A Comparison of the Prevalence of Sexually Transmitted Infections Among Circumcised and Uncircumcised Adult Males in Rustenburg, South Africa: A Cross-Sectional Study

Blanchard Mbay Iyemosolo (blanchardmbay@gmail.com)
Stellenbosch University Faculty of Medicine and Health Sciences

Tawanda Chivese
Qatar University

Tonya Marianne Esterhuizen
Stellenbosch University

Research article

Keywords: Male circumcision; high-risk population, sexually transmitted infections (STIs), South Africa

DOI: https://doi.org/10.21203/rs.3.rs-21895/v2

License: This work is licensed under a Creative Commons Attribution 4.0 International License. Read Full License
Abstract

**Background** South Africa has a persistent burden of sexually transmitted infections (STIs). Male circumcision has been shown to be effective in preventing HIV, and STIs but data are scarce on the protective effect of circumcision in high-risk populations such as migrant miners. The objective of this study was to assess the effect of medical and traditional circumcision on the prevalence of STIs after adjusting for other risk factors in Rustenburg, a mining town in North West Province, South Africa.

**Methods** This cross-sectional study used baseline data collected from a cohort study. Adult males in a mining town were assessed for STIs (gonorrhea, chlamydia, and trichomoniasis) using syndromic assessment. Data on circumcision status and other risk factors for STIs were collected using an interviewer-administered questionnaire. Multiple logistic regression analysis was used to assess the independent effect of circumcision on STI presence after adjusting for confounders.

**Results** A total of 339 participants with a median age of 25 years (IQR 22-29) were included in the study, of whom 116 (34.2%) were circumcised. The overall STIs prevalence was 27.4% (95% CI 22.8% to 32.6%) and was lower in the circumcised participants compared with those who were uncircumcised (15.5% vs 33.6%, respectively, p<0.001). Both medical (OR 0.57, 95% CI 0.34-0.95, p = 0.030) and traditional circumcision (OR 0.34, 95% CI 0.13-0.86, p = 0.022) were strongly associated with a lower risk of STIs after adjustment for employment and condom use.

**Conclusion**

In this high-risk population, with a relatively high prevalence of STIs, and 34% circumcision, both medical and traditional circumcision appear to be protective against STIs.

**Background**

Despite improvements in prevention, screening, and treatment, the global burden of sexually transmitted infections (STIs) remains high (1). Worldwide, more than a million people acquire sexually transmitted infections every day. 499 million new cases of treatable STIs (gonorrhea, chlamydia, syphilis, and trichomoniasis) arise each year, and 536 million people are estimated to be living with one curable herpes simplex virus type 2 (HSV-2) (2). In South Africa, the prevalence of STIs in men was 5% for chlamydia and 17% for herpes simplex virus type 2 between October 2016 and January 2017 (3). A home-based prevalence survey conducted in rural KwaZulu Natal, South Africa, among young men and women aged between 15–24 years old found a weighted prevalence of treatable STIs; 1.8% for gonorrhea, 0% and 0.4% for active syphilis, 0.6% and 4.6% for trichomoniasis (3). There is a need to both promote and evaluate existing interventions to improve the effectiveness of prevention of STIs.

STIs have varying consequences on sexual and reproductive health. Syphilis in pregnancy leads to an estimated 305 000 adult and new-born deaths and leaves 215 000 babies at high risk of losing their life from prematurity, low birth weight or congenital disease each year in the world (2). Gonorrhea and chlamydia are risk factors for infertility, and untreated genital infection may be the cause of up to 85% of sterility of women seeking infertility treatment (2). As a result of an understanding of the persistent problem of STIs, as well as the effects on health, the World Health Organization (WHO) Global Health Sector strategy on STI 2016–2021 (4) has outlined the goals and targets for global STIs prevention and control. Among these targets is to collect information on STI prevalence and incidence across representative populations (4). In South Africa, the government is promoting voluntary male circumcision and condom use (6) and has sentinel surveillance in place across the nine provinces (5). However, the burden of STIs remains high and this may require combining the biological and behavioral interventions.

Male circumcision is one of the oldest and most common surgical procedures worldwide and is accepted for many reasons including religious, cultural, social and medical (7). Circumcision decreases the entry of pathogens through abrasions in the thinly keratinized inner mucosal surface of the foreskin and eliminates the moist environment under the foreskin, which may favor pathogen persistence and reproduction (4). From an efficacy point of view, there is conclusive evidence that male circumcision reduces the risk of HIV and STI infection risk is conclusive. Three randomized controlled trials (RCTs), a meta-analysis of the 3 RCTs, and several cohort studies have shown consistent benefits and the WHO now recommends voluntary medical male circumcision (VMMC) as one of the key HIV and STI prevention strategies (9). The first RCT was conducted in Johannesburg, South Africa, from October 25, 2005, including 3274 uncircumcised men of 18–24 years old, reported that male circumcision reduced risk of HIV infection by60% (8). The same authors found a 58% reduction in risk of incident *Trichomonas vaginalis* in women with circumcised partners, compared to those with uncircumcised partners, in a prospective study conducted in Kenya (10). Another RCT found that male circumcision decreased *Trichomonas vaginalis* infection among men (OR 0.49, p = 0.030, AOR 0.41, p = 0.030 (11)) among men aged 18–24 years, in Orange farm in South Africa. A systematic review of 57 observational studies also found that females were at a decreased risk of STIs when their male partners were medically circumcised (12). Another systematic review and meta-analysis of global data from April 2019 of 62 observational studies including 119248 men who have sex with men (MSM) found that circumcision was associated with 23% reduced odds of HIV infection among MSM (OR 0.77, 95% CI 0.67–0.89) (13). In controlled settings and the general population, male circumcision is effective in reducing the risk of STIs in both men and women.

Although data from clinical trials and several observational studies show the efficacy of VMMC in reducing the risk of STDs, several questions remain unanswered. This may have an unintended effect in that circumcised men expose themselves more, in the belief that they will not get STIs (19). Behavioral risk compensation is not limited to men only as women may change their behavior in the belief that VMMC protects them. In one study in South Africa, women who were aware of the benefits believed that VMMC reduced the need to worry about HIV and were less likely to use condoms with circumcised men (20). STIs tend to be diagnosed late in women and commercial sex workers may act as reservoirs of infection and increase the risk of incident cases and re-infection (21). Further, resumption of sexual activity before 6 weeks post circumcision wound healing period increases the risk of STIs (19). How these factors affect the risk of STIs in a setting where high-risk sexual activity is prevalent such as migrant mining communities found in certain parts of South Africa is not
known (22). Further, many traditional communities practice circumcision as a rite of passage to manhood (23). Available data suggest that traditional circumcision may increase the risk of STI through a lack of health education, incomplete skin removal and higher risk sexual behaviors such as multiple partners and lower condom use (23). More research is needed to investigate how all these factors affect the efficacy of interventions for the reduction of STI risk, such as male circumcision.

This study compares the prevalence of STIs between men who are circumcised and those who are not, in an observational setting, where high-risk sexual behaviors are prevalent. Further, we compared the prevalence of STIs between males who were traditionally circumcised and those medically circumcised. Lastly, we assessed the effect of circumcision on the risk of STIs, after adjusting for established risk factors for STIs.

Methods

We used baseline cross-sectional data on men collected from a previous study - The International AIDS Vaccine initiation (IAVIB) study at Aurum institute Rustenburg, Bojanala district, Rustenburg. The parent study was a cohort study that aimed to measure the incidence of HIV infection (14).

Setting

Rustenburg city is in the Bojanala Platinum District in the North West province, 173 kilometers from Johannesburg. The Tshwane ethnicity and diverse internal and external migrants are the predominant populations in this community (14). The migration population is due to the mining industry which attracts many people seeking employment. Also, this industry attracts many sex workers (15). This may increase the prevalence of STIs in the population.

Sample Size and power

The baseline data on 339 men collected over 6 months were available for analysis. The prevalence of STIs in the total population was estimated at 30%, with an estimated prevalence of circumcision at 34%. Among those circumcised, we estimated that approximately 15% will have STIs while the prevalence will be double in the uncircumcised group. A sample size of 339 had 84.8% power to detect a difference given these assumptions.

Data collection

Data were collected using interviewer-administered questionnaires. Data collected included socio-demographic data, risky sexual behavior and circumcision status and assessment of STIs. The questionnaire used for the assessment of risky sexual behavior was previously validated in this population while the checklist used for assessing STIs was also validated (14).

Assessment of circumcision

This was done using an interviewer-administered questionnaire. Participants were asked whether they were circumcised and if so, whether they were circumcised culturally or medically (14).

Assessment of STIs

Syndromic assessment and management of sexually transmitted infections were done in the parent study, brief physical examination including vital signs, weight, height, examination external genital, and rectal examinations for relevant symptoms (14). Inconsistent condom use as was categorized as never, frequently, or sometimes using condoms with partners in the last three months, while consistent condom use was always using a condom with all partners. Clinicians conducted a genital exam and STIs were diagnosed syndromically and treated according to national guidelines (14).

Data analysis

All analyses were performed using SPSS version 25 (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.), and the level of significance was set at p <0.05. Data from the primary study were imported into SPSS for analysis. Numerical data were presented using mean and standard deviation (SD) when variables were normally distributed, otherwise median and inter-quarter ranges (IQR) were reported. Frequencies and percentages were used to summarize categorical variables.

Numerical data were compared between participants with and without STIs using independent samples t-tests or Wilcoxon rank-sum test (where data were not normally distributed), and categorical outcomes compared using chi-squared or Fisher's exact tests. The prevalence of STIs overall (gonorrhea, chlamydia, and trichomoniasis) was presented with 95% confidence intervals and by age group. The association between risk factors including circumcision and STI prevalence was assessed initially using chi-square tests and univariate logistic regression analysis reporting crude odds ratios and 95% confidence intervals. Circumcision as well as the other risk factors which were found to show an association with STIs at <= 0.2 level of significance were included in the predictive multivariable logistic regression analysis model. Backward selection based on likelihood ratios was used to arrive at a final model. The magnitude of the association between identified factors and outcomes was summarized using adjusted odds ratios and 95% confidence intervals. Both crude and adjusted odds ratios with 95% confidence intervals are presented.

Ethics considerations
The study was approved by the Health Research Ethics Committee at Stellenbosch University, (Reference No: S19/07/134), with a waiver of informed consent, as no new data were collected from participants. Permission to use the data was obtained from the Arum Institute.

Results

Table 1 shows the demographics of the participants by circumcision status. Baseline data on 339 participants were included in the study. In total 116 (34.2%) of the participants were circumcised. The majority (68%) were medically circumcised while the remainder were culturally circumcised. Their median age was 25 years, with an inter-quartile range from 22 to 29 years. The mean total years of schooling was 12 years with a standard deviation of 2 years. Most of the participants were Black, married and without a partner. Demographics did not vary by circumcision status.

| Table 1: Demographics of participants by circumcision status |
|-----------------------------------------------------------|
| | Circumcised | Uncircumcised | Total |
|------------------------------------------------------------------------------------------------|
| Enrolment Age | Median | 25 | 25 | 25 |
| | Percentile 25 | 23 | 22 | 22 |
| | Percentile 75 | 31 | 28 | 29 |
| Total years of schooling (years) | Mean | 12.1 | 12.4 | 12.28 |
| | Standard deviation | 1.8 | 1.9 | 1.9 |
| Race: n (%) | Black | 116 (34.5%) | 220 (65.5%) | 336 (99.1%) |
| | White | 0 | 1 (100%) | 1 (0.3%) |
| | Other | 0 | 2 (100%) | 2 (0.6%) |
| Marital status: n (%) | Single | 106 (33%) | 215 (66.9%) | 321 (94.7%) |
| | Divorced | 2 (100%) | 0 | 2 (0.6%) |
| | Married | 8 (50%) | 8 (50%) | 16 (4.7%) |
| Does your partner live with you: n (%) | No | 91 (35.1%) | 168 (65.6%) | 259 (76.4%) |
| | Yes | 19 (34.5%) | 36 (65.5%) | 55 (16.2%) |
| | Not applicable | 6 (24%) | 19 (76%) | 25 (7.4%) |
| Employment | Unemployed | 76 (33.7%) | 110 (66.3%) | 186 (49%) |
| | Self employed | 7 (30.4%) | 16 (69.6%) | 23 (6.8%) |
| | Student | 10 (38.5%) | 16 (61.5%) | 26 (7.7%) |
| | Employed | 43 (35.2%) | 79 (64.7%) | 122 (36%) |
| | Other | 0 | 2 (100%) | 2 (0.6%) |

The prevalence of STIs overall was 27.4% (93/339) (95% CI 22.8–32.6%). The prevalence of STIs was higher in uncircumcised males, compared to those circumcised (33.6% vs 15.5%, respectively. Further, the prevalence of STIs in participants who were medically circumcised was 17.7% versus 10.8% in those who were culturally circumcised.

Table 2: The prevalence of sexually transmitted infections by age group

| STI presence | 95% Confidence Interval for STI presence |
|--------------|----------------------------------------|
| Count | % | Count | % |
| STI presence | Present (n=93) | Absent (n=246) |
| Age group | 20-24 | 39 | 25.5% | 114 | 74.5% | 19.1% to 32.8% |
| | 24-29 | 27 | 24.8% | 82 | 75.2% | 17.4% to 33.5% |
| | 30-34 | 16 | 40.0% | 24 | 60.0% | 25.9% to 55.4% |
| | 35-39 | 7 | 26.9% | 19 | 73.1% | 12.9% to 45.7% |
| | 40-49 | 4 | 30.4% | 7 | 69.6% | 13.7% to 65.2% |
| Overall | 93 | 27.4% | 246 | 72.6% | 22.8% to 32.6% |

Table 3: Univariate association between circumcision, other risk factors, and STI presence
Table 3 shows univariate associations between risk factors and STI prevalence. Circumcised males were less likely to develop STIs than uncircumcised men, (OR 0.362, 95%CI 0.20–0.64, p < 0.001). Always using condoms was significantly protective for STIs (OR 0.291, 95%CI 0.13–0.67 p = 0.004), while using condoms with new female partners was not associated with STI protection. The enrolment age and years of schooling were weakly positively associated with STIs.

The six covariates were entered into a multiple logistic regression model. Using backward selection based on likelihood ratios, within four steps the final model containing circumcision, employment, and frequency of condom use remained. Circumcision remained strongly protective against STIs (OR 0.36, 95%CI 0.20–0.64, p = 0.001), after adjusting for employment, and condom use, as shown in Table 4.

| Factor | Levels | STI Presence | Crude OR (95% CI) | P-value |
|--------|--------|--------------|------------------|---------|
|        | Present | Absent       |                  |         |
|        | 75 (33.6%) | 148 (66.4%) | 1 (reference)    |         |
|        | 18 (15.5%) | 98 (84.5%) | 0.36 (0.20 to 0.64) | <0.001 |
| Circumcision | Yes | | | |
|        | 35(21.1%) | 131(78.9%) | 1 (reference)    |         |
| Employment | No | | | |
|        | 8(34.8%) | 15(65.2%) | 1.99 (0.78 to 5.09) | 0.148 |
|        | 1(10.2%) | 21(89.8%) | 0.89 (0.31 to 2.53) | 0.829 |
|        | 44(36.1%) | 78(63.9%) | 2.11 (1.25 to 3.57) | 0.005 |
|        | 1(50.0%) | 1(50.0%) | 3.74 (0.23 to 61.35) | 0.355 |
| Does your partner live with you? | No | | | |
|        | 66(25.5%) | 193(74.5%) | 1 (reference)    |         |
|        | 20(36.4%) | 35(63.6%) | 1.67 (0.90 to 3.09) | 0.103 |
|        | 27(29.0%) | 68(71.0%) | 1.19(0.62 to 2.28) | 0.597 |
|        | 317(21.1%) | 357(78.9%) | 1 (reference)    |         |
|        | 20(36.4%) | 35(63.6%) | 1.67 (0.90 to 3.09) | 0.103 |
|        | 62(23.5%) | 212(76.5%) | 1.14 (0.46 to 2.84) | 0.783 |
|        | 23 (24.7%) | 69 (28.0%) | 1 (reference)    |         |
| During the last month, on average, how often have you had a drink containing alcohol? | none | | | |
|        | 27 (29.0%) | 68 (71.0%) | 1.19 (0.62 to 2.28) | 0.597 |
|        | 4 (4.3%) | 6 (2.4%) | 2.00 (0.52 to 7.71) | 0.314 |
|        | 128 (52.0%) | 49 (48.0%) | 1 (reference)    |         |
|        | 91 (37.0%) | 103 (63.0%) | 1 (reference)    |         |
|        | 16 (22.2%) | 56 (77.8%) | 1.03 (0.62 to 1.72) | 0.890 |
|        | 9 (3.7%) | 4 (4.3%) | 2.00 (0.52 to 7.71) | 0.314 |
|        | 25 (18.4%) | 111 (81.6%) | 1 (reference)    |         |
|        | 25 (18.4%) | 111 (81.6%) | 1 (reference)    |         |
| Frequency of use of condom with female partner(s) | Never | | | |
|        | 18 (38.3%) | 29 (61.7%) | 1 (reference)    |         |
|        | 43 (32.6%) | 89 (67.4%) | 1.30 (0.90 to 4.12) | 0.187 |
|        | 16 (22.2%) | 56 (77.8%) | 0.98 (0.40 to 2.35) | 0.949 |
|        | 25 (18.4%) | 111 (81.6%) | 1 (reference)    |         |
|        | 8 (17.8%) | 37 (82.2%) | 1.03 (0.27 to 3.85) | 0.968 |
|        | 35 (70.8%) | 14 (29.2%) | 1.03 (0.27 to 3.85) | 0.968 |
|        | 4 (16.0%) | 21 (84.0%) | 0.91 (0.19 to 4.13) | 0.897 |
|        | 25 (18.4%) | 111 (81.6%) | 1 (reference)    |         |
|        | 52 (47.3%) | 58 (52.7%) | 4.26 (1.36 to 13.33) | 0.013 |
| Frequency of use of condom with new female partner(s) | Never | | | |
|        | 4 (17.4%) | 19 (82.6%) | 1 (reference)    |         |
|        | 4 (17.4%) | 19 (82.6%) | 1 (reference)    |         |
|        | 8 (17.8%) | 37 (82.2%) | 1.03 (0.27 to 3.85) | 0.968 |
|        | 35 (70.8%) | 14 (29.2%) | 1.03 (0.27 to 3.85) | 0.968 |
|        | 4 (16.0%) | 21 (84.0%) | 0.91 (0.19 to 4.13) | 0.897 |
|        | 25 (18.4%) | 111 (81.6%) | 1 (reference)    |         |
|        | 52 (47.3%) | 58 (52.7%) | 4.26 (1.36 to 13.33) | 0.013 |
| Enrolment Age: median (IQR) | 26 (23-30) | 25 (22-28) | 1.03 (0.99 to 1.07) | 0.166 |
|        | 17 (16-18) | 17 (13-18) | 0.98 (0.91 to 1.05) | 0.479 |
| Years of schooling: mean (sd) | 12.53(1.75) | 12.19(1.96) | 1.10 (0.97 to 1.25) | 0.144 |

Table 3: Univariate associations between risk factors and STI prevalence.

Table 4: Multiple logistic regression model for risk factors for STIs.
| Factor | p value | Odds Ratio | Lower 95% CI | Upper 95% CI |
|--------|---------|------------|--------------|--------------|
| Circumcised (yes vs no) | 0.001 | 0.36 | 0.19 | 0.66 |
| Employment | 0.046 | | | |
| Self-employed vs unemployed | 0.160 | 2.01 | 0.76 | 5.32 |
| Student vs unemployed | 0.752 | 0.83 | 0.26 | 2.66 |
| Employed vs unemployed | 0.005 | 2.22 | 1.28 | 3.85 |
| Other vs unemployed | 0.469 | 2.84 | 0.17 | 48.31 |
| Frequent use of condom with female partner(s) | 0.022 | | | |
| Sometimes vs never | 0.607 | 0.83 | 0.40 | 1.71 |
| Frequently vs never | 0.116 | 0.51 | 0.22 | 1.18 |
| Always vs never | 0.009 | 0.32 | 0.13 | 0.75 |

### Discussion

In this study, we found a high prevalence of 27.4% for STIs overall, and that uncircumcised males had double the prevalence (33.6%) compared to circumcised males (15.5%). We also found that circumcision reduced the risk of STIs by 64%, after adjusting for sociodemographic variables and risky sexual behavior variables. Medically circumcised males had a higher prevalence of STIs compared to traditionally circumcised males, however, further studies are needed to determine the effect of medial circumcision versus traditional male circumcision.

In 2007, UNAIDS and WHO concluded that the efficacy of male circumcision in reducing female to male transmission of HIV had been proved beyond reasonable doubt (17). The risk reduction that circumcision showed in our study is similar to three randomized controlled trials that evaluated male circumcision for the prevention of sexually transmitted infections. The trials found that circumcision decreased human immunodeficiency virus acquisition by 53–60%, herpes simplex virus type 2 acquisition by 28–34%, and human papillomavirus by 32 to 35% (16). Therefore, our study results add more support to the former findings. Furthermore, the protective effect of circumcision held after the adjustment for condom use and other factors, providing further evidence of its independent effect in reducing the risk of STIs.

Employed men were more likely to acquire STIs compared to unemployed men in our study. This may be partially due to the thriving commercial sex trade in this region (15). We also found that condoms were protective against STIs, which was expected (18). The control of STIs is an important public health priority for HIV prevention and included male circumcision, health education, condom promotion, and STIs and HIV testing.

Since this study was not a randomized controlled trial, it is also difficult to determine the causality of effect. We can merely state an association that is apparent in the data. Another limitation is that the risk behavior was determined by self-report of participants and risky behaviors might have been under-reported and may lead to potential information bias.

### Conclusion

Male circumcision is associated with lower odds of sexually transmitted infections in a population with a relatively high STI prevalence and a 34% circumcision rate. Further evidence from robust randomized controlled trials may be required to assess the efficacy of male circumcision as a prevention tool against STIs in this population. The prevalence of STIs in culturally circumcised participants was slightly lower than that in medically circumcised participants (10.8% vs 17.7%), however, stratification by type of circumcision was not possible due to the low sample size of culturally circumcised individuals. A future study comparing these two populations with enough power in each group would be required to confirm any differences in STI risk.

### Abbreviations

- **STI**: Sexually transmitted infection
- **HIV**: Human immunodeficiency virus
- **HSV2**: Herpes simplex virus 2
- **MSM**: Men who have sex with men
- **SPSS**: Statistical package for social science
- **AOR**: Adjusted odds ratio
- **CI**: Confidence intervals
- **IRQ**: Inter-quarter range
VMMC: voluntary medical male circumcision

**Declarations**

**Ethics approval and consent to participate**

In the parent study, the ethics approval was obtained at the University of Kwazulu Natal Health Research Ethics Committee (ethics reference no: BF059/08) and each participant provided written informed consent. For this sub-study ethics approval and waiver of informed consent was obtained from the Stellenbosch University Health Research Ethics Committee, as the study did not investigate objectives outside the primary study.

**Consent for publication**

Not Applicable

**Availability of data and materials**

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

**Competing interests**

BMI – none declared

TC – none declared

TME – none declared

**Funding**

Not applicable.

**Authors contributions**

BMI – conception of, drafting of protocol, data analysis, writing up manuscript and approval for final submission.

TC - conception of, revision of protocol, revision of manuscript and approval for final submission

TME – conception of, revision of the protocol, revision of the manuscript, data analysis and approval for final submission

**Acknowledgments**

We would like to acknowledge the Aurum institute Rustenburg for the support and for making the data available to us. We thank Dr. Pholo Maenetje (A program manager at Aurum Institute) and Dr. William Brumskine for their support and during the study.

**References**

1. WHO. Report on global sexually transmitted infection surveillance 2015. World Heal Organ [Internet]. 2016;54p. Available from: http://apps.who.int/iris/bitstream/handle/10665/249553/9789241565301eng.pdf;jsessionid=9870D6A3677641C8CDD?sequence=1

2. World Health Organization. Sexually Transmitted Infections (STIs). The importance of a renewed commitment to STI prevention and control in achieving sexual and reproductive health. World Heal Organ [Internet]. 2013;1–8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/24694329

3. Torrone EA, Morrison CS, Chen P-L, Kwok C, Francis SC, Hayes RJ, et al. Prevalence of sexually transmitted infections and bacterial vaginosis among women in sub-Saharan Africa: An individual participant data meta-analysis of 18 HIV prevention studies [Internet]. Vol. 15, PLOS Medicine. 2018. e1002511 p. Available from: http://dx.plos.org/10.1371/journal.pmed.1002511

4. Korenromp EL, Wi T, Resch S, Stover J, Brouet N (2017) Costing of National STI Program Implementation for the Global STI Control Strategy for the Health Sector, 2016-2021. PLoS ONE 12(1): e0170773. DOI: 10.1371/journal.pone.0170773

5. Kularatne RS, Niit R, Rowley J, KufaChakeza T, Peters RPH, Taylor MM, et al. (2018) Adult gonorrhea, chlamydia and syphilis prevalence, incidence, treatment and syndromic case reporting in South Africa: Estimates using the Spectrum-STI model, 1990-2017. PLoS ONE 13 (10); e0205863. https://doi.org/10.1371/journal.pone.0205863

6. Newman L, Rowley J, Vander Hoom S, Wijesooriya NS, Unemo M, Low N, et al. (2015) Global Estimates of the Prevalence and Incidence of Four Curable Sexually Transmitted Infections in 2012 Based on Systematic Review and Global Reporting. PLoS ONE 10(12); e0143304. DOI:10.1371/journal.pone.0143304

7. Newman L, Rowley J, Vander Hoom S, Wijesooriya NS, Unemo M, Low N, et al. (2015) Global Estimates of the Prevalence and Incidence of Four Curable Sexually Transmitted Infections in 2012 Based on Systematic Review and Global Reporting. PLoS ONE 10(12); e0143304. DOI:10.1371/journal.pone.0143304
8. Puren A, Auvert B, Taljaard D, Lagarde E. Randomized Controlled Intervention Trial of Male Circumcision for Reduction of HIV Infection Risk: The ANRS 1265 trial. PLoS Med 2(11): e298 DOI: 10.1371/journal.pmed.0020298

9. WHO/UNAIDS Technical Consultation on Male Circumcision and HIV Prevention: Research Implications for Policy and Programming Montreux, 6 – 8 March 2007. https://apps.who.int/iris/handle/10665/43751

10. Pintye J, Drake AL, Unger JA, Matemo D, Kinuthia J, Mcclelland S, et al. Male partner circumcision associated with lower Trichomonas vaginalis incidence among pregnant and postpartum Kenyan women: a prospective cohort study. BMJ. 2018;93(2):137–43.

11. Sobngwi-Tambekou J, Taljaard D, Nieuwoudt M, Lissouba P, Puren A, Auvert B. Male circumcision and Neisseria gonorrhoeae, Chlamydia trachomatis and Trichomonas vaginalis: Observations after a randomised controlled trial for HIV prevention. Sex Transm Infect. 2009;85(2):116–20.

12. Grund JM, Bryant TS, Jackson I, Curran K, Bock N, Toledo C, et al. Articles Association between male circumcision and women's biomedical health outcomes: a systematic review. Lancet Glob Heal. 2019;5(11):e1113–22.

13. Yuan T, Fitzpatrick T, Ko N, Cai Y, Chen Y, Zhao J, et al. Articles Circumcision to prevent HIV and other sexually transmitted infections in men who have sex with men: a systematic review and meta-analysis of global data. Lancet Glob Heal [Internet]. 2019;7(4):e436–47. Available from: http://dx.doi.org/10.1016/S2214-109X(18)30567-9

14. Africa S, Id PM, Lindan C, Id HM, Chetty-makkan CM, Latka MH, et al. HIV incidence and predictors of inconsistent condom use among adult men enrolled into an HIV vaccine preparedness study, PLoS ONE 14(4): e0214786. https://doi.org/10.1371/journal.pone.0214786

15. Richter ML, Chersich M, Sartorius B, Temmerman M. Migration Status, Work Conditions and Health Utilization of Female Sex Workers in Three South African Cities Migration Status, Work Conditions and Health Utilization of Female Sex Workers in Three South African Cities. J Immigrant Minority Health (2014) 16:7–17 DOI 10.1007/s10903-012-9758-4

16. Elijah Odoyo-June, MBCHB, MSc, *, †, John H. Rogers, BS, MPH, †, Walter Jaoko, MBCHB, Ph.D., †, and Robert C. Bailey, Ph.D., MPH, Factors Associated With Resumption of Sex Before Complete Wound Healing in Circumcised HIV-Positive and HIV-Negative Men in Kisumu, Kenya, J Acquir Immune Defic Syndr. 2013 April 1; 62(4): 465–470. DOI:10.1097/QAI.0b013e3182800710.

17. Moses S. Male circumcision: a new approach to reducing HIV transmission. CMAJ October13, 2009 181 (8) E134-E135; DOI: https://doi.org/10.1503/cmaj.090809

18. Weller SC, Davis-Beaty K. Condom effectiveness in reducing heterosexual HIV transmission. Cochrane Database of Systematic Reviews 2002, Issue 1. Art. No.: CD003255. DOI: 10.1002/14651858.CD003255

19. Hewett PC, Hallett TB, Mensch BS, Dzekedzeke K, Zimba-Tembo S, Garnett GP, et al. Sex with stitches: assessing the resumption of sexual activity during the post circumcision wound-healing period. 2012,(August 2011). AIDS. 26(6):749–756, DOI:10.1097/QAD.0b013e328350977f, PMID 22269970

20. Kalichman S, Mathews C, Kalichman M, Eaton LA, Nkoko K. Male circumcision for HIV prevention: Awareness, risk compensation, and risk perceptions among South African women. Global public health. 2018 Nov 2;13(11):1682-90.

21. Mactaggart F, McDermott L, Tynan A, Whittaker M. Exploring the broader health and well-being outcomes of mining communities in low-and middle-income countries: A systematic review. Global public health. 2018 Jul 3;13(7):899-913

22. Sagaon-Teyssier L, Balique H, Diallo F, Kalampalikis N, Mora M, Bourrelly M, Suzan-Monti M, Spire B, Keita BD. Prevalence of HIV at the Kokoyo informal gold mining site: What lies behind the glitter of gold with regard to HIV epidemics in Mali? A community-based approach (The ANRS-12339 Sanu Gundo cross-sectional survey). BMJ open. 2017 Aug 1;7(8): e016558

23. Shi C, Li M, Dushoff J. Traditional male circumcision is associated with sexual risk behaviours in Sub-Saharan countries prioritized for male circumcision. AIDS and Behaviour. 2019 Apr 6:1-9.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- STROBEchecklist.docx