a household census that precedes a survey. During the household census, household membership, births, deaths since the last visit, duration of stay per member, household possession, dwelling characteristics and mobility are determined. During the survey of eligible consenting participants who are present, data are collected on sociodemographic characteristics, sexual behavior, intimate partner violence, alcohol consumption, knowledge, attitudes and practices of HIV prevention methods, HIV testing, family planning, selected non-communicable diseases, and health services utilization. Participants also provide blood samples. Each study round may last approximately 18 months, but the recall period for most survey questions is within the preceding 12 months.

The RCCS has enabled increased understanding of HIV dynamics at individual and population level, and recently demonstrated a 42% reduction in HIV incidence since scale up of PEPFAR-supported Combination HIV Prevention in 2006 (Grabowski et al., 2017). This followed conclusion of the three male circumcision trials (Auvert et al., 2005; Bailey et al., 2007; Gray et al., 2007), one of which was in this setting (Gray et al., 2007), and the WHO/UNAIDS recommendation to include circumcision in prevention packages (WHO/UNAIDS, 2007). Free circumcision services are provided mostly by non-physicians (clinical officers as circumcisers and nurses as assistants) through community outreaches and at static units at strategically selected government health facilities, and free HIV care services are mostly provided through static units at government health facilities.

All participants in the RCCS are reminded about HIV prevention such as condom use, faithfulness, male circumcision, and enrolling or staying in care if HIV positive. Additionally, since mid-2014, men in some randomly selected RCCS communities additionally receive targeted de-medicalized messaging and services for Combination HIV Prevention (CHP) through the Stylish living campaign. Key messages in this campaign include HIV testing and counseling, treating partners with respect, caring about one's health, caring about family's health and wellbeing, discussing family issues with partner, condom use or faithfulness to partner, circumcision, seeking care and treatment if HIV positive, and family planning among others.

Study participants

This study includes HIV-positive men aged 15–49 from 35 RCCS communities who were initially uncircumcised at at the survey round between August 2011 and March 2013, were followed up for circumcision status at survey round between July 2013 and January 2015 (baseline) and subsequent sexual risk behavior at survey round between February 2015 and September 2016 (follow up).

Variables of interest, definitions and measurement

All variables were self-reported. Baseline sociodemographic characteristics included age, marital status, community type (fishing or non-fishing), education, and religion. Sexual risk behaviors were determined at baseline and follow up, and these included sexual activity, any alcohol consumption before sex, any transactional sex, multiple sex partners, casual sex partners, and inconsistent condom use with casual partners.

Sexual activity was defined and measured as sexual intercourse with any person in the last 12 months. Alcohol consumption before sex was defined as consumption of alcohol before sex with any partner in the last 12 months, and this was asked up to a maximum of 4 partners starting with the most recent. Transactional sex was defined as a man giving or receiving money, gifts, or favors for sex with any partner in the last 12 months, and this was asked up to a maximum of 4 partners starting with the most recent. Multiple sex partners was defined as three or more different sexual partners in

the last 12 months including marital or consensual partners and any other partners, and this was measured as the actual number stated or as "many" if one had more than 3 but was unsure of exact number. Casual sex partners were defined and measured as any current sexual relationship with someone to whom the man is not officially married or in a consensual union. Inconsistent condom use with casual partners was defined as any incident of sex with a casual partner without use of a condom within the last 12 months, and this too was determined up to a maximum of 4 partners starting with the most recent.

Statistical analysis

Descriptive statistics were performed using chi-square tests or Fisher exact tests as appropriate for binary and categorical covariates, while student t tests and Wilcoxon rank-sum tests were used to compare means(SD) and medians(IQR) of continuous covariates respectively. Indicator variables were used for missing baseline covariates. Men whose circumcision status changed during follow up were excluded. Among men seen at the follow up visit, the temporal change from baseline was assessed for each sexual risk behavior using the two-sample test of proportions (*prtest* in STATA), and the difference in change between the two groups was evaluated using the two-sample unpaired z test (*ztesti* in STATA).

The association of circumcision with subsequent sexual risk behavior was determined using modified poisson regression for participants seen both at baseline and follow up. In the adjusted analyses, we controlled for baseline age, marital status, community type, education status, religion, enrollment in HIV care, additional exposure to targeted messaging in the stylish living campaign, as well as the respective sexual risk behavior at baseline. Age was treated as a continuous variable, and necessity for age splines was checked using Wald tests. Covariates were evaluated for collinearity using variance inflation factors, and all final models were evaluated for Pearson's goodness of fit.

Sensitivity analyses were performed using the *mi estimate* command in STATA 14.2 to run modified Poisson regression on results from 20 imputations for missing data. The imputation was done using Multiple imputation with chained equations (MICE) method, assuming missingness at random. This was done for missing outcomes in participants lost to follow up, and for some missing data for participation in the stylish living campaign and transactional sex at baseline. MICE has been shown to perform well for small datasets (Schmitt, Mandel, & Guedj, 2015). Statistical significance for all tests was alpha <0.05. All analyses were performed with STATA 14.2 (StataCorp LP, College Station, Texas 77845 USA).

The study was approved by the Johns Hopkins University, Bloomberg School of Public Health IRB. The cohort was approved by the Research and Ethics Committee of the Uganda Virus Research Institute, the Uganda National Council for Science and Technology, and Western IRB (Olympia WA).

Results

Baseline characteristics & behavior

As shown in Table 1, 538 HIV-positive men from the Rakai Community Cohort Study (RCCS) were identified. Overall median age was 34.5 years and majority lived in fishing communities (62.1%), were in a marital union (64.3%), had a primary school education (75.7%), and were catholic (77.0%). Most were sexually active at baseline (93.5%) and majority used alcohol before sex (60.0%). Of the 538 men identified, 113(21%) were newly circumcised at baseline and 425(79%) were uncircumcised. Men in fishing communities were more likely to be circumcised ($p = 0.032$), as well as men who had participated in the *Stylish living* campaign ($p < 0.001$). Circumcised and uncircumcised men had comparable sexual risk behaviors at baseline.

Loss to follow up

A total of 350 men (65.1%) were seen at the follow up visit while 188 men (34.9%) were lost to follow up. Compared to men who were followed up, those lost to follow up were more likely to be uncircumcised ($p = 0.020$) and more likely to never have heard about the *Stylish living* campaign ($p = 0.005$). Those lost and those followed up were comparable with respect to other baseline characteristics and sexual risk behaviors (Table 2).

Temporal trend in sexual risk behavior

In the uncircumcised group, the only significant temporal change in sexual risk behaviors among those seen at the follow up visit was a decline in inconsistent condom use with casual partners (change = −15.4% points; 95%CI −23.6,−7.2; $p < 0.001$). In the circumcised group, no significant change was observed. The circumcised and uncircumcised groups had comparable temporal trends for all sexual risk behaviors (p-values testing equality of changes for each sexual risk behavior >0.05, Table 3).

Table 1. Baseline characteristics and baseline sexual risk behaviors of uncircumcised HIV +ve men versus circumcised HIV +ve men §.

	All N = 538	Uncircumcised N = 425	Circumcised N = 113	p-value
Age; mean(SD)	35.0(7.1)	35.2(7.2)	34.5(6.7)	0.356
median(IQR)	34.5(30–40)	35(30–40)	33(29–40)	0.305
Marital status, *n*(%)				
currently unmarried	162(30.1)	130(30.6)	32(28.3)	0.514
currently married	346(64.3)	269(63.3)	77(68.1)	
Never married	30(5.6)	26(6.1)	4(3.5)	
Community, *n*(%)				
Non-fishing	204(37.9)	171(40.2)	33(29.2)	0.032
Fishing	334(62.1)	254(59.8)	80(70.8)	
Education, *n*(%)				
None	56(10.4)	43(10.1)	13(11.5)	0.826
Primary school	407(75.7)	324(76.2)	83(73.5)	
Secondary school or higher	75(13.9)	58(13.7)	17(15.0)	
Religion, *n*(%)				
Catholic	414(77.0)	330(77.7)	84(74.3)	0.329
Protestant	96(17.8)	71(16.7)	25(22.1)	
Other	28(5.2)	24(5.7)	4(3.5)	
Exposure to stylish living campaign ∞, *n*(%)				
Participated	77(14.3)	39(9.2)	38(33.6)	<0.001
Heard, did not participate	144(26.8)	124(29.2)	20(17.7)	
Never heard	289(53.7)	236(55.5)	53(46.9)	
Missing (Unknown)	28(5.2)	26(6.1)	2(1.8)	
In HIV care, *n*(%)				
Yes, with ART	237(44.1)	187(44.0)	50(44.3)	0.498
Yes, with Septrin only	136(25.3)	102(24.0)	34(30.1)	
Yes, but no Septrin or ART	148(27.5)	122(28.7)	26(23.0)	
Never	17(3.2)	14(3.3)	3(2.7)	
Sexually active, *n*(%)				
No	35(6.5)	32(7.5)	3(2.7)	0.083
Yes	503(93.5)	393(92.5)	110(97.4)	
Alcohol before sex, *n*(%)				
No	215(40.0)	168(39.5)	47(41.6)	0.691
Yes	323(60.0)	257(60.5)	66(58.4)	
Transactional sex, *n*(%)				
No	360(66.9)	286(67.3)	74(65.5)	0.789
Yes	107(19.9)	82(19.3)	25(22.1)	
Missing (Unknown)	71(13.2)	57(13.4)	14(12.4)	
Multiple sex partners (3+), *n*(%)				
No	416(77.3)	331(77.9)	85(75.2)	0.548
Yes	122(22.7)	94(22.1)	28(24.8)	
Casual sex partners, *n*(%)				
No	264(49.1)	210(49.4)	54(47.8)	0.759
Yes	274(50.9)	215(50.6)	59(52.2)	
Condom use with casual partners, *n*(%)				
Consistent or no casual partner	268(49.8)	214(50.4)	54(47.8)	0.628
Inconsistent	270(50.2)	211(49.7)	59(52.2)	

§ The baseline survey was conducted between July 2013 and January 2015.
∞ The Stylish living campaign involves targeted messaging for Combination HIV Prevention (CHP), and was conducted in randomly selected communities within the Rakai Community Cohort Study (RCCS) since mid-2014.

Table 2. Baseline characteristics and baseline sexual risk behaviors of HIV +ve men retained versus HIV +ve men lost to follow up.

	Retained N = 350	Lost N = 188	p-value
Circumcision status, *n*(%)			
Uncircumcised	266(76.0)	159(84.6)	0.020
Circumcised	84(24.0)	29(15.4)	
Age; mean(SD)	35.2(6.7)	34.8(7.8)	0.533
median(IQR)	35(30–40)	34(28.5–40)	0.416
Marital status, *n*(%)			
currently unmarried	97(27.7)	65(34.6)	0.113
currently married	236(67.4)	110(58.5)	
never married	17(4.9)	13(6.9)	
Community, *n*(%)			
Non-fishing	134(38.3)	70(37.2)	0.811
Fishing	216(71.7)	118(62.8)	
Education, *n*(%)			
None	40(11.4)	16(8.5)	0.571
Primary school	262(74.9)	145(77.1)	
Secondary school or higher	48(13.7)	27(14.4)	
Religion, *n*(%)			
Catholic	276(78.9)	138(73.4)	0.170
Protestant	60(17.1)	36(19.2)	
Other	14(4.0)	14(7.5)	
Exposure to stylish living campaign, *n*(%)			
Participated	60(17.1)	17(9.0)	0.005
Heard, did not participate	102(29.1)	42(22.3)	
Never heard	173(49.4)	116(61.7)	
Missing (Unknown)	15(4.3)	13(6.9)	
In HIV care, *n*(%)			
Yes, with ART	166(47.4)	71(37.8)	0.145
Yes, with Septrin only	82(23.4)	54(28.7)	
Yes, but no Septrin or ART	90(25.7)	58(30.9)	
Never	12(3.4)	5(2.7)	
Sexually active, *n*(%)			
No	24(6.9)	11(5.9)	0.652
Yes	326(93.1)	177(94.1)	
Alcohol before sex, *n*(%)			
No	150(42.9)	65(34.6)	0.061
Yes	200(57.1)	123(65.4)	
Transactional sex, *n*(%)			
No	233(66.6)	127(67.6)	0.736
Yes	68(19.4)	39(20.7)	
Missing (Unknown)	49(14.0)	22(11.7)	
Multiple sex partners (3+), *n*(%)			
No	272(77.7)	144(76.6)	0.768
Yes	78(22.3)	44(23.4)	
Casual sex partners, *n*(%)			
No	178(50.9)	86(45.7)	0.258
Yes	172(49.1)	102(54.3)	
Condom use with casual partners, *n*(%)			
Consistent or no casual partner	181(51.7)	87(46.3)	0.229
Inconsistent	169(48.3)	101(53.7)	

Association of circumcision with subsequent sexual risk behaviors

Transactional sex appeared to be associated with circumcision of HIV positive men in unadjusted analyses (PR = 1.58; 95%CI = 1.01,2.48; $p = 0.045$) and adjusted analyses (adj.PR = 1.54, 95%CI 1.06,2.23; $p = 0.022$), Table 4 and Supplemental Table 1.

However, after imputation for missing data in the sensitivity analyses, the association between transactional sex and circumcision of HIV positive men was no longer significant (adj.PR = 1.43, 95%CI = 0.98,2.08; $p = 0.066$). Other sexual risk behaviors were still not associated with circumcision in sensitivity analyses, Supplemental Table 2.

Discussion

Our study shows that there was no significant difference in sexual risk behaviors between circumcised and uncircumcised HIV-positive men. The only apparent

Table 3. Change in sexual risk behaviors of uncircumcised and circumcised HIV +ve men in Rakai, Uganda[¶].

Sexual risk behavior in last 12 months	Uncircumcised ($N = 266$) Baseline ***n*(%)**	Follow up ***n*(%)**	Δ_{uc}	95% CI	***p*-value testing H_0: $\Delta_{uc} = 0$**	Circumcised ($N = 84$) Baseline *n*(%)	Follow up *n*(%)	Δ_c	95% CI	***p*-value testing H_0: $\Delta_c = 0$**	*p*-value testing H_0: $\Delta_{uc} = \Delta_c$
Sexually active, yes	244(91.7)	243(91.4)	−0.3	−5.1,4.4	0.876	82(97.6)	79(94.1)	−3.5	−9.6,2.4	0.247	0.413
Alcohol before sex, yes	155(58.3)	149(56.0)	−2.3	−10.7,6.2	0.599	45(53.6)	42(50.0)	−3.6	−18.7,11.5	0.643	0.881
Transactional sex, yes	48(18.1)	44(16.5)	−4.6	−11.5,2.3	0.191	20(23.8)	22(26.2)	−0.8	−14.6,13.0	0.905	0.633
Multiple sex partners (3+), yes	58(21.8)	51(19.2)	−2.6	−9.5,4.2	0.452	20(23.8)	22(26.2)	+2.4	−10.7,15.5	0.722	0.506
Casual sex partners, yes	130(48.9)	118(44.4)	−4.5	−13.0,4.0	0.297	42(50.0)	45(53.6)	+3.6	−11.5,18.7	0.643	0.360
Inconsistent condom use with casual partners, yes	127(47.7)	86(32.3)	−15.4	−23.6,−7.2	<0.001	42(50.0)	36(42.9)	−7.1	−22.2,7.9	0.353	0.344

¶ Changes are only among the 350 men retained i.e., those seen at the baseline visit (07/2013-01/2015) and follow up visit (02/2015-09/2016).
Δ_{uc} Change in the uncircumcised group (proportion engaging in sexual risk behavior at follow up minus proportion at baseline).
Δ_c Change in the circumcised group (proportion engaging in sexual risk behavior at follow up minus proportion at baseline).

association of transactional sex with circumcision of HIV positive men was no longer consistent in sensitivity analyses. This could be explained by a possible emigrative selection bias. Men lost to follow up were more likely to fall in one category of exposure (the uncircumcised group) as shown in Table 2. Their exit probably differentially lowered the prevalence of transactional sex in the uncircumcised group, leading to an apparently higher prevalence ratio of transactional sex in the circumcised versus the uncircumcised group in the analysis of only complete cases.

Therefore, the absence of a significant association between circumcision of HIV positive men and subsequent sexual risk behaviors suggests that engagement in subsequent sexual risk behaviors may happen independent of circumcision. Our finding is in agreement with a number of previous studies that found no such association in this setting (Gray et al., 2012; Kong et al., 2012) and other settings (Mattson et al., 2008; Westercamp et al., 2014) in all men irrespective of their HIV status. Instead, subsequent sexual risk behaviors could be driven by other factors such as already prevailing behavior, residence in a fishing community, and low exposure to targeted messaging, as shown in Supplemental Table 1 and Supplemental Table 2. Our findings are also in contrast with some other studies in Uganda (Kibira et al., 2014; Kibira, Sandøy, et al., 2015) and other settings (Kibira, Makumbi, Daniel, Atuyambe, & Sandøy, 2015; Wang et al., 2016) that found an association. Although one of these studies explicitly reported that circumcised men had higher prevalence of sexual risk behaviors, they observed that majority of these men were HIV negative. To the best of our knowledge, none of the studies that reported increased sexual risk behavior post-circumcision attributed it to an HIV positive status.

Table 4. Association between circumcision of HIV +ve men and subsequent sexual risk behaviors, circumcised versus uncircumcised[¶].

Sexual risk behavior in last 12 months	Unadjusted PR	95% CI	***p*-value**	Adjusted[a,§] PR	95% CI	***p*-value**
Sexual activity	1.02	0.96,1.10	0.384	0.99	0.94,1.05	0.790
Alcohol before sex	0.89	0.70,1.13	0.352	0.94	0.75,1.18	0.613
Transactional sex	1.58	1.01,2.48	0.045	1.54	1.06,2.23	0.022
Multiple sexual partners (3+)	1.36	0.88,2.11	0.161	1.39	0.92,2.10	0.115
Casual sex partners	1.21	0.95,1.54	0.124	1.19	0.96,1.48	0.118
Inconsistent condom use with casual partners	1.33	0.98,1.79	0.068	1.25	0.94,1.67	0.131

¶ Associations are only among the 350 men retained i.e., those seen at the baseline visit (07/2013-01/2015) and follow up visit (02/2015-09/2016)
[a]Adjusted for baseline age, marital status, community type, education status, religion, enrollment in HIV care, additional exposure to targeted messaging in the stylish living campaign, as well as the respective behavior at baseline
§Full results for each adjusted model are included in supplements (Supplemental Table 1).

Our findings also demonstrate that background sexual risk behavior may not influence the choice for circumcision (no association, Table 1), although it could influence subsequent behavior. Confounding by indication due to background sexual risk behavior was therefore unlikely. HIV positive men may chose to get circumcised due to other factors such as targeted messaging and enhanced services in high risk communities (as shown in Table 1) but not because they are engaging in sexual risk behaviors. This is in contrast to findings in a cross-sectional study from the 2011 Uganda AIDS Indicator Survey by Kibira et al which suggested that early adopters of circumcision probably did so because they were already engaging in some sexual risk behaviors (Kibira, Makumbi, et al., 2015). Due to this concern, we controlled for baseline sexual risk behavior in the final models although we had found no association with exposure status (circumcision or uncircumcised). It is important to note that that particular study considered perceived risk for HIV but not the actual HIV status of men.

Sexual risk behaviors remained largely unchanged during the follow up period. Our follow up period was short, but the trend is largely consistent with recent findings in a study by Grabowski et al (Grabowski et al., 2017) also used data from the Rakai Community Cohort

Study but over a 17-year period. The only significant changes they reported was a marked increase in delay to initiate sex among adolescent boys aged 15–19 years from 35% in 1999 to 56% in 2016, and a decline in multiple sexual partnerships from 40% in 1999 to 19% in 2016 in the same age group. In the general population of men aged 15–49, reported behaviors remained largely unchanged.

It is noteworthy however that the levels of sexual risk behaviors in our study of HIV positive men seem to be lower than that in the general population of men reported by Grabowski et al. For example by 2016, only 22.7% of HIV positive men in our study had multiple sex partnerships versus about 35% in the general population of men (Grabowski et al., 2017). Also, only 50.2%% of HIV positive men in our study inconsistently used condoms with casual partners versus about 60% in the general population of men. Grabowski et al also showed that circumcision coverage increased over time for both HIV negative and HIV positive men, but the increase was faster for HIV negative men compared to HIV positive men. This means without extra effort, HIV positive men may be slower in choosing to get circumcised. Positively however, they could also be less likely to engage in sexual risk behaviors compared to the general population in which majority are HIV negative. This implies HIV status could confound the relationship between circumcision status and subsequent sexual risk behavior. Having considered only HIV positive men in our study, we could have eliminated the potential confounding effect of HIV status, leading to the absence of an association between circumcision and subsequent sexual risk behavior in a cohort of only HIV positive men. A subsequent study could evaluate the same association particularly in the group of HIV negative men from the same cohort.

There are limitations to this study. Risk behaviors were self-reported and thus subject to social desirability and recall bias, but such bias should be comparable between circumcised and uncircumcised men. Self-selection bias is possible especially with respect to targeted HIV prevention messaging in the *Stylish living* campaign where exposed men more likely to get circumcised. However, this variable was controlled for in the adjusted models (Supplemental Table 1). Those unexposed to this intervention engaged in more transactional sex than those exposed, but this was not observed for other behaviors.

Conclusion

We found no association between circumcision of HIV positive men and subsequent sexual risk behavior. Therefore, circumcision services should be available to HIV-positive men with no medical contraindications for surgery.

Acknowledgement

We thank the Rakai Health Sciences Program for availing the data. We also appreciate Prof. Diener West and Prof. Rosa Crum of the Bloomberg School of Public Health for constructive feedback.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

The study was supported by, the National Institute of Allergy and Infectious Diseases (R01AI110324, U01AI100031, R01AI110324, R01AI102939), the National Institute of Child Health and Development (RO1HD070769, R01HD050180), the Bill & Melinda Gates Foundation (22006.02), and the NIH Fogarty International Center (5D43TW009578-02).

References

Auvert, B., Taljaard, D., Lagarde, E., Sobngwi-Tambekou, J., Sitta, R., Puren, A., & Deeks, S. (2005). Randomized, controlled intervention trial of male circumcision for reduction of HIV infection risk: The ANRS 1265 trial. *PLoS Medicine*, *2*(11), e298. doi:10.1371/journal.pmed.0020298

Awad, S. F., Sgaier, S. K., Lau, F. K., Mohamoud, Y. A., Tambatamba, B. C., Kripke, K. E., … Graham, S. M. (2017). Could circumcision of HIV-positive males benefit voluntary medical male circumcision programs in Africa? Mathematical modeling analysis. *PLoS One*, *12*(1), e0170641. Retrieved from https://search.proquest.com/docview/1861455198. doi:10.1371/journal.pone.0170641

Bailey, R. C., Moses, S., Parker, C. B., Agot, K., Maclean, I., Krieger, J. N., … Ndinya-Achola, J. O. (2007). Male circumcision for HIV prevention in young men in Kisumu, Kenya: A randomised controlled trial. *The Lancet*, *369*(9562), 643–656. Retrieved from http://www.sciencedirect.com/science/article/pii/S0140673607603122. doi:10.1016/S0140-6736(07)60312-2

Cassell, M. M., Halperin, D. T., Shelton, J. D., & Stanton, D. (2017). Risk compensation: The Achilles' heel of innovations in HIV prevention? *ProQuest*. Retrieved from http://search.proquest.com/openview/d36ac3bba2f1d55b02119dee8b73ed31/1?pq-origsite=gscholar&cbl=2040978

Grabowski, M. K., Serwadda, D. M., Gray, R. H., Nakigozi, G., Kigozi, G., Kagaayi, J., … Chang, L. W. (2017). HIV prevention efforts and incidence of HIV in Uganda. *New England Journal of Medicine*, *377*(22), 2154–2166. Retrieved from http://www.nejm.org/doi/pdf/10.1056/NEJMoa1702150

Gray, R., Kigozi, G., Kong, X., Ssempiija, V., Makumbi, F., Wattya, S., … Wawer, M. J. (2012). The effectiveness of male circumcision for HIV prevention and effects on risk

behaviors in a post-trial follow up study in Rakai, Uganda. *AIDS*, *26*(5), 609–615. doi:10.1097/QAD.0b013e3283504a3f

Gray, R. H., Kigozi, G., Serwadda, D., Makumbi, F., Watya, S., Nalugoda, F., … Wawer, M. J. (2007). Male circumcision for HIV prevention in men in rakai, uganda: A randomised trial. *The Lancet*, *369*(9562), 657–666. doi:10.1016/S0140-6736(07)60313-4

Grund, J. M., & Hennink, M. M. (2012). A qualitative study of sexual behavior change and risk compensation following adult male circumcision in urban Swaziland. *AIDS Care*, *24*(2), 245–251. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/09540121.2011.596516. doi:10.1080/09540121.2011.596516

Kibira, S. P. S., Makumbi, F., Daniel, M., Atuyambe, L. M., & Sandøy, I. F. (2015). Sexual risk behaviours and willingness to be circumcised among uncircumcised adult men in Uganda. *PLoS One*, *10*(12), e0144843. Retrieved from https://search.proquest.com/docview/1748858022. doi:10.1371/journal.pone.0144843

Kibira, S. P., Nansubuga, E., Tumwesigye, N. M., Atuyambe, L. M., & Makumbi, F. (2014). Differences in risky sexual behaviors and HIV prevalence of circumcised and uncircumcised men in Uganda: Evidence from a 2011 cross-sectional national survey. *Reproductive Health*, *11*(1), 657. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/24656204. doi:10.1186/1742-4755-11-25

Kibira, S. P. S., Sandøy, I. F., Daniel, M., Atuyambe, L. M., & Makumbi, F. E. (2015). A comparison of sexual risk behaviours and HIV seroprevalence among circumcised and uncircumcised men before and after implementation of the safe male circumcision programme in Uganda. *BMC Public Health*, *16*, CD003362. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/26727935

Kong, X., Kigozi, G., Nalugoda, F., Musoke, R., Kagaayi, J., Latkin, C., … Gray, R. (2012). Assessment of changes in risk behaviors during 3 years of posttrial follow-up of male circumcision trial participants uncircumcised at trial closure in Rakai, Uganda. *American Journal of Epidemiology*, *176*(10), 875–885. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/23097257. doi:10.1093/aje/kws179

Mattson, C. L., Campbell, R. T., Bailey, R. C., Agot, K., Ndinya-Achola, J. O., Moses, S., & Myer, L. (2008). Risk compensation is not associated with male circumcision in Kisumu, Kenya: A multi-faceted assessment of men enrolled in a randomized controlled trial. *PLoS One*, *3*(6), e2443. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/18560581. doi:10.1371/journal.pone.0002443

Mukudu, H. (2016). *Voluntary medical male circumcision for prevention of heterosexual transmission of HIV and risk compensation in adult males in Soweto: What do indicators and incidence rate show?* Johannesburg, South Africa: University of the Witwatersrand.

Rakai Community Cohort Study. (2017). Retrieved from http://www.rhsp.org/index.php/what-we-do/o-research/rakai-community-cohort-study. Updated 2017

Riess, T. H., Achieng', M. M., Otieno, S., Ndinya-Achola, J. O., Bailey, R. C., & Myer, L. (2010). "When I was circumcised I was taught certain things": Risk compensation and protective sexual behavior among circumcised men in Kisumu, Kenya. *PLoS One*, *5*(8), e12366. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/20811622. doi:10.1371/journal.pone.0012366

Schmitt, P., Mandel, J., & Guedj, M. (2015). A comparison of six methods for missing data imputation. *Journal of Biometrics and Biostatistics*, *6*(224), 1.

Tobian, A. A. R., Kigozi, G., Manucci, J., Grabowski, M. K., Serwadda, D., Musoke, R., … Low, N. (2015). HIV shedding from male circumcision wounds in HIV-infected men: A prospective cohort study. *PLOS Medicine*, *12*(4), e1001820. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/25919012. doi:10.1371/journal.pmed.1001820

Wang, Z., Feng, T., & Lau, J. T. F. (2016). Prevalence and associated factors of behavioral intention for risk compensation following voluntary medical male circumcision among male sexually transmitted diseases patients in china. *AIDS Care*, *28*(10), 1332–1337. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/09540121.2016.1178696. doi:10.1080/09540121.2016.1178696

Wawer, M. J., Makumbi, F., Kigozi, G., Serwadda, D., Watya, S., Nalugoda, F., … Gray, R. H. (2009). Circumcision in HIV-infected men and its effect on HIV transmission to female partners in Rakai, Uganda: A randomised controlled trial. *The Lancet*, *374*(9685), 229–237. Retrieved from http://www.sciencedirect.com/science/article/pii/S0140673609609983. doi:10.1016/S0140-6736(09)60998-3

Westercamp, N., Agot, K., Jaoko, W., & Bailey, R. C. (2014). Risk compensation following male circumcision: Results from a two-year prospective cohort study of recently circumcised and uncircumcised men in Nyanza province, Kenya. *AIDS and Behavior*, *18*(9), 1764–1775. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/25047688. doi:10.1007/s10461-014-0846-4

WHO. (2007). WHO | new data on male circumcision and HIV prevention. Retrieved from http://www.who.int/hiv/pub/malecircumcision/research_implications/en/

WHO/UNAIDS. (2007). WHO/UNAIDS Technical Consultation: Male Circumcision and HIV Prevention: Research Implications for Policy and Programming (2007: Montreux, Switzerland), World Health Organization, UNAIDS. New data on male circumcision and HIV prevention: Policy and programme implications: WHO/UNAIDS technical consultation male circumcision and HIV prevention: Research implications for policy and programming, montreux, 6-8 march 2007: Conclusions and recommendations.