

## Male circumcision and its association with HIV infection and sexually transmitted diseases: evidence from 18 demographic and health surveys in sub-Saharan Africa

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### Abstract

The study aimed to assess the association between male circumcision and HIV infection and STDs. The issue is controversial as various studies reported conflicting findings. A cross-sectional comparative study based on the secondary data of 18 Demographic Health Surveys (DHS), carried out in Sub-Saharan Africa starting from 2003, was conducted. From all surveys, information on 70 554 males aged 15 - 59 years was extracted. The association between male circumcision and HIV infection and STD symptoms (genital discharge or genital ulcer/sore) was assessed using binary logistic regression. Adjustment was made for sexual history and basic socio-demographic variables. The weighted prevalence of HIV among men 15 - 59 years was 3.1%. In the bivariate analysis uncircumcised status was significantly associated with risk of HIV, with odds ratio (OR) 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 for number of lifetime sexual partners and socio-demographic variables. The risk associated with uncircumcised status is significantly lower among younger men aged 15 - 29 years than those in 30 - 59-year age category. About 5.5% of the study subjects reported either genital discharge or genital sore/ulcer in the preceding 12 months of the surveys. Circumcision status was not significantly associated with either of the symptoms, with adjusted OR of 1.07 (95% CI: 0.99 - 1.15). The study concludes that there is a strong association between uncircumcised status and HIV infection. Hence, male circumcision can be considered as a possible way of reducing the spread of HIV infection in areas where the practice is rare. A comprehensive study to assess the association between circumcision and different types of STDs is recommended.

**Keywords:** Male circumcision, HIV infection, sexually transmitted infections, sub-Saharan Africa, demographic and health survey.

### Résumé

L'étude a pour but d'évaluer le degré d'association entre la circoncision, et l'infection à VIH et les maladies sexuellement transmissibles (MST). L'objet de cette étude est controversé car plusieurs études ont révélé des conclusions contradictoires. Une étude transversale comparative basée sur les données de seconde main de 18 enquêtes démographiques et sanitaires (EDS), réalisées en Afrique subsaharienne à partir de 2003, a été menée. Extraites de toutes les enquêtes, des informations sur 70 554 hommes âgés de 15 - 59 ans ont été recueillies. L'association entre la circoncision masculine et, l'infection à VIH et les symptômes de MST (écoulement génital ou ulcère/plaie génitale) a été évaluée en utilisant une régression logistique binaire. L'ajustement a été fait en fonction des variables socio-démographiques basiques et du passé sexuel. La prévalence pondérée du VIH parmi les hommes âgés de 15 - 59 ans était de 3.1%. Dans l'analyse bivariable, le statut de non-circoncis était significativement associé au risque de VIH avec un Odds ratio (OR) de 4.12 (95% IC:3.85 - 4.42). L'association fut même encore plus importante - (4.95 (IC 95%: 4.57 - 5.36) ) après l'ajustement lié aux variables socio-démographiques et celle du nombre de partenaires sexuels au cours d'une vie. Le risque associé au statut de non-circoncis est nettement plus faible chez les hommes plus jeunes, âgés de 15 - 29 ans, que chez ceux de la catégorie d'âge 30 - 59 ans. Environ 5.5% des sujets de l'étude ont fait part d'un écoulement génital ou d'un ulcère/plaie génitale au cours des 12 derniers mois précédant la réalisation des enquêtes. Le statut de circoncis n'a pas été significativement associé à l'un de ces problèmes avec un OR ajusté de 1.07 (IC 95%: 0.99 - 1.15). L'étude conclut qu'il existe un fort lien entre le statut de non-circoncis et l'infection à VIH. Ainsi, la circoncision masculine peut être considérée comme un des moyens possible pour réduire la propagation de l'infection à VIH dans les zones où cette pratique est rare. Une étude approfondie pour évaluer l'association entre la circoncision et les différents types de MST est recommandée.

**Mots clés:** Circoncision masculine, infection à VIH, infections sexuellement transmissibles, Afrique subsaharienne, enquête démographique et sanitaire.

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## Background

Since the first clinical evidence of AIDS reported over three decades ago, the population affected and impact of HIV/AIDS are increasing dramatically. AIDS is now a pandemic. In 2007 worldwide a total of 33.2 million people were living with the virus, 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 this area has 26.6 million people living with HIV/AIDS (UNAIDS/WHO, 2007).

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 (Weiss, Halperin, Bailey, Hayes, Schmid & Hankins 2008). The debate over the association between male circumcision and HIV infection was started in 1986 when the American urologist Aaron Fink claimed that the foreskin increases risk of HIV infection since it is less keratinised (CIRP, 2009). Later laboratory investigations reported the inner mucosa of the foreskin has higher susceptibility to tear and it has a higher density of target cells for HIV infection (Howe, 1999; CDC, 2009).

The earliest epidemiological evidence of the association between male circumcision and HIV infection was reported in the late 1980s through ecological studies conducted in sub-Saharan Africa (Howe, 1999; Moses, Brandly, Nagelkerke, Ronald, Achola & Plummer, 1990). Later in 1990s and early 2000s more advanced studies were conducted. In 2000, a systematic review of 19 cross-sectional, 5 case-control and 3 cohort studies reported the risk of infection was 44% lower among circumcised men (Weiss, Quigley & Hayes, 2000). More recently three randomised controlled clinical trials in South Africa (Auvert, Taljaard, Lagarde, Tambekou, Sitta & Puren, 2005), Kenya (Bailey, Moses, Parker, Agot, Maclean, Krieger *et al.*, 2007) and Uganda (Gray, Kigozi, Serwadda, Makumbi, Watya, Nalugoda *et al.*, 2007) found a statistically significant reduction in risk of HIV infection after medical circumcision. However, the findings were not conclusive as a number of other studies reported no association (Carael, Van de Perre PH, Lepage, Allen, Nsengumuremyi, Van Goethem *et al.*, 1988; Grosskurth, Mosha, Todd, Mwijarubi, Klokke, Senkoro *et al.*, 1995; Barongo, Borgdorff, Mosha, Nicoll, Grosskurth, Senkoro *et al.*, 1992). Even a meta-analysis of 29 cross-sectional published articles indicated circumcised men have 12% greater risk of acquiring HIV (Howe, 1999).

The relationship between male circumcision and sexually transmitted diseases (STDs) is also controversial as divergent findings were reported. Few studies witnessed association (Weiss, Thomas, Munabi & Hayes, 2006; Fergusson, Boden & Horwood, 2006), while others not (Reynolds, Shepherd, Risbud, Gangakhedkar, Brookmeyer, Divekar *et al.* 2004; Dickson, 2008; Donovan, Bassett & Bodsworth, 1994; Lavreys, Rakwar, Thompson, Jackson, Mandaliya & Chohan, 1999; Hernandez, Shvetsov, Goodman, Wilkens, Thompson, Zhu X *et al.*, 2010; Mehta, Moses, Agot, Parker, Ndinya-Achola, Maclean *et al.*, 2009). Some studies reported association between male circumcision and specific types of STDs like Human Papillomavirus (Gray, Serwadda, Kong,

Makumbi, Kigozi, Gravitt *et al.*, 2010; Nielson, Schiaffino, Dunne, Salemi & Giuliano, 2009; Lu, Wu, Nielson, Flores, Abrahamsen, Papenfuss *et al.*, 2009; Giuliano, Lazcano, Villa, Flores, Salmeron, Lee *et al.*, 2009; Tobian, Serwadda, Quinn, Kigozi, Gravitt, Laeyendecker *et al.*, 2009; Auvert, Sobngwi-Tambekou, Cutler, Nieuwoudt, Lissouba, Puren *et al.*, 2009; Smith, Greenup & Takafuji, 1987).

Thus the 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 association between male circumcision and HIV and STDs. As the study has huge sample size and as it is conducted over large geographical area, it can bring additional scientific evidence.

## Methodology

### Study setting

The target area of analysis is sub-Saharan Africa. The region is selected because the main mode of transmission of the disease in the area is heterosexual contact and the region has the highest incidence of HIV infection.

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. 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 epidemics 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) (UNAIDS/WHO, 2007).

### Study design and data extraction

This is a cross-sectional comparative study based on the secondary data of DHS. The analysis focused on DHS since the data collection and analysis procedure was uniform and comparable across all surveys. Twenty standard and special DHS conducted in SSA starting from 2003 were eligible to be included in the analysis. However, the data for Uganda Standard SBS (Sero-Behavioural Survey) 2004/5 were not available for analysis. Similarly, the data for Cote d'Ivoire Standard AIS (AIDS Indicator Survey) 2005 were excluded as 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 include basic socio-demographic information (age, educational status, religion, marital status, occupation and economic status), access to mass media (frequency of watching television, listening radio and reading newspaper or magazines), sexual history (number of lifetime sexual partners, age

**Table 1. Demographic health surveys included in the analysis**

SN	Country	Type	Sample size
1	Burkina Faso	Standard DHS 2003	3 341
2	Congo DR	Standard DHS 2007	4 292
3	Cameroon	Standard DHS 2004	5 036
4	Ethiopia	Standard DHS 2005	5 097
5	Ghana	Standard DHS 2003	4 265
6	Guinea	Standard DHS 2005	2 924
7	Kenya	Standard DHS 2003	2 914
8	Liberia	Standard DHS 2007	5 159
9	Lesotho	Standard DHS 2004	2 231
10	Mali	Standard DHS 2006	1 159
11	Malawi	Standard DHS 2004	2 342
12	Niger	Standard DHS 2006	3 231
13	Rwanda	Standard DHS 2005	4 703
14	Senegal	Standard DHS 2005	3 246
15	Swaziland	Standard DHS 2006/07	3 602
16	Tanzania	Standard AIS 2007/08	6315
17	Zambia	Standard DHS 2007	5 161
18	Zimbabwe	Standard DHS 2005/06	5 536
	Total		70 554

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 techniques. Stratification based on *de facto* place 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. The questionnaire was administered by trained interviewers.

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 re-tested. 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 multivariate 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. A *p*-value of 0.05 was taken as level of significance.

### Ethical issues

The datasets 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 employed in this study;

- 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 an STD.
- 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.
- Good access to mass media: A person who watches television or listens to radio or reads newspapers or magazines almost every day.
- 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 or magazines at least once in a week.
- 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.
- No access to mass media: A person who never used any of the aforementioned mass media types.
- Safe sexual behaviour: 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.
- 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 in consideration of the following limitations:

- The association between uncircumcised status and STDs might

have been underestimated as the study only depends on genital sore/ulcer and discharge to operationally define STD.

- The association between uncircumcised status and 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.
- Weighted prevalence of HIV infection in the sub-continent and across various socio-demographic variables is computed by merging data collected over significantly wider period of time (2003 - 2008).
- Circumcision status is assessed based on self-reporting. Hence, depending of the norm of the locality it can be over- or underreported.

## Results

### Socio-demographic information

A total of 70 554 subjects were included in the analysis. The mean age of the subjects was 29.9 years ( $\pm 11.6$ ). More than two-thirds of them were living in rural areas at the time of the surveys. One-fifth were illiterate. More than 50% of the participants were married or living together. Detailed socio-demographic characteristics of study subjects are given in Table 2.

**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	16 468	23.3

### Weighted HIV prevalence across selected socio-demographic characteristics

The weighted prevalence (based on male population size of respective country) 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 among literates 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 (Fig. 1). No significant difference was observed across 5 categories of wealth index.

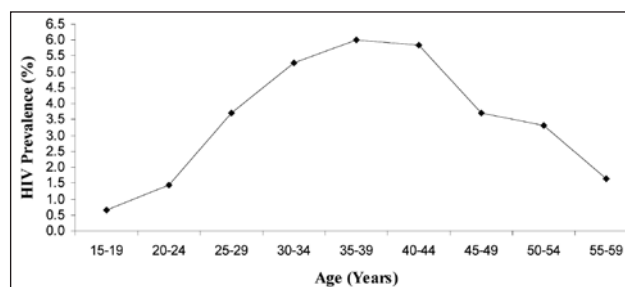


Fig. 1. Weighted HIV prevalence across different age categories, sub-Saharan Africa, 2003 - 2008.

### Sexual behaviour

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 or fiancée, respectively. Non-regular sexual partners such as casual acquaintances, commercial sex workers and friends were reported in the remaining 7.0% of cases. Of those who had sexual relation with a non-regular partner, only 46.9% used a 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, 2 271 (3.2%) and 1 955 (2.8%) reported that they had genital discharge and genital sores or ulcers in the preceding 12 months of the surveys, respectively. About 5.5% reported either of the symptoms. The association between male circumcision and symptomatic STD was assessed using binary logistic regression. The bivariate analysis indicated circumcised men are significantly less likely to report symptoms of genital discharge or genital sores or ulcers, with OR of 0.88 (95% CI: 0.83 - 0.95). However, after adjustment was made for the number of lifetime sexual partners, marital status, age, education status and place of residence (urban/rural), the association failed to be significant, with OR of 1.07 (95% CI: 0.99-1.15).

**Table 3. Risk of HIV infection among uncircumcised men in comparison with circumcised men across different age categories**

Age category	Crudes OR	Adjusted OR <sup>a</sup>
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)

<sup>a</sup>Adjusted for number of lifetime partners, sexual behaviour, place of residence (urban/rural), educational status, marital status, comprehensive knowledge towards HIV/AIDS and access to mass media.

### Male circumcision and HIV infection

The association between male circumcision and HIV infection was assessed using binary logistic regression. In the bivariate analysis uncircumcised status was significantly associated with risk of HIV, with OR of 4.12 (95% CI: 3.85 - 4.42). The association was even more significant at 4.95 (95% CI: 4.57 - 5.36) after adjustment was made for number of lifetime sexual partners, sexual behaviour, age, place of residence (urban/rural), educational status, marital status, comprehensive knowledge towards HIV/AIDS and frequency of use of mass media. The association between uncircumcised status and HIV infection is significantly lower among younger men aged 15 - 29 years than those in 30 - 44 and 45 - 49 years age categories (Table 3).

### Discussion

This study witnessed strong association between male circumcision and HIV infection. This is consistent with the findings of three randomised controlled trials conducted in Uganda (Gray, Kigozi, Serwadda *et al.*, 2007), Kenya (Bailey, Moses, Parker *et al.*, 2007) and South Africa (Auvert, Taljaard, Lagarde *et al.*, 2005) except that the strength of association appears to be stronger here. According to the study in Uganda, 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 Kenya 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, reported that incidence rate was 0.85/100 person-years in circumcised group and 2.1/100 person-years in the control group, with RR of 0.40. A study conducted in India (Reynolds, Shepherd, Risbu, *et al.*, 2004) witness the same direction of association with RR of 0.15.

However, the relatively lower association between uncircumcised status and HIV infection 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 (Lavreys, Rakwar, Thompson *et al.*, 1999) reported that circumcision status had no effect on the acquisition of urethral infections and genital warts. Another study in Kenya (Mehta, Moses, Agot *et al.*, 2009) witnessed adult male circumcision did not reduce the risk of incident *Neisseria gonorrhoeae*, *Chlamydia trachomatis* or *Trichomonas vaginalis* infection. A study in New Zealand (Donovan, Bassett &

Bodsworth, 1994) found insignificant difference in the prevalence of STIs (23.4% and 23.5% in circumcised and uncircumcised men, respectively). A study in India (Reynolds, Shepherd, Risbud *et al.*, 2004) noted no protective effect of circumcision against herpes simplex, syphilis or gonorrhoea. A study in US (Smith, Greenup & Takafuji, 1987) found no relationship between circumcision and genital herpes, chlamydial infection or non-gonococcal urethritis. Another study in US (Hernandez, Shvetsov, Goodman *et al.*, 2010) reported no difference in human papillomavirus acquisition by circumcision status.

This study witnessed that prevalence of HIV is significantly higher among Christians than Muslims ( $p < 0.000$ ). This can be explained by the difference in the prevalence of men circumcision in the two religions. The prevalence of circumcision was 98.0% among Muslims and 57.8 among Christians.

### Conclusion and recommendation

Uncircumcised status has strong association with HIV infection. Hence, male circumcision can be considered as a way of reducing the spread of HIV infection in areas where the practice is rare. 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 strength of association between uncircumcised status and 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 case definition of STD was made based on self-reported symptoms. A comprehensive study to assess the protective effect of male circumcision from different STIs is recommended.

### Competing interest

The author has no competing interest.

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