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Full Length Research Paper

Male circumcision and HIV infection in Bukoba urban district, Kagera region, Tanzania

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Kagera is one of the 22 regions of Tanzania, which has witnessed a decline in HIV prevalence from 24% in 1987 to 4.7% in 2009 in the urban district of Bukoba. The aim of this study was to study the association between male circumcision and HIV infection in an urban district with an observed decline in HIV prevalence. We conducted a population-based cross-sectional study of a representative sample of 1497 males. The HIV testing was performed using enzyme-linked immunosobent assay (ELISA) antibody detection tests. Using logistic and multivariate regression analysis we assessed the associations between HIV status and prior circumcision while taking other risk factors into account. Individuals who were uncircumcised were almost two times more likely to be HIV positive compared to individuals who were circumcised (OR=1.9, 95% CI: 1.3-2.9). This association remained statistically significant even after adjusting for potential confounding factors such as age, marital status, occupation, level of education, condom use and number of sexual partners (OR=1.7, 95 % CI:1.03-2.6). The study concludes that male circumcision has a significant protective effect against HIV infection and that policy makers should strengthen existing male circumcision programmes to prevent new HIV infections.

Key words: Male circumcision, HIV infection, Kagera, Tanzania.

INTRODUCTION

Male circumcision (MC) involves the removal of all or part of the foreskin of the penis and is in most cases undertaken for religious, cultural, social or medical reasons (Alanis and Lucidi, 2004). In contemporary Africa reasons for practicing MC vary from one community to another. The most common reasons include rites of passage from one stage to another, especially from adolescence to adulthood, promotion of personal hygiene and adherence to religious circumcision rituals (Auvert et al., 2005).

Since the mid 1980s there has been much interest in public health regarding the protective effect of MC against HIV infection (Fink, 1986). Since then several studies have been conducted in East and Southern Africa, where HIV prevalence is high and MC is less practiced (Bonga arts, Reining, Way and Conant 1989; Moses et al., 1990).

A systematic review of several epidemiological studies in Sub-Saharan Africa, where the HIV transmission mode is predominantly heterosexual, has shown that HIV prevalence is high in countries where MC is little or not practiced (Mosses et al, 1990; Halpern and Bailey, 1999). More than 30 cross-sectional studies showed that uncir-

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cumcised men had a higher risk of contracting HIV infection than circumcised men (Bailey and Mosses 2001; Bailey et al, 2007). In 2005 a randomized controlled trial from Orange farm in South Africa showed a 60% reduction in HIV infection among men who were circumcised compared to uncircumcised men (Auvert et al., 2005). These findings were later supported in two other trials, conducted in Kisumu, Kenya, and Rakai District, Uganda. They reported a risk reduction of acquiring HIV infection for circumcised men of 53% and 51% respectively (Bailey et al., 2007; Gray et al., 2007).

Biological studies also support that MC is protective against HIV infection. They describe that the inner mucosal surface foreskin, when erected and exposed, has higher density of HIV target cells such as CD4+, macrophages and langer hans' cells than does cervical tissues. However, HIV target cells on the outer surface and glans are usually protected by a layer called squamous epithelial cells (Patterson et al., 2002; McCoombe and Short, 2006). In addition, the risk of HIV infection becomes higher for uncircumcised men with a history of sexually transmitted infections (STIs) (Donaval et al., 2006).

Following evidence from these and other observational epidemiological studies, WHO recommended that MC should be considered as one of the new interventions for HIV prevention, and called for all countries to include it in their national comprehensive HIV intervention packages (WHO and UNAIDS, 2008).

Despite WHO and UNAIDS recommendations of MC as a means to prevent further spread of HIV infection, there are still challenges in the implementation of this intervention. Westercamp and Bailey (2007) argued that the effectiveness of MC depends on its acceptability, particularly in some of the African communities that traditionally do not practice MC. They further claimed that the age at which MC is performed is important for its effectiveness and suggested that infant circumcision is better than adult- or pubertal circumcision.

In Tanzania circumcision is most commonly performed before the age of 14 (URT, 2010). Several studies show that the culture of MC is based on three main factors: a rite of passage from adolescence to adulthood, a religious ritual or a personal hygienic factor (Urassa et al., 1997; Obasi et al., 1999; Tanzania commission for AIDS, 2004). Muslims practice more MC (96.7%) compared to Christians (70%) and men with traditional beliefs (25%). Muslims are the largest religious groups practicing MC because it is believed that no uncircumcised person may lawfully make the *pilgrimage to Mecca* (Rizvi et al., 1999). MC in Tanzania is traditionally practiced in some cultures as part of the initiation for boys to pass from infancy to adulthood (Wambura et al., 2011). Among Kuryan men in the northeastern part of Tanzania the circumcision procedure does not involve any use of anesthesia or suturing of an incision. This practice is an indication that circumcised men are brave and can withstand pain and that they are ready to become responsible persons in the society (Nnko et al., 2001; Mshana et al., 2011). In cultures where MC is a traditional practice it is very shameful and unacceptable for a man to remain uncircumcised and those who are not circumcised are usually stigmatized (Wambura et al, 2009). MC is also associated with social cohesion among boys of the same age by being part of expressing self-identity and masculinity (Niang, 2006).

Like many other countries in sub-Saharan Africa, Tanzania is at an early stage of scaling-up safe MC as one of the important strategies to prevent further spread of HIV infection. The country has registered a decline in HIV prevalence at national level since 2007-2008 when HIV prevalence among adults aged 15-49 years was estimated at 6.2% compared to 7.7% in 2003-2004 (National Bureau of Statistics, 2008). Kagera is one of the regions in Tanzania that has experienced a significant decline in HIV prevalence and incidence since the epidemic began. The first HIV cases in Tanzania were reported from this region in 1983. Four years later the HIV prevalence of the most urbanized area of the region was estimated to be 24% compared to 6.8% in the peri-urban and 4.5% in the most remote rural area. Based on the observed HIV prevalence in 1987, the Kagera AIDS research project (KARP) divided the region into three geographical zones; a high prevalence zone consisting of urban areas; a medium prevalence zone consisting of semi-urban areas and a low HIV prevalence zone consisting of rural areas. This division helped the project to monitor the HIV infection trends using repeated cross-sectional surveys (Killewo et al., 1993). Studies by KARP have indicated a downward trend of HIV infection in all study zones; from 24% in 1987 to 18% in 1993, to 13% in 1996, and to 8.2% in 2004 in the high prevalence zone; from 10% in 1987 to 6.8% in 1996, and to 4.3% in 1999 in the medium prevalence zone; and from 4.5 % in 1987 to 2.6% in 1999 in the low HIV prevalence zone. The decline in HIV prevalence was supported by a downward trend in HIV incidence from 47.5/1000 in 1989 to 9.1/1000 persons at risk in 1996 and from 8.2/1000 in 1989 to 3.9/1000 persons at risk in 1999/2000 in the high and medium HIV prevalence zones respectively (Killewo et al., 1990; Kwesigabo et al., 1999; Kwesigabo, 2001).

Several studies have explored possible factors responsible for the decline of HIV infection in Kagera and other regions. These include government commitment and political will to fight the epidemic by allocating more resources to prevent further spread of the epidemic, initiation of early treatment of sexually transmitted infections in hospitals, health centres and dispensaries, ensuring adequate availability of voluntary counseling and testing (VCT), increased use of condoms as well as prevention of mother to child transmission (PMTCT). The involvement of non-governmental organizations as well as private and informal sectors in the campaigns for promoting condoms use, limiting the number of sexual

partners/staying faithful to one partner, and delaying sexual debut in young persons have also been described as contributing to the HIV decline in the country (Kwesigabo, 2001; URT, 2008). A study from Kagera reported a decrease in the stigma associated with HIV/AIDS, increased risk awareness and an openness to talk about the disease that together influenced people to change their risky sexual behavior (Lugalla et al., 2004). Social capital, in its structural and cognitive forms, has also been reported to have influenced people's sexual behaviors positively and thereby contributed to the observed decline in HIV prevalence (Frumence et al, 2011).

As reported by Auvert et al., (2004), efforts by the government and other stakeholders to provide free antiretroviral therapy (ART) to people living with HIV/AIDS has also contributed to reduction of further spread of HIV infection.

In 2009 Tanzania introduced MC as an intervention to reduce HIV infection in eight regions including Kagera (URT, 2012) based on WHO and UNAIDS recommendations that *'Male circumcision should be recognized as an efficacious intervention for HIV prevention'* and that *'promoting male circumcision should be recognized as an additional, important strategy for the prevention of heterosexually acquired HIV infection in men'* (WHO & UNAIDS, 2007 page 4). MC is thus seen as additional and important strategy towards preventing further HIV infection because in most of the African countries, including Tanzania, over 90% of HIV infections are acquired through vaginal intercourse. Therefore understanding the factors that may reduce men's HIV vulnerability are of great interest and importance (Bailey, 2001). Several studies have reported on possible factors responsible for the declining trend of HIV infection in Kagera (Kwesigabo, 2001; Lugalla et al., 2004; Frumence et at., 2011) but so far no study has determined the contribution of MC in reducing HIV infection in the region. Therefore this study attempts to estimate the impact of MC on HIV infection in Kagera region of Tanzania.

METHODS

Study Area and Population

The study was performed in the Bukoba urban district in Kagera region, an area with an observed declining trend in HIV infections between late 1980's and mid 2000 (Kwesigabo, 2001). Administratively, Bukoba urban district has only one division, which is divided into 14 wards, each of which is further subdivided into several 'streets' that form the smallest administrative units. The district had a total population of 128,796 with a mean household size of 3.9 (National Bureau of Statistics, 2012).

Sample Size

The main outcome measure in this study was prevalence of HIV infection, thus the sample size for the study was calculated based on the HIV prevalence estimate from the 2004 survey (8.4%). With a desired precision level of 15%, a 5% significance level, a cluster design effect of 1.5 and a non-response rate of 10%, the final sample size for male respondents was estimated at1497.

Sampling Procedure

We used the same sampling procedure as reported in our previous studies where a two stage-cluster sample was drawn (Frumence et al, 2011). In the first stage all streets in the fourteen wards were visited and clusters of ten-cells were selected from each street with a probability proportional to the size of the street. In the second stage one 15-64 year old adult within each household was randomly selected until the sample size was realized.

Study Period

Data collection

The study team consisted of researchers and trained research assistants. The research assistants were mostly nurses, who were experienced in the field of HIV/AIDS counseling and patient care. Despite their medical background and counseling experiences the research assistants were given an additional one week of training on interview techniques, pre- and post counseling and how to draw, store and transport blood samples. The data was collected between September 2010 and January 2011.

The field team visited selected households in pairs of one male and one female to interview selected individuals after informed verbal consent. Subsequently the subject/respondent was asked to donate blood for HIV testing following pre-test counseling. The questionnaire was translated into Swahili to facilitate communication during interviews between respondents, researchers and field assistants. The first author and the field assistants administered the questionnaire and a blood sample was collected from each consenting individual and later tested for HIV-1 antibodies. The results were returned to the study participants who wished to know their HIV status. This was done three months after completion of testing following a post-test counseling.

Measure Instrument

The questionnaire was designed to capture information through interviews on demographic and socio-economic

indicators, male circumcision status and previous HIV testing. Male circumcision was measured by asking “Are you circumcised? And the response was ‘yes’ or ‘no’.

HIV Testing Procedures

Blood samples were collected aseptically in 5 ml red top vacutainers (BD, NJ, USA) and left to clot. Sera from individual blood specimens were separated after centrifugation, aliquoted into two portions of 2 ml cryotubes (Nalge Nunc International, IL, and USA) and stored at -20°C until the time for assay. HIV status was determined by ELISA tests. Abbott Murex Wellcozyme anti-HIV-1 recombinant was used as first ELISA. Specimens with negative results underwent no further testing and were considered negative. Reactive samples were retested by a second ELISA test; Dade Behring Enzygnost anti-HIV-1/2. This assay detects both HIV-1/2 infections. All samples that were reactive on first and second ELISA were regarded as positive for IgG anti HIV antibodies. Inno-Lia HIV I/II immunoblot assay (Immunogenetics) was used as a reference method. Discrepant results between the two ELISAs were confirmed by western blot using Inno-Lia HIV I/II assay.

Wealth Index

Ownership of assets and access to basic services as indicators of socio-economic status were used to generate a wealth index through principal component analysis (PCA). Scholars of PCA suggest that the approach provides a good method for weighting asset data in a single indicator and is an appropriate method for capturing the most important aspect of socio-economic position for health studies (Howe et al., 2008). We generated weighted scores from the household assets, which included source of drinking water, and type of excreta disposal facilities possessed, dwelling construction materials, and land possession. Other assets included a landline telephone, a mobile phone, a refrigerator, a radio, a television, a car, a bicycle and motorcycle. Through the use of principal component and factor analysis the weighted scores were standardized to a distribution with a mean of zero and standard deviation of one. Finally, for each household, we generated the total scores, ranked them into a wealth index and used to stratify the households into five quintiles of socio-economic status based on the World Bank standard: very rich, rich, moderate, poor and very poor (Filmer and Pritchett, 1998).

Ethical Considerations

The study was conducted following ethical approval from the research and publications committee of the Muhimbili University of Health and Allied Sciences. At the regional and district levels, permission to carry out the study was sought and granted by the respective authorities while at the community level, ward leaders were informed about the study aims and their cooperation for the study enlisted. Furthermore, informed consent was sought from the study participants after the field assistants had explained to them the study purpose and the methods of data collection. The pre- and post-test counseling was conducted during collection of blood samples and returning of HIV results respectively.

Data Management And Analysis

Data were computerized, checked and cleaned using Epi Info and analyzed using SPSS. Our analysis focused on status of male circumcision as an exposure variable and its association with HIV infection as an outcome measure. Bivariate and multivariable logistic regression analysis was performed to estimate the effect of MC and demographic and socio-economic characteristics on the HIV status. Independent variables that in the bivariate analysis showed a significant effect on the dependent variable were included in the multivariable analysis. The significance level was set at 0.05.

RESULTS

Socio-Demographic Characteristics and HIV Prevalence

Of 1691 men who were approached and asked for consent to participate in the study, 1497 agreed to participate, making a response rate of 94%. Out of the 1497 individuals who were interviewed, 1425 (95%) responded fully and agreed to test for HIV. The overall HIV prevalence was 7.4%, (95% CI: 6.0-8.8). The HIV prevalence increased with increasing age from 6.1% (95% CI: 4.9-7.3) for those aged 15-34, to 11% (95% CI: 9.4-12.6) for those aged 35-44 and to 14% (95% CI: 12-16) for those aged 45-64. A high HIV prevalence was also found for those who were separated/divorced and widowed (17%, 95% CI; 15-19) compared to married mono-polygamous (10%, 95% CI: 8.4-12) and never married (3.7%, 95% CI: 2.7-4.7). Table 1 presents the prevalence of HIV by socio-demographic characteristics.

Factors Associated with Circumcision

The overall prevalence of male circumcision in the study area was 59%. Young men less than 24 years were less likely to be circumcised (56%) whereas slightly above 60% of those aged 25 years and above were circumcised. Majority of the men (77%) who had second-

Table 1. Prevalence of HIV by demographic and socio-economic characteristics.

Characteristic	Category	Number tested	Number HIV positive	Prevalence (%)
Age	15-34	783	48	6.1
	35-44	273	30	11.0
	45-64	174	24	13.8
Marital status	Married mono-polygamous	684	70	10.2
	Separated/divorced/Widowed	88	15	17.0
	Never married	458	17	3.7
Education	Secondary and above	268	11	4.1
	Primary	902	86	9.5
	No education	60	5	8.3
Occupation	Professional	393	20	5.1
	Business	286	18	6.3
	Farmers	198	28	14.1
	Others	353	36	10.2
Religion	Christian	965	88	9.1
	Moslem	265	14	5.3
Wealth index	Very poor	275	31	11.3
	Poor	256	22	8.6
	Moderate	243	22	9.1
	Rich	259	18	6.9
	Very rich	197	9	4.6
Total			102	

Table 2. Prevalence of circumcision by demographic and socio-economic characteristics.

Characteristic	Category	Total	Number circumcised	Prevalence circumcised (%)
Age	15-34	975	569	58.4
	35-44	276	166	60.1
	45-64	174	106	60.9
Marital status	Married mono-polygamous	684	417	61.0
	Separated/divorced/Widowed	88	55	62.5
	Never married	653	369	56.6
Education	Secondary and above	325	252	77.5
	Primary	1034	564	54.5
	No education	66	25	37.9
Occupation	Professional	415	289	69.6
	Business	305	209	68.5
	Farmers	207	90	43.5
	Others	498	253	50.8
Religion	Christian	1126	564	50.1
	Moslem	299	277	92.6
Wealth index	Very poor	301	182	60.5
	Poor	300	142	47.3
	Moderate	276	155	56.2
	Rich	297	174	58.6
	Very rich	251	188	74.9
Total				

Table 3. Bivariate and multiple logistic regression analysis of the association between demographic characteristics, HIV risk behaviors (Condom use in the last sex act, number of sex partners and circumcision status) and HIV prevalence. Odds ratio (OR) and 95% confidence interval (CI).

Characteristic	Category	HIV-positive		Bivariate analysis		*Multiple logistic regression	
		Yes	No	OR	95% CI	OR	95% CI
Age	15-34	48	735	1		1	
	35-44	30	243	2.2	1.3-3.5	1.5	1.1-2.0
	45-64	24	150	2.9	1.7-4.8	0.97	0.65-1.4
Marital status	Never married	17	441	1		1	
	Separated/divorced/widowed	15	73	5.3	2.5-11.1	3.9	2.5-6.3
	Married mono-polygamous	70	614	2.9	1.7-5.1	1.5	0.97-2.4
Education	Secondary or higher	11	257	1		1	
	Primary	86	816	2.9	1.4-5.8	2.2	1.2-4.1
	No education	5	55	3.0	1.1-9.0	1.3	0.80-1.9
Occupation	Professional	20	373	1		1	
	Business	18	268	1.2	0.64-2.4	1.5	0.94-2.3
	Farmers	28	170	3.1	1.7-5.6	1.6	1.0-2.5
	Others	36	317	2.1	1.2-3.7	1.6	1.0-2.4
Religion	Muslim plus others	14	251	1		1	
	Christian	88	877	1.8	1.01-3.2	1.3	0.92-1.7
Wealth index	Very rich	9	188	1		1	
	Rich	18	241	1.6	0.68-3.5	1.1	0.67-1.8
	Moderate	22	221	2.1	0.93-4.6	1.8	1.2-2.7
	Poor	22	234	1.9	0.88-4.4	1.6	1.0-2.5
	Very poor	31	244	2.7	1.2-5.7	2.0	1.3-3.1
Condom use in the last sexual act	Yes	26	403	1			
	No	76	725	3.2	1.8-5.7	1.3	0.92-1.7
Sex partners	None	18	204	1		1	
	1	71	805	1.0	0.58-1.7	0.81	0.57-1.2
	≥2	13	119	1.2	0.59-2.6	1.0	0.55-1.9
Circumcised	Yes	47	794	1		1	
	No	58	526	1.9	1.3-2.9	1.5	1.03-2.1

ary and above level of education were circumcised while only 38% of those with no education were circumcised. Most professionals (70%) were circumcised while only 43% of farmers were circumcised. A higher percentage of Moslems (92%) were circumcised as compared to 50% among Christian men. Possession of wealth increased the likelihood of men being circumcised as 75% of very rich men were circumcised while only 47% of poor men were circumcised. Table 2 presents the prevalence of male circumcision by demographic and socio-economic factors.

Association between Male Circumcision and HIV Infection

Table 3 shows that the risk of being HIV positive was significantly increased for 35-44 year old men in comparison with 15-24 year old men (OR = 1.5, 95% CI: 1.1-2.0), men being separated/divorced/widowed were almost four times more likely to be HIV infected compared to men being married (OR = 3.9, 95% CI: 2.5-6.3. Men with primary education were two times more likely to be HIV infected compared to men who had secondary and higher level of education (OR= 2.2, 95% CI: 2.2). Male farmers were more likely to be HIV in-

fected compared to professionals (OR – 1.6, CI: 1.0-2.5). The risk of being HIV positive also increased with increasing poverty. Very poor men were two times more likely to be HIV infected compared to very rich men (OR = 2.0, 95% CI: 1.3-3.1).

Table 3 also presents the results of the bivariate and multiple logistic regression analysis of the association between male circumcision and HIV infection among sexually active 15-64 year old adult men. The bivariate analysis shows that uncircumcised men were almost two times more likely to be HIV infected compared to those who were circumcised (OR = 1.9, 95% CI: 1.3-2.9). After adjusting for sex, age, marital status, level of education, religion, occupation, wealth index, condom use during last sexual act and number of sexual partners the association weakened but remained statistically significant, showing that uncircumcised men were 1.5 times likely to be HIV positive compared to circumcised men (OR = 1.5, CI: 1.03-2.1).

DISCUSSION

The findings from this study have shown that the overall prevalence of male circumcision in the study area was around 60% with a somewhat lower prevalence among the youngest age group. Men who were not circumcised had a significantly higher risk of being HIV positive compared to circumcised men.

Male circumcision can be measured in surveys, relying on individual self-reports or by physicians who perform genital examinations to assess the grade of MC (No/partial/complete). The individual self-reports can be supported by a verbal description of MC or showing a picture of a penis with and without MC. Several validation studies have been performed. Nnko et al., (2001) performed surveys of 15-44 year old men in rural North-west Tanzania in 1994-95 and in 1996-97. Out of 243 men that in the first survey reported that they were circumcised 43 (27%) reported in the second survey that they were not circumcised and out of 160 men who said they were circumcised at the second survey 40 (25%) stated that they had been circumcised during the last two years. Weiss et al., (2008) interviewed 5354 school children with a median age of 15 years in 1998 and 2001 and arrived at similar estimates (Kappa coefficient 0.67; 95%CI: 0.64-0.70). Physician-performed genital examinations could be regarded as the golden standard, but it is sometimes difficult to assess degree of MC (Forbes et al., 2012; Hewett et al, 2012), which is important as only complete MC is regarded as effective for HIV prevention. Further, in a study in urban Zambia and urban Swaziland 24% and 7.5% respectively refused to participate in the visual examination of their penis (Hewett et al., 2012).

A decade after the discovery of the virus that causes HIV infection, several observational studies were conducted in Africa to determine the effect of male circumcision on HIV infection. However, these studies did not provide enough evidence that circumcision intervention can prevent HIV infection (Siegfried et al., 2003). In fact a number of studies showed that circumcision was associated with HIV infection. A study conducted in Kenya, Lesotho and Tanzania showed that circumcised youth and virgins had a higher risk of HIV infection than those who were uncircumcised (Brewer, 2007). These results corroborate with another study conducted in Mozambique, which reported that circumcised and scarified children and youth were two to three times more likely to be infected with HIV than their peers who were uncircumcised (Brewer, 2011). This association has been explained by the fact that circumcision may expose children and youth to blood-borne pathogens during circumcision and scarification (Ayeni et al., 2007).

Contrary to the studies reporting MC as a risk for HIV infection, this study adds to the existing evidence that MC is protective to HIV infection. After controlling for potential confounders including number of sexual partners and condom use, this study suggests that prior male circumcision is significantly associated with a decreased risk of HIV infection. The overall findings are in agreement with results from other studies from low-income countries, especially in Africa (Bailey et al., 2001; Urassa et al., 1997). The most undisputable evidence that circumcision of men reduces the risk of acquiring HIV infection through sexual intercourse are probably those conducted in South Africa, Kenya and Uganda using a randomized controlled trial design (Auvert et al., 2005; Bailey et al., 2007**;** Gray et al., 2007). Auvert and colleagues (2005) measured the efficacy of MC in protecting men against HIV infection in the general population in South Africa and indicated that practicing MC may reduce the HIV transmission from women to men by 60%. Gray and his colleagues (2007) who conducted the randomized trial study in Rakai, Uganda also noted that there was a significant reduction in HIV incidence among circumcised men when compared with uncircumcised men. Similarly the randomized study conducted in Kisumu, Kenya, reported a reduction of HIV incidence among circumcised men by 53% (Bailey et al., 2007).

Several biological reasons have been given to explain the mechanisms by which MC could provide protection against acquiring HIV infection. Donoval et al., (2006), McCoombe and Short (2006) and Patterson et al., (2002) have reported that the penile foreskin provides a risk environment for HIV infection because it is rich in HIV target cells such as Langerhans' and dendritic cells, macrophages, CD4+ T cells. It is also reported that the inner mucosa of the prepuce is vulnerable to HIV infection because it is unkeratinised (McCoombe and Short, 2006; Szabo and Short 2002). Szabo and Short (2002) report further that during intercourse the penile fore-skin is pulled back over the shaft exposing the inner fragile mucosa to vaginal and cervical fluids. It has also

been underscored that since uncircumcised men are more susceptible to genital ulcer disease compared to circumcised men, such diseases may increase their vulnerability to HIV infection (Weiss et al., 2006; Szabo and Short, 2002).

The evidence provided by this and other studies presents a strong case to programme managers and policy makers that male circumcision, if performed in a safe and clean environment, is protective to HIV infection and should be promoted as an important intervention in the fight against further spread of HIV infection. The hospital based male circumcision program, initiated in 2009 by the government of Tanzania provides evidence that key stakeholders recognize the protective effect of MC against HIV infection and that similar effort should be initiated in all regions of the country.

Strengths and Limitations

The strength of this study relies much on the multidisciplinary research team involving epidemiologists, microbiology technologists, biostatisticians, and social scientists as well as well as trained and experienced research assistants who were working as hospital nurses and laboratory technicians. Both researchers and research assistants conducted peer-debriefing sessions to reflect and discuss procedures and interpretations of the data. Despite the positive findings, this study has some shortcomings. Measurement of male circumcision relied on self-reports, which could result in under-, or over reporting. The study was conducted in one district in Kagera region in Tanzania and, therefore, may not be easily generalizable to other regions. However, since heterosexual intercourse in Sub-Saharan African countries is the main route of HIV transmission, and several studies (Patterson et al., 2002; Auvert et al., (2005); Donoval et al., 2006; McCoombe and Short, 2006) have reported on the protective effect of MC to HIV infection, the findings from this study may be applicable to other settings with similar context in Sub-Saharan Africa.

In summary, our analysis of the association between male circumcision and HIV infection has shown that male circumcision is protective against HIV infection. Therefore interventions targeting male circumcision should be encouraged as important efforts towards prevention of further spread of HIV infection.

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