ORIGINAL RESEARCH ARTICLE

Assessment of the Protective Effect of Male Circumcision from HIV Infection and Sexually Transmitted Diseases: Evidence from 18 Demographic and Health Surveys in Sub-Saharan Africa

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ABSTRACT

A cross-sectional study based on the secondary data of 18 Demographic Health Surveys carried out in Sub-Saharan Africa was conducted to assess the protective effect of male circumcision from HIV infection and STDs. Information on 70,554 males aged 15-59 years was extracted. The association between circumcision and HIV infection and STD symptoms (Genital discharge or ulcer/sore) was assessed using logistic regression. Un-circumcision was significantly associated with risk of HIV with odds ratio of 4.12 (95%CI: 3.85-4.42). The association was even more significant, 4.95 (95%CI: 4.57-5.36), after adjustment was made for number lifetime sexual partners and socio-demographic variables. The risk associated with un-circumcision is significantly lower among younger men aged 15-29 years than older age categories. However, circumcision found to have no association with the symptoms of STDs. The study concluded that male circumcision can be considered as a way of reducing the spread of HIV infection (*Afr. J. Reprod. Health* 2010; 14[2]: 105-113).

RÉSUMÉ

Evaluation de l'effet protecteur de la circumcision contre l'infection du VIH et des maladies sexuellement transmissibles : Evidence tirée à partir des 18 enquêtes démographiques et sanitaires en Afrique sub – saharéenne. Une étude transversale basée sur les données secondaires portant sur les 18 Enquêtes de la Santé Démographique qui a été menée en Afrique sub–saharéenne a été effectuée pour évaluer l'effet protecteur de la circoncision du mâle contre le VIH et les MSTs. Nous avons collecté des informations sur 70554 mâles âgés de 15 – 59. A l'aide de la régression logistique, nous avons évalué l'association entre la circoncision et l'infection du VIH et les symptômes des MSTs (l'écoulement génital ou l'ulcère/la plaie). L'incirconcision a été associée, considérablement au risque du VIH ayant un indice de cote de 4,12 (95% CI : 385 – 4,42). L'association a été encore plus significative, 4,95 (95% CI :4,57 – 5,36), après avoir effectué une modification sur le nombre de partenaires sexuels à vie et les variables socio-démographiques. Le risque lié à l'incirconcision est considérablement moins chez les hommes plus jeunes, âgés de 15 – 29 que chez les plus âgés. Néanmoins, on a trouvé que la circoncision n'est pas liée aux symptômes des MSTs. Comme conclusion, l'étude affirme que la circoncision peut être considérée comme un moyen de réduire la propagation de l'infection du VIH (*Afr. J. Reprod. Health* 2010; 14[2]: 105-113).

KEYWORDS: Circumcision, HIV infection, Sexually Transmitted Infections.

INTRODUCTION

Since the first clinical evidence of AIDS reported over three decades ago, the population affected and impact of HIV/AIDS is increasing dramatically. AIDS is now a pandemic. In 2007 worldwide a total of 33.2 million people were living with the disease, and an estimated 2.1 million people died. According to UNAIDS, Sub-Saharan Africa (SSA) is the most seriously affected and it continues to rank first both in terms of new HIV infections as well as AIDS mortality. Over three-quarters of total AIDS deaths occurred in SSA, and the area has 26.6 million people living with HIV/AIDS[1].

Starting from the beginning of the new millennium, in the context of the urgent need for expanded HIV prevention efforts, male circumcision is being considered as a strategy to reduce the risk of HIV acquisition[2]. The debate over the association between male circumcision and HIV infection was started in 1986 when the American urologist Aaron Fink claimed the foreskin increase risk of HIV infection since it is less keratinized [3]. Latter, laboratory investigations reported that the inner mucosa of the foreskin has higher susceptibility to tear and it has a higher density of target cells for HIV infection[3,4].

The earliest epidemiological evidences on the association between male circumcision and HIV infection were reported in the end of 1980's through ecological studies conducted in Sub-Saharan Africa[5,6]. Later in 1990's and early 2000's more advanced studies were conducted. In 2000, a systematic review of 19 cross-sectional, 5 case-control and 3 cohort studies reported that the risk of infection was 44% lower among circumcised men[7]. More recently three randomized controlled clinical trials in South Africa[8], Kenya[9] and Uganda[10] found a statistically significant reduction in risk of HIV infection from medical circumcision. However the findings were not conclusive as a number of other studies reported no association[11,12,13]. Even a meta-analysis of 29 published articles indicated circumcised men have 12% greater risk of acquiring HIV[5].

The association between male circumcision and risk of different Sexually Transmitted Diseases (STDs) is also controversial as divergent findings were reported. Few studies witnessed the protective effect of circumcision against STDs[14,15], while others found no association[16,17,18,19]. A couple of studies reported protective effect of male circumcision against specific types of STDs[20,21].

Thus secondary data analysis of 18 Demographic and Health Surveys (DHS) which were conducted in Sub-Saharan Africa between 2003 and 2008 was carried out to assess the protective effect of male circumcision from HIV and STDs.

METHODOLOGY

Study Setting

The target area of the analysis is the Sub-Saharan Africa. The region is selected as the main mode of transmission of the disease in the area is heterosexual contact and the area has the highest transmission rate of HIV.

Sub-Saharan Africa covers an area of 24.3 million square kilometers with population size of more than 800 million. It is the poorest region in the world and contains most of the least developed countries of the world. Figures for life expectancy, school enrolment, malnourishment and infant mortality are at the worst level. In addition, in the last two decades, the region has suffered the dramatic impact of HIV/AIDS infections. According to UNAIDS, in 2007 an estimated 1.9 million people were newly infected with HIV in the region and 26 million people were living with HIV. The epidemic vary significantly from country to country in both scale and scope. National prevalence is below 2% in several countries of West and Central Africa, as well as in the horn of Africa, but it exceeded 15% in seven southern African countries (Botswana, Lesotho, Namibia, South Africa, Swaziland, Zambia, and Zimbabwe), and was above 5% in seven other countries, mostly in Central and East Africa (Cameroon, Central African Republic, Gabon, Malawi, Mozambique, Uganda, and Tanzania)[1].

Table 1. List of 18 Demographic Health Surveys Included in the Analysis.

Country	Type	Sample size
Burkina Faso	Standard DHS 2003	3341
Congo DR	Standard DHS 2007	4292
Cameroon	Standard DHS 2004	5036
Ethiopia	Standard DHS 2005	5097
Ghana	Standard DHS 2003	4265
Guinea	Standard DHS 2005	2924
Kenya	Standard DHS 2003	2914
Liberia	Standard DHS 2007	5159
Lesotho	Standard DHS 2004	2231
Mali	Standard DHS 2006	1159
Malawi	Standard DHS 2004	2342
Niger	Standard DHS 2006	3231
Rwanda	Standard DHS 2005	4703
Senegal	Standard DHS 2005	3246
Swaziland	Standard DHS 2006/07	3602
Tanzania	Standard AIS 2007/08	6315
Zambia	Standard DHS 2007	5161
Zimbabwe	Standard DHS 2005/06	5536
Total		**70,554**

Study Design and Data Extraction

This is a cross sectional comparative study based on secondary data of Demographic Health Surveys (DHS). The analysis focused on DHS since the data collection and analysis procedure was uniform and comparable across all surveys. Twenty standard and special Demographic and Health Surveys conducted in SSA starting from 2003 were eligible to be included in the analysis. However the data for Uganda Standard SBS (Sero Behavioral Survey) 2004/5 was not available for analysis. Similarly the data for Cote d'Ivoire Standard AIS (AIDS Indicator Survey) 2005 was excluded as ample information was lacking to link the HIV sero-survey with male respondents' data. Hence analysis was done based on the remaining 18 surveys (Table 1).

From all surveys, information on 70,554 males aged 15-59 years was extracted. The extracted data includes basic socio-demographic information (age, educational status, religion, marital status, occupation and economical status), access to mass media (frequency of watching television, listening radio and reading newspaper/magazine), sexual history (number of lifetime sexual partners, age at first sexual intercourse, type of recent sexual partner, condom use during recent sex), knowledge towards the basic HIV/AIDS prevention methods (abstinence, one to one faithful sexual relation and condom use), circumcision status, reported symptoms of STD (genital sore/ulcer or discharge) and HIV serostatus.

Data Collection Methods of the Original Studies

In all studies men aged 15-49 or 15-59 years were the study subjects. All men in the aforementioned age category living in the households chosen for the main DHS survey were eligible for the HIV testing. Participants were selected using multi-stage sampling technique. Stratification based on de-facto pla-ce of residence (urban or rural) was also made. In all studies more than 70% of all eligible subjects were willing to give blood samples. Data on sexual history and socio-demographic variables were gathered using pretested and standard tool which was more or less uniform across the surveys.

Regarding HIV testing, Dried Blood Spot (DBS) samples were collected from study subjects. All specimens were tested with two different ELISA screening tests, according to the testing algorithm, samples

positive on both ELISAs were regarded as positive and samples negative for both ELISAs were regarded as negative. Samples that had discordant results were subject to a retest. Discordant samples from the repeated ELISAs, were tested with a confirmatory Western Blot test.

Data Handling and Analysis

The data containing sexual and socio-demographic variables and HIV serostatus of respondents were independently downloaded from Measure DHS website in SPSS format. The two datasets for every country were merged based on individual case identification number and unwanted variables were removed from the dataset accordingly. Data analysis was done by the principal investigator using SPSS 15.0 for windows. Frequencies, percentage, mean and median were used for descriptive analysis. Binary logistic regression was employed to control confounders and to explore association between dependent (HIV serostatus and reported STD symptoms) and independent (circumcision status) variables. During analysis, fitness of the logistic model and statistical assumptions of logistic regression were checked to be satisfied. Variables were entered into the model using backward elimination likelihood ratio method. P value of 0.05 was taken as level of significance.

Ethical issues

The dataset for all countries were downloaded and used after the purpose of the analysis was communicated and permission was taken from Measure DHS and concerned respective national agencies. The primary data were also collected in line with international ethical guidelines.

Operational Definitions

The following operational definitions were applied in this study;

1. Sexually Transmitted Disease (STD): A person who reported to have symptoms of either genital discharge or genital sore/ulcer in the preceding 12 months of the surveys was considered to have STD.
2. Comprehensive knowledge towards HIV/AIDS: A person who is aware of two of the three major HIV prevention methods (abstinence, faithful one to one sexual relation, and condom use) was considered to have comprehensive knowledge towards HIV/AIDS.
3. Good access to mass media: A person who watches television or listens to radio or reads newspapers/magazines almost every day.
4. Fair access to mass media: A person who has not been included in the first category (good access to mass media) and who watches television or listens to radio or reads newspapers / magazines at least once in a week.
5. Poor access to mass media: A person who has not been included in the first two categories (good or fair access to mass media) and who watches television or listens to radio or reads newspapers/magazines less than once in a week.
6. No access to mass media: A person who never used any of the aforementioned mass media types.
7. Safe sexual behavior: A person who never had sex or who had his recent sexual intercourse with a regular partner or who used condoms in the recent sexual relation with casual partners.
8. Wealth index: A composite indicator of cumulative living standard is calculated based on ownership of selected assets, such as televisions and bicycles, materials used for housing construction, and types of water access and sanitation facilities. The five categories (Lowest, Second, Middle, Fourth, and Highest) were generated using Principal Components Analysis statistical technique. This study used a pre-computed wealth index values.

Limitations of the study

The interpretations of this study should be taken inconsideration with the following limitations;

1. The protective effect of circumcision from STDs might have been underestimated as the study only depends on genital sore/ulcer and discharge to operationally define STD.
2. The protective effect of circumcision from HIV and STDs might have been over or underestimated as circumcision is assumed to be performed prior to the age of the first sexual exposure, which might not always be the case.
3. Weighted prevalence of HIV infection in the subcontinent and across various socio-demographic variables is computed by merging data collected over significantly wider period of time (2003-2008).

RESULTS

Socio-demographic Information:

A total of 70,554 subjects' data were included in the analysis. The mean age of the

Table 2. Socio-demographic information of respondents, Sub-Saharan Africa, 2003-2008.

Variable	Freq	%
Age of the respondent (n = 70,554)		
15-29 years	38,637	54.8
30-44 years	21,574	30.6
45-59 years	10,343	14.7
Place of Residence (n = 70,554)		
Urban	23,035	32.6
Rural	47,519	67.4
Highest Educational Level (n = 70,550)		
No education	15,697	22.2
Primary	27,674	39.2
Secondary	24,161	34.2
Higher	3,018	4.3
Religion (n = 61,923)		
Christians	33,458	54.0
Muslim	16,472	26.6
Traditional/Animist	1,734	2.8
No Religion	3,298	5.3
Others	6,961	9.9
Marital Status (n = 70,551)		
Never married	30,028	42.6
Married/Living Together	37,297	52.9
Widowed	488	0.7
Divorced/Separated	2,743	3.9
Working Status (n = 70,159)		
Working	52,290	74.5
Not working	17,869	25.5
Wealth Index (n = 70,551)		
Poorest	12,558	17.8
Poorer	12,906	18.3
Middle	13,942	19.8
Richer	14,677	20.8
Richest	16468	23.3

subjects was 29.9 years (±11.6). More than two-third of them were living in rural areas at the time of the surveys. Education status wise, one fifth were illiterates. More than 50% of the participants were married or living together with sexual partners. Detail socio-demographic characteristics of study subjects are given in Table 2.

Weighted HIV Prevalence across Selected Socio-demographic Characteristics

The weighted prevalence (based on male population size of the respective countries) of HIV among men 15-59 years was 3.1%. The prevalence in urban and rural areas was 4.6% and 2.6%, respectively. The prevalence

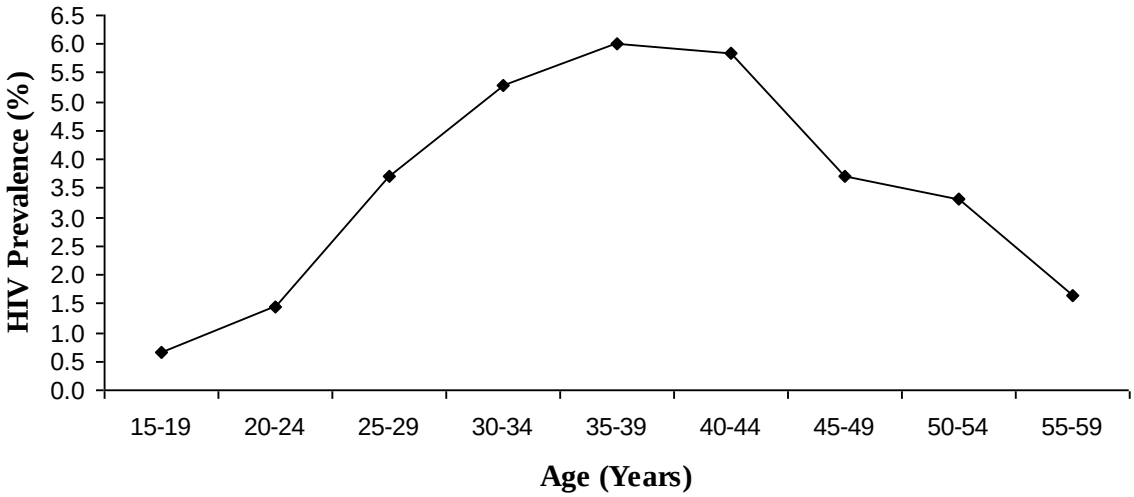

Figure 1. Weighted HIV Prevalence Across Different Age Categories, Sub-Saharan Africa, 2003-2008.

among illiterates and those at primary education level was 3.0%. However, significantly higher prevalence was observed among those at secondary (3.6%) and beyond secondary (3.9%) educational status. The prevalence among Christians (3.1%) was significantly higher than Muslims (2.5%). Age wise the highest prevalence was observed in the age category 30-44 years (Figure 1). No significant difference was observed across 5 categories of wealth index.

Sexual Behavior

Among 48,945 men who had at least one sexual intercourse in the preceding 12 months of the surveys, the type of the recent sexual partner was assessed. Accordingly 71.0% and 21.9% reported they had their recent sexual relation with their spouse and fiancé, respectively. Non-regular sexual partners like casual acquaintance, commercial sex workers and friends were reported in the remaining 7.0% of cases. Of those who had sexual relation with non-regular partner, only 46.9% used condom during their recent sexual intercourse. Among all study subjects, the median number of reported lifetime sexual partners was 3.

The number of lifetime partners was directly correlated with weighted prevalence of HIV infection. The prevalence of HIV among those who reported no sexual relation before was 0.8%. The prevalence among those who reported 1, 2-5 and 6-15 lifetime sexual partners was 2.2%, 4.0% and 6.0%, respectively. The highest prevalence of 8.2% was observed among those who had 15 or more sexual partners.

Male Circumcision and Symptomatic STD

Among all respondents, 2271 (3.2%) and 1955 (2.8%) reported that they had genital discharge and genital sore/ulcer in the preceding 12 months of the surveys, respectively. About 5.5% reported either of the symptoms. The association between male circumcision and the symptoms of STD was assessed using binary logistic regression. The bivairate analysis indicated uncircumcision has significant protective effect from symptoms of genital discharge or genital sore/ulcer with OR of 0.88 (95% CI: 0.83-0.95) (Table 3). However after adjustment was made for number of lifetime sexual partners, marital status, age, education status and place of residence (urban/rural), the

Table 3. Association between male circumcision and symptoms of STD, Sub-Saharan Africa, 2003-2008.

Circumcision Status	Genital discharge or genital sore/ulcer		Crude Odds Ratio (95%CI)	Adjusted Odds Ratio (95%CI)
	Reported	Not reported		
Uncircumcised	1,178	21,926	0.88 (0.83-0.95)*	1.07 (0.99-1.15)
Circumcised	2,623	43,363	1[r]	1[r]

r - Set as reference category
*- Significant association

Table 4. Association between male circumcision and HIV infection, Sub-Saharan Africa, 2003-2008.

Circumcision Status	HIV Sero-status		Crude Odds Ratio (95%CI)	Adjusted Odds Ratio (95%CI)
	Positive	Negative		
Uncircumcised	2,500	20,940	4.12 (3.85-4.42)*	4.95 (4.57-5.36)*
Circumcised	1,326	45,788	1[r]	1[r]

r - Set as reference category
*- Significant association

Table 5. Risk of HIV infection among un-circumcised men in comparison with circumcised men across different age categories.

Age Category	Crudes OR	Adjusted OR[a]
15-29 years	3.53 (95% CI: 3.11-4.00)	4.20 (95% CI: 3.64-4.78)
30-44 years	5.28 (95% CI: 4.80-5.80)	5.34 (95% CI: 4.80-5.95)
45-59 years	5.26 (95% CI: 4.65-5.87)	5.57 (95% CI: 4.86-6.28)

a: adjusted for number of lifetime partners, sexual behavior, place of residence (urban/rural), educational status, marital status, comprehensive knowledge towards HIV/AIDS and access to mass media.

association failed to be significant with OR of 1.07 (95% CI: 0.99-1.15).

Male Circumcision and HIV Infection

The association between male circumcision and HIV infection was assessed using binary logistic regression. In the bivairate analysis being uncircumcised was significantly associated with risk of HIV with OR of 4.12 (95% CI: 3.85-4.42) (Table 4). The association was even more significant, 4.95 (95% CI: 4.57-5.36), after adjustment made for number of lifetime partners, sexual behavior, age, place of residence (urban/rural), educational status, marital status, comprehensive knowledge towards HIV/AIDS and frequency of use of mass media.

The risk associated with un-circumcision is significantly lower among younger men aged 15-29 years than those in 30-44 and 45-49 years age categories (Table 5).

DISCUSSION

This study witnessed strong association between male circumcision and reduced risk of HIV infection. This is consistent with the findings of three randomized controlled trials conducted in Uganda[10], Kenya[9] and South Africa[8] except that the strength of association

appears to be stronger here. According to the study in Rakai, Uganda[10], incidence of HIV was significantly lower in the circumcised men (1.1/100 person-years), compared with the uncircumcised men (1.8/100 person-years) with adjusted risk ratio (RR) of 0.53. The study in Kisumu, Kenya[9] reported HIV incidence of 2.1% in the circumcised group and 4.2% in the control group with RR of 0.47. Similarly, the study in South Africa[8], reported that incidence rate was 0.85 per 100 person-years in circumcised group and 2.1 per 100 person-years in the control group, with RR of 0.40. A study conducted in India[16], witness the same direction of association but with relatively stronger RR of 0.15.

However, the relatively lower risk of uncircumcision among men in younger age group has not been reported before. This should be assessed through longitudinal studies.

Unlike HIV infection, circumcision was not associated with the risk of having genital discharge and genital ulcer/sore. This finding is not conclusive as it did not capture asymptomatic infection and specific types of STDs. However, parallel findings were also reported in other studies. A prospective cohort study in Kenya[19] reported no significant difference in the incidence of individual or cumulative infection of *N. gonorrhoeae*, *C. trachomatis*, and *T. vaginalis* in circumcised and uncircumcised group. A recent study in New Zealand[18] found insignificant difference in the prevalence of STIs (23.4% and 23.5% in circumcised and uncircumcised men, respectively). A study in India noted no protective effect of circumcision against herpes simplex, syphilis, or gonorrhea[16]. Another study in US[21] found no relationship between circumcision and genital herpes, chlamydial infection, or nongonococcal urethritis.

CONCLUSION AND RECOMMENDATION

Male circumcision has strong association with reduced risk of HIV infection. Hence, it can be considered as a way of reducing the spread of HIV infection. However, promotion of the practice should be made cautiously so that sense of invulnerability cannot be created among circumcised men and it cannot be used for the purpose of sexual negotiation. Variation in the protection effect of circumcision from HIV infection across different age categories should be investigated. The study did not witness any association of circumcision status with symptoms of STDs. However this finding is not conclusive as the case definition of STD was made based on self reported symptoms. A comprehensive study to assess the association between circumcision and different STIs is recommended.

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