Voluntary medical male circumcision for HIV Prevention

Markus Haacker, Harvard University

Summary

Male circumcision for HIV prevention has been a cornerstone in global efforts towards "ending AIDS." It has been recognized as one of the most effective and cost-effective HIV prevention interventions, and as of end-2017, nearly 19 million men had been medically circumcised in 14 "priority countries." Looking ahead, the contribution and cost-effectiveness of male circumcision depends on two factors:

- The continuing expansion of treatment affects the effectiveness of male circumcision for HIV prevention. The higher treatment coverage, and the more effective treatment is in suppressing the virus and preventing HIV transmission, the smaller is the contribution of male circumcision in preventing new HIV infections.
- Following the scaling-up of male circumcision across the male population so far, and reflecting considerations on cost-effectiveness, the focus of programs offering male circumcision has shifted to adolescents and young adults.

The appraisal takes into consideration this changing context, and the variation in the burden of the disease and the state of the response across countries. We distinguish different levels of HIV prevalence (5% to 20%) and treatment coverage (50% to 80%), and offer estimates on male circumcision for adolescents (age 15) and adults at age 30. Estimated benefit-cost ratios range from 1.1 (age 30, HIV prevalence 5%, treatment coverage 80 percent) to 56 (age 15, HIV prevalence 20%, treatment coverage 50 percent).

Identification of problem

HIV has been a dominant health challenge across much of sub-Saharan Africa over the last decades. HIV deaths peaked at 1.6 million across the region in 2005, accounting for 18 percent of all deaths (IHME, 2018), and reducing life expectancy by well over a decade in high-prevalence countries. Mortality has declined steeply because of the expansion of treatment programs, but as of 2017 AIDS was still causing 700,000 deaths annually (10% of all deaths).

Male circumcision is recognized as one of the most effective and cost-effective HIV prevention interventions, reducing the risk of female-to-male HIV transmission by about one-half (Siegfried, Muller, Deeks, and Volmink, 2009). While male circumcision has been shown to reduce male-to-female transmission of some sexually transmitted diseases, the evidence on female-to-male HIV transmission is weak and the effect likely small (Grund and others, 2017). Nevertheless, reduced HIV infections among men mean that fewer sexual partners become infected, and these indirect effects beyond the population circumcised are often estimated at a similar magnitude as the direct effects on the population circumcised (Haacker, Fraser-Hurt, and Gorgens (2016), White (2008)).[43]

Male circumcision for HIV prevention has been recognized as a cornerstone of efforts towards controlling the epidemic, and has been included among the basic program activities under the UNAIDS investment framework (Schwartländer and others, 2011) and the "fast track" strategy on "ending AIDS" by 2030 (UNAIDS, 2014). The WHO and UNAIDS (2011) framework on male circumcision aimed at reaching a target of 80 percent of men being circumcised by 2016 in 14 "priority countries" with high HIV prevalence and a low level of male circumcision. Between 2008 and 2017, 18.6 million men got medically circumcised in these countries (WHO Regional Office for Africa, 2018), corresponding to about one-quarter of the male population at ages 15-49.

[43] Male circumcision has also been shown to have some protective effect for men who have sex with men, but we focus on heterosexual transmission which is the dominant mode in sub-Saharan Africa.

Looking ahead, it will be important to take note of the progress already achieved, and the ongoing challenges in maintaining or increasing the coverage of male circumcision. It is also important to recognize that effectiveness and cost-effectiveness of male circumcision may differ depending on the state of the epidemic and of the response to it. Specifically, we evaluate the cost-effectiveness of male circumcision under the following circumstances:

- HIV prevalence (ages 15-49) of 5%, 10%, and 20%, broadly spanning the "priority countries," where HIV prevalence ranges from about 5 percent (Kenya, Uganda) to over 20 percent (Botswana, Lesotho, Swaziland).
- Male circumcision at age 30 and age 15.
- Age 30 (about the average age of a male adult in sub-Saharan Africa) proxies a continuation of efforts on scaling up male circumcision across the adult population. However, following the expansion of male circumcision that has already taken place, about three-quarters of new circumcisions now occur at ages 10-19 (Davis and others, 2018).
- The estimate for age 15 therefore reflects thrust of ongoing circumcision programs, because of saturation in older age groups, the need to circumcise males growing into adulthood to maintain high coverage of male circumcision overall, and the fact that male circumcision is most feasible and effective in the young age brackets.
- Treatment coverage at 50 percent (of all people living with HIV), with 80 percent achieving viral suppression, or treatment coverage at 81 percent, with 90 percent achieving viral suppression. Assumptions on treatment coverage broadly span the current situation in the region (e.g., ranging from 55 percent in Mozambique to 85 percent in Botswana, Namibia, Swaziland, and Zimbabwe), according to UNAIDS (2018)). Looking ahead, the assumptions capture how the effects of male circumcision change as treatment is expanded in line with "ending AIDS" 90-90-90 targets.[44]

Costs of the intervention

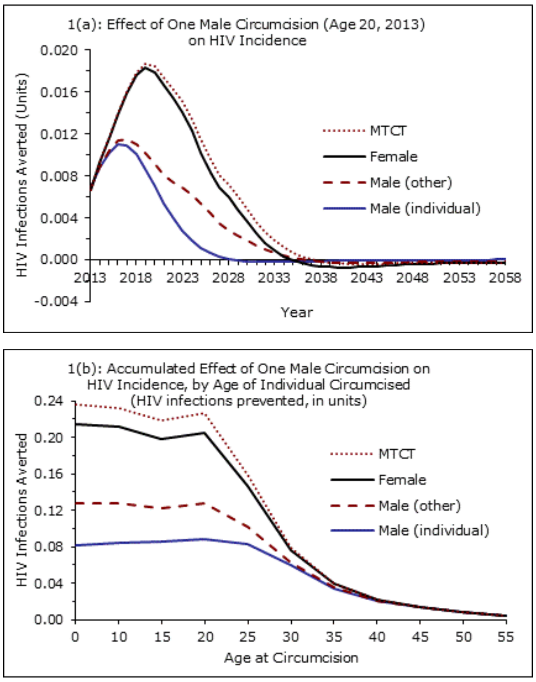
We assume a unit cost for medical male circumcision of US$ 90, close to the average cost estimated for sub-Saharan Africa (Kripke and others, 2016a, 2016b; Bautista-Arredondo and others, 2018). These costs include labor costs, consumables and other facility level-costs, and an allowance for above-facility costs. It does not include demand-creation costs; much of these are bound-up with HIV awareness campaigns overall and attributing some to male circumcision programs is beyond the scope of this note, and private costs of accessing VMMC, estimated at US$ 9 in South Africa (Tchuenche and others, 2016) but arguably lower across the region (in line with GDP per capita).

Identification of the benefits

Male circumcision provides partial and lasting protection against contracting HIV for the population circumcised ("male (individual)" effect in Figure 1). However, as fewer men circumcised become HIV-positive, their female partners also benefit from reduced risk of contracting HIV ("female" effect in Figure 1), and so on ("MTCT" (mother-to-child transmission), HIV infections among "male (other)"). Male circumcision, in terms of the total number of HIV infection averted, is most effective up to about age 20, but the effectiveness declines steeply at higher ages (Figure 1(b)).

44 Whereby 90 percent of people living with HIV are diagnosed, 90 percent of those diagnosed (i.e., 81 percent of people living with HIV) receive treatment, and 90 percent of those receiving treatment achieve viral suppression.

FIGURE 1. EFFECT OF ONE MALE CIRCUMCISION



Source: Haacker, Fraser-Hurt, and Gorgens (2016, on South Africa).

To adapt the estimates described in Figure 1 to other countries, we scale the direct individual-level effects (on men circumcised) in line with key determinants of the risk of contracting HIV for men, namely HIV prevalence in the female population p_F, treatment coverage (c), and its effectiveness in preventing HIV transmission(x). Specifically, we assume that the effects are proportional to the risk of contracting HIV $i_M = a(1 - x * c)p_F$, where a is a constant. The indirect effects are scaled (1) by the same factor as the direct effects and (2) by a factor measuring the life-time odds of passing on HIV, $Y = b(U + (1 - x) * T)(1 - p_F)$, i.e., they depend on the expected years spent without treatment (U) and on treatment (T), the effectiveness of treatment in achieving viral suppression, and the share of the female population not HIV positive. For the setting with treatment coverage of 50 percent of all people living with HIV, we assume an average time of 11 years without treatment, 11 years on treatment, and a loss of 22 life years per HIV infection. For the setting with treatment coverage of 81 percent, there are on average 8 years without treatment, 25 years on treatment, and a loss of 11 life years per HIV infection.[45] The lifetime costs of treatment are set at US$ 2,500 (treatment coverage: 81%) or US$ 1,000 (treatment coverage: 50%),[46] and the value of a life year lost is set at US$ 1959 (1.3 times the average level of GNI per capita across sub-Saharan Africa as of 2018, according to World Bank (2019)), and assumed to grow at an annual rate of 3 percent.[47]

45 These estimates are adapted from Haacker (2016), pp. 161-164. We assume that in the setting with 50 percent coverage, treatment is initiated on average between CD4 counts of 100 and 200, and with treatment coverage of 80 percent treatment is initiated at a CD4 count of 350.

46 Based on Haacker (2016), pp. 161-164, also using a discount rate of 5 percent, but applying an annual cost of treatment of US$ 300, close to the median cost for sub-Saharan Africa applied by Kripke and others (2016b).

47 While GNI per capita varies considerably across sub-Saharan Africa, the unit costs of male circumcision vary positively with GNI per capita, e.g., between just over US$ 40 (Kenya, Zambia) and over US$ 100 in South Africa, according to Bautista-Arredondo and others (2018). Differences in benefit-cost ratios by income level are therefore of a much smaller magnitude than the differences in GNI.

TABLE 1 EFFECTIVENESS AND COST-EFFECTIVENESS OF MALE CIRCUMCISION

	Circumcission/ HIV Infection Averted		Benefit-Cost Ratio	
	MC at Age 15	MC at Age 30	MC at Age 15	MC at Age 30
Treatment coverage 50%, viral suppression at 80%				
HIV prevalence 20%	3.9	10.6	45	20
HIV prevalence 10%	7.8	20.5	25	10
HIV prevalence 5%	13.7	40.1	13	5
Treatment coverage 81%, viral suppression at 90%				
HIV prevalence 20%	10.0	24.8	10	4.7
HIV prevalence 10%	18.3	48.0	5	2.4
HIV prevalence 5%	35.1	94.4	3	1.2

We find that male circumcision remains a very effective and cost-effective HIV prevention intervention, especially for adolescents (age 15) where estimated benefit-cost ratios range from 3 to 45. (We obtain similar results up to age 25.) Compared to this, circumcision at age 30 is less effective (in terms of circumcisions required to prevent one HIV infection) by a factor of about 2.5, and returns a benefit-cost ratios between 1.2 (low prevalence, high treatment coverage) and 20.

The ongoing scaling up of treatment diminishes the effectiveness of and returns to investments in male circumcision. Nevertheless, we estimate benefit-cost ratios of between 1.2 (age 30, HIV prevalence 5%) and 10 (age 15, HIV prevalence 20%) in a setting consistent with reaching a 90-90-90 target, reinforcing assessments (e.g., Kripke and others, 2016b) that male circumcision will play an important role in achieving progress towards "ending AIDS" alongside meeting the 90-90-90 treatment targets.

These benefit-cost ratios – based on national averages – likely understate the potential for male circumcision. E.g., the benefits could be higher if efforts could be targeted at sub-populations with higher HIV prevalence, or more intense ongoing HIV transmission. Methodologically, the principal shortcoming of our assessment is the reliance on extrapolation, using summary indicators of the state of the epidemic and the response to it. In particular, we may not capture the complexities of the interactions between improved treatment access and the effectiveness of male circumcision. Economic factors – notably, differences in service delivery costs of male circumcision and treatment, and in the valuation of years of life lost – would also affect the estimates on cost-effectiveness. However, the magnitude of the estimated benefit-cost ratios suggests that the thrust of our findings in robust to more sophisticated and differentiated approaches.

References

Bautista-Arredondo, Sergio, and others, 2018, "Influence of Supply-Side Factors on Voluntary Medical Male Circumcision Costs in Kenya, Rwanda, South Africa, and Zambia," PLoS One, Vol. 13, No. 9: e0203121.

Davis, Stephanie M., and others, 2018, "Progress in Voluntary Medical Male Circumcision for HIV Prevention Supported by the US President's Emergency Plan for AIDS Relief through 2017: Longitudinal and Recent Cross-Sectional Programme Data," *BMJ Open*, Vol.8, No. 8, p.e021835.

Grund, Jonathan M., and others, 2017, "Association between Male Circumcision and Women's Biomedical Health Outcomes: A Systematic Review," *The Lancet Global Health*, Vol.5, No. 11, pp. e1113-e1122.

Haacker, Markus, 2016, *The Economics of the Global Response to HIV/AIDS* (Oxford and New York: Oxford University Press).

Haacker, Markus, Nicole Fraser-Hurt, and Marelize Gorgens, 2016, "Effectiveness of and Financial Returns to Voluntary Medical Male Circumcision for HIV Prevention in South Africa: An Incremental Cost-Effectiveness Analysis," *PLoS Medicine*, Vol. 13, No. 5: e1002012.

Kripke, Katharine, and others, 2016a, "Assessing Progress, Impact, and Next Steps in

Rolling Out Voluntary Medical Male Circumcision for HIV Prevention in 14 Priority Countries in Eastern and Southern Africa through 2014," *PLoS One*, Vol. 11, No. 7: e0158767.

Kripke, Katharine, and others, 2016b, "Impact and Cost of Scaling Up Voluntary Medical Male Circumcision for HIV Prevention in the Context of the New 90-90-90 HIV Treatment Targets," *PLoS One*, Vol. 11, No. 10: e0155734.

Njeuhmeli E, Forsythe S, Reed J, Opuni M, Bollinger L, Heard N, et al. 2011, Voluntary Medical Male Circumcision: Modeling the Impact and Cost of Expanding Male Circumcision for HIV Prevention in Eastern and Southern Africa. *PLoS Medicine*, Vol. 8, No. 11: e1001132.

Schwartländer, Bernhard, and others, 2011, "Towards an Improved Investment Approach for an Effective Response to HIV/AIDS," *The Lancet*, Vol. 377, Issue 9782, pp.2031-2041.

Siegfried, Nandi, Martie Muller, Jonathan J. Deeks, and Jimmy Volmink, 2009, "Male circumcision for Prevention of Heterosexual Acquisition of HIV in Men," *Cochrane Database of Systematic Reviews*, 2009, Issue 2, Article No. CD003362.

Tchuenche, Michel, and others, 2016, "Estimating Client Out-of-Pocket Costs for Accessing Voluntary Medical Male Circumcision in South Africa, *PLoS One*, Vol. 11, No. 10:e0164147.

UNAIDS, 2014, "Fast Track – Ending the AIDS Epidemic by 2014" (Geneva: UNAIDS).

UNAIDS, 2018, "UNAIDS 2018 estimates," accessed at: http://aidsinfo.unaids.org/ in October 2018.

White, Richard G., and others, 2008, "Male Circumcision for HIV Prevention in Sub-Saharan Africa: Who, What and When?" *AIDS*, Vol. 22, No. 14, pp.1841-1850.

World Bank, 2019, World Development Indicators database, last updated July 10, 2019 (Washington DC: World Bank).

World Health Organization (WHO), Regional Office for Africa, 2018, "Who Progress Brief: Voluntary Medical Male Circumcision for HIV Prevention, July 2018."

WHO and UNAIDS, 2011, Joint Strategic Action Framework to Accelerate the Scale-Up of Voluntary Medical Male Circumcision for HIV Prevention in Eastern and Southern Africa 2012–2016 (Geneva: UNAIDS).