

Male circumcision uptake and misperceived norms about male circumcision: Cross-sectional, population-based study in rural Uganda

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Background Over the past decade, 15 high-priority countries in eastern and southern Africa have promoted voluntary medical male circumcision for human immunodeficiency virus (HIV) and sexually transmitted infection (STI) prevention. The prevalence of male circumcision in Uganda nearly doubled from 26% in 2011 to 43% in 2016, but remains below the 2020 target level. Little is known about how common male circumcision is perceived to be, how accurate such perceptions are, and whether they are associated with men's own circumcision uptake.

Methods We conducted a cross-sectional study of all adult residents of eight villages in Rwampara District, southwestern Uganda in 2020-2022. We elicited their perceptions of the adult male circumcision prevalence within their village: >50% (most men), 10% to <50% (some), <10%, (few to none), or do not know. We compared their perceived norms to the aggregated prevalence of circumcision reported in these villages. We used a modified multi-variable Poisson regression model to estimate the association between perceived norms and personal circumcision uptake among men.

Results We surveyed 1566 participants (91% response rate): 698 men and 868 women. Among the men, 167 (27%) reported being circumcised, including 167/444 (38%) men <50 years of age. Approximately one-fourth of the population (189 (27%) men and 177 (20%) women) believed that few to no men in their own village had been circumcised. In a multivariable regression model, men who underestimated the prevalence of male circumcision were less likely to be circumcised themselves (adjusted relative risk (aRR)=0.51; 95% confidence interval (CI)=0.37-0.83).

Conclusions In this population-based study in rural Uganda, one-fourth of men underestimated the prevalence of male circumcision. Men who underestimated the extent of circumcision uptake were themselves less likely to be circumcised. If the observed association is causal and underestimates within the population contribute to low uptake, then interventions correcting these misperceived norms could increase uptake of voluntary medical male circumcision.

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In 2007, the World Health Organization (WHO) and the Joint United Nations Programme on human immunodeficiency virus/acquired immune deficiency syndrome (HIV/AIDS) recommended increasing voluntary medical male circumcision (VMMC) uptake in populations at high risk of HIV infection, especially in HIV-endemic countries [1]. Studies had indicated that VMMC uptake

was associated with reduced HIV acquisition risk among men [2-6] and, indirectly, among women [7,8]. Additionally, VMMC uptake was associated with a reduced risk of acquiring other sexually transmitted infections such as syphilis, herpes simplex virus type 2, penile human papillomavirus, and cervical cancer [9-13]. Consequently, governments and international organisations began supporting efforts to enhance VMMC uptake as a part of HIV prevention efforts [7,14], with recent research continually indicating its efficiency in this regard [15-18]. VMMC uptake reduces risk of infection by removing penile tissue that may be more susceptible to infection and by affecting the penile immune and microbial environment [19].

In 2016, the WHO set a target of achieving an additional 25 million VMMCs performed among boys and men across 15 “high-priority” countries in eastern and southern Africa by 2020 [20]. Although uptake increased [6], the cumulative number of VMMCs fell seven million short of the target for 2020, with uneven progress between countries and age groups [21]. For example, VMMC uptake is still much lower in Uganda than in other high priority countries [22,23] and is thus insufficient to translate into meaningful reductions in HIV incidence. Nationwide estimates indicate that the prevalence of circumcision among men aged 15-49 years had increased only to 43% by 2016-2017 [24,25], leaving a need for greater uptake among men at high risk of HIV acquisition and among men and boys aged ≥ 15 years [26]. Critically, increasing VMMC uptake requires novel implementation strategies, especially those that do not stigmatise uncircumcised individuals [27].

Several studies in southern Africa have found associations between men’s beliefs about what their social contacts would support and their personal intention to get circumcised. For example, young uncircumcised men in Eswatini were more likely to report a personal intention to get circumcised if they thought that their friends, parents, or partner encouraged male circumcision and if they thought that most of their male friends were circumcised [28]. Similarly, young uncircumcised men in Zimbabwe were more likely to report a personal intention to get circumcised if they believed that their mother would encourage male circumcision and if they believed that their male friends would get circumcised [29]. A recent systematic review concluded that familial and peer support for male circumcision facilitates uptake of VMMC [30]. Likewise, hearing about circumcision promotion from influential people such as religious leaders or a peer who underwent VMMC is also associated with circumcision uptake [31,32].

Theoretical and empirical research has shown that perceived descriptive norms (i.e. what individuals think most other people do) influence one’s own behaviors and beliefs [33-40]. However, individuals often misperceive local norms: they tend to underestimate the extent to which health-promoting behaviours are normative and overestimate the extent to which health-risk behaviours are normative [41-47]. Many factors contribute to this misalignment between perceived norms and actual local norms: lack of conversation with relevant peers about such behaviors or beliefs, lack of visible cues in the local environment about health-promoting behaviors, greater visibility of high risk behavior on social media, and biases in conversational, memory, and psychological inference processes [48,49]. Critically, health-promoting behaviors may be invisible due to associated stigma or local taboos preventing conversation, or because the behaviors are relatively private.

Studies have not yet assessed the accuracy of perceived norms about male circumcision nor the extent to which they can be harnessed to increase VMMC uptake in rural Uganda and in similar contexts. Recent studies on HIV prevention, substance use, violence, and other health-related behaviors in Uganda and South Africa have found that individuals often overestimate the prevalence of peer behaviors that increase the risk of HIV acquisition and transmission (e.g. avoiding testing, substance use, condomless sex, intimate partner violence, and non-adherence to antiretroviral medications) and that these misperceptions are associated with personal behavior [50-58].

We aimed to investigate perceptions about the local prevalence of male circumcision among all men and women across eight villages in rural Uganda. We compared participants’ beliefs about male circumcision prevalence (in their village) to the actual village-level prevalence of male circumcision. We then sought to estimate the association between these perceptions and men’s personal circumcision status. If many people misperceive local norms for male circumcision, then an opportunity would exist to assess whether correcting misperceptions would promote VMMC uptake. Many studies on other health behaviors have found that changing perceived norms leads to behavioral change [48,59-65].

METHODS

Study setting and design

We conducted a cross-sectional, whole-population study targeting all residents aged ≥ 18 years within eight villages in a rural, administrative parish in Rwampara District, southwestern Uganda, located approximate-

ly 20 km from Mbarara City. We selected this parish in collaboration with local leaders due to its tractable population, geographic size, and similarity to other rural areas in Uganda where most Ugandans reside [66]. Specifically, 75% of people in Uganda (and most people in other eastern and southern African countries) reside in local economies featuring agricultural and small-scale trading/enterprise, household food and water insecurity, and limited access to electricity and piped water [66-70]. The study population characteristics were also similar to national characteristics. For example, most adults in Uganda are married, have less than secondary education completed, and are between 18 and 30 years old [66,71,72]. Additionally, the setting resembles other areas in the 15 priority countries targeted for VMMC uptake in eastern and southern Africa.

Study procedures

Research assistants who spoke the local language (Runyankore) gathered data in 2020-2022. Using a continuously updated parish census list of all age-eligible adult residents, they contacted all age-eligible residents of the targeted villages, if the residents were not incapacitated/intoxicated at the time of data collection. The research assistants asked for informed consent, obtaining participants' signatures or thumbprints (for those unable to write). They then conducted one-on-one survey-based interviews and recorded survey responses using a computer-assisted tool. If procedures could not be conducted in person (typically in or near a participant's home) due to coronavirus disease 2019 pandemic restrictions, the research assistants obtained consent and conducted data collection over the phone. All individuals who participated in the survey interview (in person or by phone) received their choice of a kilogram of sugar or a bar of soap (per local norms) for their time.

Measures

The survey questions were written in English, translated into Runyankore, and then back-translated to English to verify the translation's fidelity to the intended meaning. Question piloting and translation followed an iterative process. One question elicited from each man whether he was circumcised (yes/no), while another elicited from both men and women their estimates of the male circumcision prevalence in their village (i.e. their perceived norm about male circumcision uptake). Specifically, they were asked how many men in their own village were circumcised, using a 4-point Likert-type scale ranging from "all or almost all men (>90%)", "more than half of men but fewer than 90%", "fewer than half of men but more than 10%", "very few or no men (<10%)", or "do not know". Pre-testing suggested that participants easily understood "Other adult men in your village" as the reference or comparison group for this question. Therefore, that group was set as the social reference group for identifying local norms [73,74]. Other studies conducted in this setting have used similar wording to capture perceptions about local norms. In the remainder of this manuscript, we use shorthand to refer to these perceived norm response categories as "most" (combining "all or almost all" and "more than half"), "some", and "few".

Additional covariates

Male circumcision uptake varies by sociodemographic characteristics [22,75-82], HIV testing history [32,80,81,83], knowledge of one's own HIV status [82], and condomless sexual activity [75]. We thus assessed several additional factors, including having had condomless sex with a non-spousal partner in the past year, having had a sexually transmitted infection (STI) in the past year, having been tested for HIV in the past year, perceived personal HIV risk (none, low, medium, or high), and HIV status. Sociodemographic variables included age, marital status (married/cohabiting vs divorced/separated/single), religion (Protestant, Catholic, Muslim, other), education (completed primary vs did not), and household wealth quintile. To measure household wealth, we created a household asset index by conducting a principal components analysis on 26 separate variables representing household assets and housing characteristics (no missing data). We retained the first principal component to define the wealth index and then split it into quintiles [84,85].

Statistical analysis

To quantify the extent of misperceived norms, we compared respondents' perceptions of the village-level prevalence of male circumcision to the actual village-level prevalence of self-reported circumcision among men. We calculated the prevalence of respondents who underestimated male circumcision prevalence and stratified it by circumcision status among men and sociodemographic subgroups.

We estimated the association between respondents' perceptions of the village-level prevalence of male circumcision and self-reported circumcision among men <50 years of age and then re-estimated this association among all men. To do so, we fitted modified multivariable Poisson regression models specifying per-

sonal circumcision status as the dependent variable. With a binary dependent variable, the modified Poisson regression model has been shown to yield estimated incidence rate ratios that can be interpreted straightforwardly as relative risk ratios [86]. The models adjusted for HIV perceived risk and status, history of HIV testing, any STI in past year, condomless sex with nonspousal partner in past year, age, marital status, education, wealth, religion, and number of household members. We excluded Muslims in both models because all men who identified as Muslim reported being circumcised. We used cluster-correlated robust estimates of variance to account for clustering of observations by village [87], with $P < 0.05$ considered as statistically significant. We also calculated the predicted probabilities of being circumcised by perception categories. Finally, we used methods proposed by Vanderweele & Ding to calculate the e-value [88,89], a minimum

strength of association (on the risk ratio scale) that an unobserved confounder would need to have with both the exposure (perception) and the outcome (circumcision) to completely account for the estimated association, conditional upon the included covariates. A large e-value suggests that potential confounding would need to be very strong in order to sufficiently explain away the observed association. We conducted all analyses with Stata, version 16 (StataCorp LLC, College Station, Texas, USA).

Table 1. Characteristics of all male residents, and those who reported being circumcised, aged 18-50-years-old across eight villages in Rwampara District, southwest Uganda*

	Men in study <50 years old†	Men who reported being circumcised
Total	444 (100)	167 (38)
Age in years		
18-25	84 (19)	40 (48)
26-35	160 (36)	64 (40)
36-45	152 (34)	49 (32)
46-55	48 (11)	14 (29)
Marital status		
Not married	147 (33)	57 (39)
Married/cohabiting as if married	297 (67)	110 (37)
Religion		
Catholic	93 (21)	40 (43)
Muslim	7 (2)	7 (100)
Protestant	321 (72)	110 (34)
Other (not religious, seventh day adventist)	23 (5)	10 (43)
Education		
Less than primary education	112 (25)	27 (24)
Completed primary education	332 (75)	140 (42)
Household asset wealth		
1st (poorest)	83 (19)	28 (34)
2nd	99 (22)	36 (36)
3rd	90 (20)	34 (38)
4th	87 (20)	31 (36)
5th (least poor)	85 (19)	38 (45)
Was tested for HIV in past 12 months		
No	227 (51)	74 (33)
Yes	217 (49)	93 (43)
Had an STI in past 12 months		
No	411 (93)	153 (37)
Yes	33 (7)	14 (42)
Had condomless sex with a non-spouse partner in past 12 months		
No	371 (84)	136 (37)
Yes	73 (16)	31 (42)
Perceived personal HIV risk		
Identified as HIV-positive	32 (7)	9 (28)
Identified as HIV-negative/ unknown status with perceived no/low HIV risk	353 (80)	137 (39)
Identified HIV-negative/ unknown status with perceived medium/high HIV risk	55 (13)	20 (36)

*Values presented as n (%) unless specified otherwise.

†Circumcision status for 28 participants was unknown and thus is not included in this table: nine refused to answer and 19 were accidentally not asked the question after indicating that they had never had sex.

RESULTS

Among 1723 people who were eligible for study participation, 1566 were interviewed (90.9% response rate), of whom 698 (45%) were men. The mean age across the full population was 42 years (standard deviation (SD) = 16). Most participants (940 (60%)) had completed primary education or more, and most were married/cohabiting as if married (1024 (65%)). Twenty-two participants (1%) identified as Muslim. Overall, 767 (49%) had been tested for HIV in the past 12 months, 180 (11%) reported an HIV-positive status, 75 (5%) had an STI in the past 12 months, 179 (11%) had condomless sex with a non-spousal partner in the past 12 months, and 220 (14%) perceived their personal HIV risk to be medium/high.

Thirty-eight men did not report their circumcision status: 17 refused to answer and 21 had never had sex and were accidentally not asked about their circumcision status due to a logic branching error during data collection. Among the 660 men with a reported circumcision status, 191 (27%) reported being circumcised. This prevalence ranged from 23% to 37% across the eight villages.

Among 444 male participants who were <50 years of age and who provided a response about their circumcision status, 167 (38%) reported that they were circumcised. Village-level circumcision rates ranged from 27% to 51%. The male circumcision prevalence was higher among younger age groups. For example, almost half of men aged 18-25 years old were circumcised ($n = 40$ (48%)). The prevalence was lower among men who had not completed primary school (Table 1).

Extent of underestimated norms about male circumcision

Among the 469 men who had not been circumcised, 154 (33%) thought that few to no men had been circumcised and 47 (10%) did not know. Among the 191 men who had been circumcised, 26 (14%) thought that few to no men had been circumcised and nine (5%) did not know. Among 868 women, 177 (20%) thought that few to no men had been circumcised and 220 (25%) did not know. Overall, 366 of 1566 participants (23%) incorrectly

thought that few men in their villages had been circumcised, while 287 (18%) reported not knowing this information. Misperceiving that few or no village men had been circumcised varied in prevalence from 10% to 35% across sex-specific sociodemographic and HIV risk categories (Table 2). The combined prevalence of underestimation and “do not know” responses varied from 36% to 47% across villages.

Table 2. Misperceived norms about male circumcision in own village among adults across eight villages in Rwampara District, south-west Uganda (n = 1566)*

	Number of male study participants	Men who incorrectly thought few men are circumcised	Men who did not know how many men are circumcised	Number of female study participants	Women who incorrectly thought few men are circumcised	Women who did not know how many men are circumcised
Total	698	189 (27)	67 (10)	868	177 (20)	220 (26)
Age in years						
17-25	102	20 (20)	7 (7)	139	37 (27)	30 (22)
26-35	164	39 (24)	8 (5)	213	48 (23)	36 (17)
36-45	157	55 (35)	10 (6)	182	41 (23)	38 (21)
46-55	142	37 (26)	15 (11)	146	23 (16)	29 (20)
≥56	130	38 (29)	26 (20)	174	28 (16)	78 (46)
Marital status						
Not married and not cohabiting	205	50 (24)	22 (11)	337	71 (21)	109 (33)
Married/cohabiting as if married	493	139 (28)	45 (9)	531	106 (20)	111 (21)
Religion						
Catholic	155	40 (26)	17 (11)	189	39 (21)	44 (23)
Muslim	9	2 (22)	0 (0)	13	2 (15)	4 (31)
Protestant	505	140 (28)	48 (10)	617	123 (20)	157 (26)
Other (Not religious; Seventh-Day Adventist; Born-again Pentecostal)	29	7 (24)	2 (7)	49	13 (27)	15 (31)
Education						
None/some primary education	224	65 (29)	29 (13)	402	63 (16)	126 (32)
Completed primary education or more	474	124 (26)	38 (8)	466	114 (24)	94 (20)
Household asset wealth						
1st quintile (poorest)	111	33 (30)	6 (5)	202	40 (20)	62 (31)
2nd quintile	138	41 (30)	10 (7)	175	36 (21)	35 (20)
3rd quintile	142	31 (22)	15 (11)	172	32 (19)	43 (25)
4th quintile	152	39 (26)	20 (13)	161	37 (23)	40 (25)
5th quintile (least poor)	155	45 (29)	16 (10)	158	32 (20)	40 (25)
Had been tested for HIV in past 12 months						
No	383	106 (28)	44 (12)	416	65 (16)	130 (32)
Yes	315	83 (26)	23 (7)	452	112 (25)	90 (20)
Had an STI in past 12 months						
No	637	176 (28)	65 (10)	803	157 (20)	202 (25)
Yes	40	8 (20)	0 (0)	35	8 (23)	12 (34)
Had condomless sex with a non-spouse partner in past 12 months						
No	580	166 (29)	56 (10)	756	148 (20%)	187 (25)
Yes	97	18 (19)	9 (9)	82	17 (21)	27 (33)
Perceived personal HIV risk						
Identified as HIV-positive	67	22 (33)	6 (9)	113	24 (21)	21 (19)
Identified as HIV-negative/unknown status with perceived no/low HIV risk	546	138 (25)	51 (9)	598	126 (21)	164 (28)
Identified HIV-negative/unknown status with perceived medium/high HIV risk	77	26 (34)	8 (11)	143	26 (18)	33 (23)

HIV – human immunodeficiency virus, STI – sexually transmitted infection

*Values presented as n (%) unless specified otherwise.

Perceived norms as correlates of personal circumcision status

Among men <50 years of age and who did not identify as Muslim (n=433), those who perceived that most men in their villages had been circumcised were more likely to be circumcised than men who perceived that some men had been circumcised (adjusted relative risk (aRR) = 1.67; 95% CI = 1.20-2.30, $P=0.002$). The associated e-value was 2.73.

Men who perceived that few to no men in their villages had been circumcised were less likely to be circumcised (aRR=0.51; 95% CI, 0.35-0.74, $P<0.001$). Similarly, men who reported that they did not know

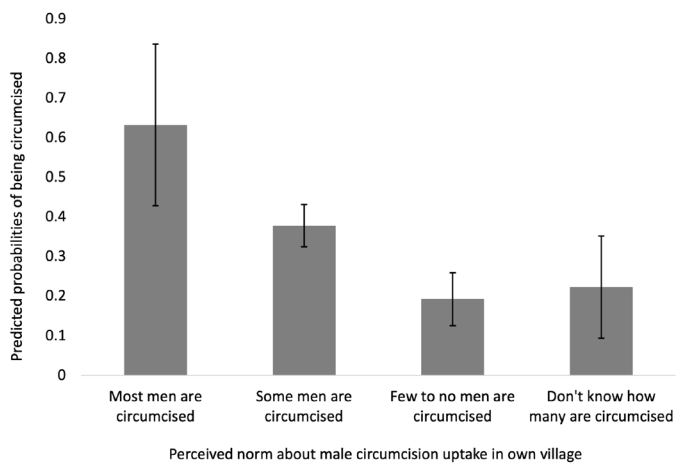


Figure 1. Predicted probabilities of being circumcised among all resident men <50 years of age across eight villages in Rwampara District, southwestern Uganda, stratified by their perception of the male circumcision prevalence in their own village after adjusting for other factors. Error bars represent the 95% confidence interval for the predicted probability.

Table 3. Modified multivariable Poisson regression model estimating associations between the perceived norm about circumcision status among men in one's village and being personally circumcised among almost all resident adult men <50 y old (excluding Muslim men) across eight villages in Rwampara District, southwestern Uganda (n=433 men)

	Yes, circumcised	aRR (95% CI)	P-value
Perceived norm about male circumcision uptake in own village			
Most men are circumcised (i.e. >50%)		1.67 (1.20-2.33)	0.002
Some men are circumcised (i.e. 10% to <50%)		ref	-
Few men are circumcised (i.e. 0 to <10%)		0.51 (0.35-0.75)	0.001
Don't know how many men are circumcised		0.59 (0.33-1.06)	0.076
Age (years)			
18-25		ref	-
26-35		0.91 (0.68-1.22)	0.520
36-45		0.81 (0.63-1.03)	0.086
46-55		0.72 (0.44-1.17)	0.182
Married/cohabiting (vs other)		1.17 (0.93-1.48)	0.180
Religion			
Catholic		ref	-
Protestant		0.86 (0.62-1.19)	0.375
Other		1.10 (0.63-1.93)	0.727
Completed primary education or more (vs did not)		1.54 (0.98-2.42)	0.062
Household asset quintile			
1st quintile (poorest)		ref	-
2nd quintile		0.96 (0.72-1.27)	0.758
3rd quintile		0.88 (0.52-1.49)	0.626
4th quintile		0.86 (0.57-1.28)	0.451
5th quintile (least poor)		1.17 (0.75-1.82)	0.480
Tested for HIV in past 12 mo (vs did not)		1.18 (0.80-1.73)	0.408
Had an STI in past 12 mo (vs did not)		1.10 (0.61-1.98)	0.759
Had condomless sex with a non-spouse partner in past 12 mo (vs did not)		1.02 (0.84-1.23)	0.872
Perceived personal HIV risk			
Identified as HIV-positive		0.88 (0.58-1.34)	0.555
Identified as HIV-negative/unknown status with perceived no/low HIV risk		ref	-
Identified HIV-negative/unknown status with perceived medium/high HIV risk		1.07 (0.87-1.32)	0.520

aRR – adjusted relative risk, CI – confidence interval, ref – reference group, HIV – human immunodeficiency virus, STI – sexually transmitted infection

how many other men in their village were circumcised were also less likely to be circumcised, although the estimate was imprecise (aRR=0.59; 95% CI=0.33-1.06, $P=0.076$). We present the predicted probabilities of being circumcised (and their 95% confidence intervals) by perception categories in **Figure 1**.

While the risk of having been circumcised appeared to decrease with age, estimates between age and circumcision status were not precise. Similarly, while men who had finished primary education or more had a greater risk of having been circumcised, the estimate was imprecise (aRR=1.54; 95% CI=0.98-2.42, $P=0.064$). None of the HIV risk factors nor any of the other socio-demographic factors were associated with participant circumcision status (**Table 3**). Results from the sensitivity analysis including all men indicate that the pattern of associations were similar to those found in main analyses (**Table S1** in the **Online Supplementary Document**).

DISCUSSION

In this population-based study across eight villages in rural Uganda, we found that many men and women underestimated the local prevalence of circumcision among men. They incorrectly thought that circumcision was extremely rare among men, even though 27% of men reported being circumcised (as did 38% of men aged 18-49). These misperceptions were present across all population subgroups including by circumcision status among men.

The public health importance of this finding is that men who misperceived norms about circumcision (i.e. underestimated the prevalence of circumcision among men in their villages) were less likely to be circumcised themselves. Importantly, there may have been other potential confounders not included in the multivariable regression models. For example, having poor HIV prevention knowledge could be correlated with low VMMC uptake and with greater misperceptions about the extent to which circumcision is normative. A regression model estimating the association between misperceptions and VMMC uptake that did not adjust for HIV prevention knowledge could therefore yield estimates of the association that are biased away from the null. Based on the e-value analysis, such an unobserved confounder would need to have an association with both circumcision uptake and perceiving that most men were circumcised of 2.73 on the risk ratio scale, conditional on the measured covariates, to explain away the association observed in our study.

Based on other studies in the region, we expect this possibility to be unlikely. For example, in a population-based study of men in eastern and southern Africa, having poor HIV prevention knowledge was associated with reduced odds of circumcision, but the magnitude of this association (adjusted odds ratio (aOR)=0.83 overall, aOR=0.53 in the Rwanda subsample, aOR=1.26 in the Kenya subsample) would not have been large enough to explain away the estimates we obtained [90].

Our findings are in line with previously published studies showing that misperceived norms are an important driver of outcomes related to HIV prevention and treatment, such as HIV testing, adherence to antiretroviral therapy, condom use, and HIV-related stigma, both in rural Uganda and elsewhere in eastern and southern Africa [50,51,54,58,91]. Taken together, these findings indicate that a social norms approach [49,92,93] to VMMC uptake would be applicable in contexts where a substantial, but not sufficient (i.e. from a public health perspective) part of the male population is circumcised, and where male circumcision has increased over time.

For example, uncircumcised men and their partners who incorrectly believe male circumcision to be rare could receive personalised normative feedback [94-97] about actual circumcision rates in the population. Additionally, a social norms campaign [98-100] targeting the whole population could emphasize VMMC as a trending norm [101] in the local context and in Uganda more broadly. These strategies would aim not to address health education or behavior change directly, but simply to correct underestimates and reinforce support for male circumcision uptake. Messages based on factual information might include: “In 2021, more than one out of every three men in this village chose to get circumcised”, or “The number of men choosing to get circumcised continues to grow. Now almost half of men aged 18 to 35 years in your village have been circumcised”. Health care providers and community health workers could share this information during routine visits or as part of other HIV- or contraception-related interventions. Similarly, local leaders could receive training on trending norms information and facilitate discussions or one-on-one conversations [31]. Local norms could be visually displayed at the entrances of clinics offering VMMC services [102] or publicised through radio or edu-entertainment messages [103,104]. Studies on other topics have found that enhancing the salience and visibility of local health-promoting norms can shift individuals’ expectations about typical and acceptable behavior and attitudes when misalignment between perceptions and actual norms exists, and in turn, prompt behavior change [48,59-65,91,100,105]. Additionally, increasing awareness of trending norms (behaviors increasing in prevalence) can also prompt behavior change [101,106,107].

Addressing incorrect beliefs about circumcision being rare among uncircumcised men (i.e. correcting their state of false consensus) [108] may encourage these men to conform with prevailing norms and to seek ways to overcome existing barriers to circumcision. Increased awareness of the actual trending norm may also weaken negative beliefs about circumcision and encourage action on previous, unfulfilled intentions. Furthermore, rectifying prevalence underestimates among circumcised men (i.e. correcting their state of pluralistic ignorance) [109] may prompt them to share their experiences with others, as they realize that their behavior aligns with the trend. They might be inclined to publicly advocate for VMMC or support others in seeking options to do so. More information regarding the higher-than-expected and increasing circumcision prevalence could help mitigate stigmatising beliefs and misconceptions, especially if paired with health education about the benefits of male circumcision.

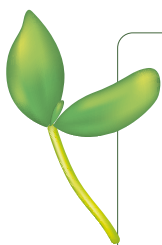
Correcting underestimates and ignorance among women about male circumcision uptake and its upward trend may also indirectly lead to VMMC uptake. Mothers, sisters, and female partners often influence men’s circumcision decisions [28,29,110-113]. Addressing their underestimates may reduce stigma toward male circumcision, increase conversation in support of circumcision, increase support for male partners to navigate any access barriers, and prevent spread of norm misperceptions. Pressure from female partners to undergo circumcision resulted in men in Uganda undergoing VMMC [113]. Men reported that their partners believed in the importance of circumcision after hearing about it from radios, newspapers, and health services [113].

This study has limitations in addition to the possible confounding by unmeasured covariates mentioned above. First, our findings may not be generalisable beyond the parish studied. However, the participants surveyed represent more than 90% of the adult parish population, and the study context is similar to rural areas across Uganda and in eastern and southern Africa. Second, our primary outcome (circumcision status) was based on self-reporting. Based on other studies conducted throughout eastern Africa, we expect self-reported circumcision status to correlate highly with circumcision status ascertained through physical examination [114]. Moreover, the prevalence of circumcision among 18-49-year-old men in our sample (38%) was slightly larger than the prevalence of circumcision among 15-49-year-old men in the 2016

Uganda Demographic and Health Survey (i.e. 26%) [66], which is consistent with the increasing uptake of circumcision at the population level within these groups. Despite these limitations, this study provides key evidence for future research on the extent to which highlighting VMMC uptake as an increasingly common decision can motivate uptake.

CONCLUSION

VMMC uptake continues to be an important cost-effective HIV prevention strategy. In this population-based study in rural Uganda, one-third to almost half of adults in every village either underestimated or did not know how many men in their own village had been circumcised. Misperceptions were present across all population subgroups, and men who had these misperceptions were less likely to report being circumcised themselves. These findings collectively indicate the potential for an opportunity to motivate VMMC uptake by addressing any underestimates of male circumcision uptake in an HIV-endemic setting where numerous men in the general community are at high-risk for HIV acquisition. Future research should assess the extent to which changing underestimated norms among uncircumcised men directly motivates VMMC uptake. Additionally, changing underestimated norms among women and circumcised men may increase conversation and support for others to get circumcised. Male circumcision in Uganda has trended upward since 2011. Providing information about the rising trend in male circumcision rates in this context and correcting prevalence underestimates will enhance VMMC uptake visibility and salience. This type of social norms approach strategy targeting both men and women to promote VMMC uptake could complement efforts to educate individuals about circumcision and its health benefits.



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Ethics statement: Ethical approval was granted by the Mass General Brigham Institutional Review Board, the Research Ethics Committee at Mbarara University of Science and Technology, and the Vanderbilt Human Research Protections Program. We also received clearance from the Uganda National Council of Science and Technology and the Research Secretariat in the Office of the President of the Republic of Uganda. The analyses were not pre-registered; therefore, the results should be considered exploratory.

Data availability: Data and code for analysis are available from the corresponding author upon reasonable request.

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Additional material

Online Supplementary Document

- 1 World Health Organization. New data on male circumcision and HIV prevention: Policy and programme implications. 2007. Available: https://apps.who.int/iris/bitstream/handle/10665/43751/9789241595988_eng.pdf? Accessed: 13 June 2023.
- 2 Auvert B, Taljaard D, Lagarde E, Sobngwi-Tambekou J, Sitta R, Puren A. Randomized, controlled intervention trial of male circumcision for reduction of HIV infection risk: The ANRS 1265 Trial. *PLoS Med.* 2005;2:e298. Medline:16231970 doi:10.1371/journal.pmed.0020298
- 3 Bailey RC, Moses S, Parker CB, Agot K, Maclean I, Krieger JN, et al. Male circumcision for HIV prevention in young men in Kisumu, Kenya: a randomised controlled trial. *Lancet.* 2007;369:643-56. Medline:17321310 doi:10.1016/S0140-6736(07)60312-2

- 4 Gray RH, Kigozi G, Serwadda D, Makumbi F, Watya S, Nalugoda F, et al. Male circumcision for HIV prevention in men in Rakai, Uganda: a randomised trial. *Lancet*. 2007;369:657-66. Medline:17321311 doi:10.1016/S0140-6736(07)60313-4
- 5 UNAIDS. Voluntary medical male circumcision—4.1 million performed in 2018. 2019. Available: https://www.unaids.org/en/resources/presscentre/featurestories/2019/october/20191021_vmmc. Accessed: 23 May 2022.
- 6 UNAIDS, World Health Organization. Progress brief: Voluntary medical male circumcision. 2021. Available: https://www.malecircumcision.org/sites/default/files/document_library/UNAIDS%20WHO%20VMC%20progress%20brief%2016Feb2021_web.pdf. Accessed: 14 March 2022.
- 7 US President's Emergency Plan for AIDS Relief (PEPFAR). PEPFAR's best practices for voluntary medical male circumcision site operations: a service guide 2013. Available: https://2017-2020.usaid.gov/sites/default/files/documents/1864/pepfar_best_practice_for_vmmc_site_operations.pdf. Accessed: 1 February 2022.
- 8 Njeuhmeli E, Forsythe S, Reed J, Opuni M, Bollinger L, Heard N, et al. Voluntary medical male circumcision: Modeling the impact and cost of expanding male circumcision for HIV prevention in Eastern and Southern Africa. *PLoS Med*. 2011;8:e1001132. Medline:22140367 doi:10.1371/journal.pmed.1001132
- 9 Moodley J, Naidoo S, Kelly C, Reddy T, Ramjee G. The impact of male partner circumcision on women's health outcomes. *AIDS Educ Prev*. 2020;32:356-66. Medline:32897129 doi:10.1521/aeap.2020.32.4.356
- 10 Weiss HA, Thomas SL, Munabi SK, Hayes RJ. Male circumcision and risk of syphilis, chancroid, and genital herpes: a systematic review and meta-analysis. *Sex Transm Infect*. 2006;82:101. Medline:16581731 doi:10.1136/sti.2005.017442
- 11 Tobian AAR, Serwadda D, Quinn TC, Kigozi G, Gravitt PE, Laeyendecker O, et al. Male circumcision for the prevention of HSV-2 and HPV infections and syphilis. *N Engl J Med*. 2009;360:1298-309. Medline:19321868 doi:10.1056/NEJMoa0802556
- 12 Castellsagué X, Bosch FX, Muñoz N, Meijer CJLM, Shah KV, de Sanjosé S, et al. Male circumcision, penile human papillomavirus infection, and cervical cancer in female partners. *N Engl J Med*. 2002;346:1105-12. Medline:11948269 doi:10.1056/NEJMoa011688
- 13 Morris BJ, Hankins CA. Effect of male circumcision on risk of sexually transmitted infections and cervical cancer in women. *Lancet Glob Health*. 2017;5:e1054-5. Medline:29025620 doi:10.1016/S2214-109X(17)30386-8
- 14 Reed JB, Njeuhmeli E, Thomas AG, Bacon MC, Bailey R, Cherutich P, et al. Voluntary medical male circumcision: An HIV prevention priority for PEPFAR. *J Acquir Immune Defic Syndr*. 2012;60:S88-95. Medline:22797745 doi:10.1097/QAI.0b013e31825cac4e
- 15 Morris BJ. Voluntary medical male circumcision proves robust for mitigating heterosexual human immunodeficiency virus infection. *Clin Infect Dis*. 2021;73:e1954-6. Medline:33043971 doi:10.1093/cid/ciaa1542
- 16 Shapiro SB, Laurie C, El-Zein M, Franco EL. Association between male circumcision and human papillomavirus infection in males and females: a systematic review, meta-analysis, and meta-regression. *Clin Microbiol Infect*. 2023;29:968-78. Medline:37011808 doi:10.1016/j.cmi.2023.03.028
- 17 Matoga M, Hosseinipour MC, Jewett S, Hoffman IF, Chasela C. Effects of HIV voluntary medical male circumcision programs on sexually transmitted infections. *Curr Opin Infect Dis*. 2021;34:50-5. Medline:33315750 doi:10.1097/QCO.0000000000000696
- 18 Bansi-Matharu L, Mudimu E, Martin-Hughes R, Hamilton M, Johnson L, ten Brink D, et al. Cost-effectiveness of voluntary medical male circumcision for HIV prevention across sub-Saharan Africa: results from five independent models. *Lancet Glob Health*. 2023;11:e244-55. Medline:36563699 doi:10.1016/S2214-109X(22)00515-0
- 19 Prodder JL, Galiwango RM, Tobian AAR, Park D, Liu CM, Kaul R. How does voluntary medical male circumcision reduce HIV risk? *Curr HIV/AIDS Rep*. 2022;19:484-90. Medline:36308579 doi:10.1007/s11904-022-00634-w
- 20 United Nations. Political Declaration on HIV and AIDS: On the Fast Track to Accelerating the Fight against HIV and to Ending the AIDS Epidemic by 2030. 2016. Available: https://www.unaids.org/sites/default/files/media_asset/2016-political-declaration-HIV-AIDS_en.pdf. Accessed: 26 April 2021.
- 21 UNAIDS, World Health Organization. Progress brief: Uneven progress on the voluntary medical male circumcision. 2022. Available: <https://cdn.who.int/media/docs/default-source/hq-hiv-hepatitis-and-stis-library/who-unaid-male-circumcision-progress-brief-2022.pdf>. Accessed: 7 June 2023.
- 22 Uganda Ministry of Health. Uganda Population-Based HIV Impact Assessment (UPHIA) 2016-2017: Final Report. 2019. Available: <https://phia.icap.columbia.edu/uganda-phia-final-report/>. Accessed: 21 Sept 2022.
- 23 Bershteyn A, Mudimu E, Platais I, Mwalili S, Zulu JE, Mwanza WN, et al. Understanding the evolving role of voluntary medical male circumcision as a public health strategy in Eastern and Southern Africa: Opportunities and challenges. *Curr HIV/AIDS Rep*. 2022;19:526-36. Medline:36459306 doi:10.1007/s11904-022-00639-5
- 24 Byabagambi J, Marks P, Megere H, Karamagi E, Byakika S, Opio A, et al. Improving the quality of voluntary medical male circumcision through use of the continuous quality improvement approach: A pilot in 30 PEPFAR-supported sites in Uganda. *PLoS One*. 2015;10:e0133369. Medline:26207986 doi:10.1371/journal.pone.0133369
- 25 Uganda Ministry of Health. Safe Male Circumcision Policy. 2010. Available: <https://www.malecircumcision.org/resource/uganda-safe-male-circumcision-policy>. Accessed: 16 January 2021.
- 26 World Health Organization. Preventing HIV through safe voluntary medical male circumcision for adolescent boys and men in generalized HIV epidemics: recommendations and key considerations. 2020. Available: <https://www.who.int/publications/i/item/978-92-4-000854-0>. Accessed: 21 October 2022.
- 27 Rennie S, Gilbertson A, Hallfors D, Luseno WK. The ethics of stigma in medical male circumcision initiatives involving adolescents in sub-Saharan Africa. *Public Health Ethics*. 2021;14:79-89. Medline:34239604 doi:10.1093/phe/pha004

- 28 Gurman TA, Dhillon P, Greene JL, Makadzange P, Khumlao P, Shekhar N. Informing the scaling up of voluntary medical male circumcision efforts through the use of Theory of Reasoned Action: Survey findings among uncircumcised young men in Swaziland. *AIDS Educ Prev*. 2015;27:153-66. Medline:25915700 doi:10.1521/aeap.2015.27.2.153
- 29 Montaña DE, Kasprzyk D, Hamilton DT, Tshimanga M, Gorn G. Evidence-based identification of key beliefs explaining adult male circumcision motivation in Zimbabwe: Targets for behavior change messaging. *AIDS Behav*. 2014;18:885-904. Medline:24443147 doi:10.1007/s10461-013-0686-7
- 30 Carrasco MA, Wilkinson J, Kasdan B, Fleming P. Systematic review of barriers and facilitators to voluntary medical male circumcision in priority countries and programmatic implications for service uptake. *Glob Public Health*. 2019;14:91-111. Medline:29695201 doi:10.1080/17441692.2018.1465108
- 31 Downs JA, Mwakisole AH, Chandika AB, Lugoba S, Kassim R, Laizer E, et al. Educating religious leaders to promote uptake of male circumcision in Tanzania: a cluster randomised trial. *Lancet*. 2017;389:1124-32. Medline:28214093 doi:10.1016/S0140-6736(16)32055-4
- 32 Montague C, Ngobo N, Mahlase G, Frohlich J, Pillay C, Yende-Zuma N, et al. Implementation of adolescent-friendly voluntary medical male circumcision using a school based recruitment program in rural KwaZulu-Natal, South Africa. *PLoS One*. 2014;9:e96468. Medline:24788339 doi:10.1371/journal.pone.0096468
- 33 Sherif M. *The psychology of social norms*. New York: Harper; 1936.
- 34 Asch SE. Studies of independence and conformity: a minority of one against a unanimous majority. *Psychological Monographs: General and Applied*. 1956;70:1-70. doi:10.1037/h0093718
- 35 Cialdini RB, Trost MR. Social influence: social norms, conformity and compliance. In: Gilbert DT, Fiske ST, Lindzey G, editors. *The Handbook of Social Psychology*. Vol. 1 and 2. 4th ed. New York: McGraw-Hill; 1998. p. 151-92.
- 36 Perkins HW, Berkowitz AD. Perceiving the community norms of alcohol use among students: some research implications for campus alcohol education programming. *Int J Addict*. 1986;21:961-76. Medline:3793315 doi:10.3109/10826088609077249
- 37 Cialdini RB, Reno RR, Kallgren CA. A focus theory of normative conduct: recycling the concept of norms to reduce littering in public places. *J Pers Soc Psychol*. 1990;58:1015-26. doi:10.1037/0022-3514.58.6.1015
- 38 Ajzen I. The theory of planned behavior. *Organ Behav Hum Decis Process*. 1991;50:179-211. doi:10.1016/0749-5978(91)90020-T
- 39 Lapinski MK, Rimal RN. An explication of social norms. *Commun Theory*. 2005;15:127-47. doi:10.1111/j.1468-2885.2005.tb00329.x
- 40 Rimal RN, Yilma H. Descriptive, injunctive, and collective norms: An expansion of the Theory of Normative Social Behavior (TNSB). *Health Commun*. 2022;37:1573-80. Medline:33761815 doi:10.1080/10410236.2021.1902108
- 41 Perkins HW. Scope of the problem: misperceptions of alcohol and drugs. *Catalyst (San Diego)*. 1995;1:1-2.
- 42 Perkins HW, Wechsler H. Variation in perceived college drinking norms and its impact on alcohol abuse: a nationwide study. *J Drug Issues*. 1996;26:961-74. doi:10.1177/002204269602600413
- 43 Perkins HW. College student misperceptions of alcohol and other drug norms among peers: exploring causes, consequences, and implications for prevention programs. *Designing alcohol and other drug prevention programs in higher education: bringing theory into practice*. Newton, MA: Higher Education Center for Alcohol and Other Drug Prevention; 1997. p. 177-206.
- 44 Perkins HW, Meilman PW, Leichter JS, Cashin JR, Presley CA. Misperceptions of the norms for the frequency of alcohol and other drug use on college campuses. *J of Americal college health*. 1999;47:253-8. Medline:10368559 doi:10.1080/07448489909595656
- 45 Perkins HW, Haines MP, Rice R. Misperceiving the college drinking norm and related problems: a nationwide study of exposure to prevention information, perceived norms and student alcohol misuse. *J Stud Alcohol Drugs*. 2005;66:470-8. Medline:16240554 doi:10.15288/jsa.2005.66.470
- 46 Perkins HW. Misperceptions of peer drinking norms in Canada: another look at the "reign of error" and its consequences among college students. *Addict Behav*. 2007;32:2645-56. Medline:17719724 doi:10.1016/j.addbeh.2007.07.007
- 47 Perkins HW. Misperception is reality: the "Reign of Error" about peer risk behaviour norms among youth and young adults. In: Xenitidou M, Edmonds B, editors. *The Complexity of Social Norms*. New York: Springer; 2014. p. 11-36.
- 48 Prentice DA. Intervening to change social norms: when does it work? *Soc Res (New York)*. 2018;85:115-39. doi:10.1353/sor.2018.0007
- 49 Perkins HW, editor. *The social norms approach to preventing school and college age substance abuse: A handbook for educators, counselors, and clinicians*. San Francisco: Jossey-Bass; 2003.
- 50 Perkins JM, Kakuhikire B, Baguma C, Rasmussen JD, Satinsky EN, Kiconco A, et al. Perceptions about local ART adherence norms and personal adherence behavior among adults living with HIV in rural Uganda. *AIDS Behav*. 2022;26:1892-904. Medline:35034237 doi:10.1007/s10461-021-03540-1
- 51 Perkins JM, Nyakato VN, Kakuhikire B, Mbabazi PK, Perkins HW, Tsai AC, et al. Actual versus perceived HIV testing norms, and personal HIV testing uptake: a cross-sectional, population-based study in rural Uganda. *AIDS Behav*. 2018;22:616-28. Medline:28233075 doi:10.1007/s10461-017-1691-z
- 52 Perkins JM, Kakuhikire B, Baguma C, Jurinsky J, Rasmussen JD, Satinsky EN, et al. Overestimation of alcohol consumption norms as a driver of alcohol consumption: a whole-population network study of men across eight villages in rural, southwestern Uganda. *Addiction*. 2022;117:68-81. Medline:34159646 doi:10.1111/add.15615
- 53 Perkins JM, Krezanoski P, Takada S, Kakuhikire B, Batwala V, Tsai AC, et al. Social norms, misperceptions, and mosquito net use: a population-based, cross-sectional study in rural Uganda. *Malar J*. 2019;18:189. Medline:31159821 doi:10.1186/s12936-019-2798-7

- 54 Tsai AC, Kakuhikire B, Perkins JM, Downey JM, Baguma C, Satinsky EN, et al. Normative vs personal attitudes toward persons with HIV, and the mediating role of perceived HIV stigma in rural Uganda. *J Glob Health*. 2021;11:04956. Medline:34552725 doi:10.7189/jogh.11.04056
- 55 Tsai AC, Kakuhikire B, Perkins JM, Vořechovská D, McDonough AQ, Ogburn EL, et al. Measuring personal beliefs and perceived norms about intimate partner violence: population-based survey experiment in rural Uganda. *PLoS Med*. 2017;14:e1002303. Medline:28542176 doi:10.1371/journal.pmed.1002303
- 56 Perkins JM, Kakuhikire B, Baguma C, Meadows M, Evans CQ, Jurinsky J, et al. Perceived and misperceived norms about khat and/or cannabis use among adults in southwest Uganda. *Int J Drug Policy*. 2022;101:103527. Medline:34890907 doi:10.1016/j.drugpo.2021.103527
- 57 Green DP, Wilke AM, Cooper J. Countering violence against women by encouraging disclosure: a mass media experiment in rural Uganda. *Comp Polit Stud*. 2020;53:2283-320. doi:10.1177/0010414020912275
- 58 Carey KB, Scott-Sheldon LAJ, Carey MP, Cain D, Mlobeli R, Vermaak R, et al. Community norms for HIV risk behaviors among men in a South African township. *J Behav Med*. 2011;34:32-40. Medline:20680673 doi:10.1007/s10865-010-9284-6
- 59 Miller DT, Prentice DA. Changing norms to change behavior. *Annu Rev Psychol*. 2016;67:339-61. Medline:26253542 doi:10.1146/annurev-psych-010814-015013
- 60 Tankard ME, Paluck EL. Norm perception as a vehicle for social change. *Soc Issues Policy Rev*. 2016;10:181-211. doi:10.1111/sipr.12022
- 61 Perkins HW, Perkins JM. Using the social norms approach to promote health and reduce risk among college students. In: Cimini MD, Rivero EM, editors. *Promoting behavioral health and reducing risk among college students*. New York: Routledge; 2018. p. 127-44.
- 62 Hallsworth M, Chadborn T, Sallis A, Sanders M, Berry D, Greaves F, et al. Provision of social norm feedback to high prescribers of antibiotics in general practice: a pragmatic national randomised controlled trial. *Lancet*. 2016;387:1743-52. Medline:26898856 doi:10.1016/S0140-6736(16)00215-4
- 63 Bursztyjn L, González AL, Yanagizawa-Drott D. Misperceived social norms: women working outside the home in Saudi Arabia. *Am Econ Rev*. 2020;110:2997-3029. doi:10.1257/aer.20180975
- 64 Cialdini RB, Jacobson RP. Influences of social norms on climate change-related behaviors. *Curr Opin Behav Sci*. 2021;42:1-8. doi:10.1016/j.cobeha.2021.01.005
- 65 Berkowitz AD, Bogen KW, Lopez RJM, Mulla MM, Orchowski LM. The social norms approach as a strategy to prevent violence perpetrated by men and boys: a review of the literature. In: Orchowski LM, Berkowitz A, editors. *Engaging Boys and Men in Sexual Assault Prevention*: Academic Press; 2021. p. 1-67.
- 66 Uganda Bureau of Statistics. *Uganda Demographic and Health Survey 2016*. 2018. Available: <http://dhsprogram.com/pubs/pdf/FR333/FR333.pdf>. Accessed: 03 March 2021.
- 67 Perkins JM, Nyakato VN, Kakuhikire B, Tsai AC, Subramanian SV, Bangsberg DR, et al. Food insecurity, social networks, and symptoms of depression among men and women in rural Uganda: a cross-sectional, population-based study. *Public Health Nutr*. 2018;21:838-48. Medline:28988551 doi:10.1017/S1368980017002154
- 68 Mushavi RC, Burns BFO, Kakuhikire B, Owembabazi M, Vořechovská D, McDonough AQ, et al. "When you have no water, it means you have no peace": A mixed-methods, whole-population study of water insecurity and depression in rural Uganda. *Soc Sci Med*. 2020;245:112561. Medline:31790879 doi:10.1016/j.socscimed.2019.112561
- 69 Tsai AC, Kakuhikire B, Mushavi R, Vořechovská D, Perkins JM, McDonough AQ, et al. Population-based study of intra-household gender differences in water insecurity: reliability and validity of a survey instrument for use in rural Uganda. *J Water Health*. 2016;14:280-92. Medline:27105413 doi:10.2166/wh.2015.165
- 70 Uganda Bureau of Statistics. *Uganda National Household Survey 2016/2017*. 2018. Available: https://www.ubos.org/wp-content/uploads/publications/03_20182016_UNHS_FINAL_REPORT.pdf. Accessed: 2 February 2020.
- 71 World Bank Group. *The World Bank in Uganda*. 2021. Available: <http://www.worldbank.org/en/country/uganda/overview>. Accessed: 13 September 2021.
- 72 Uganda Bureau of Statistics. *Population and Censuses*. 2021. Available: <https://www.ubos.org/explore-statistics/20/>. Accessed: 13 September 2021.
- 73 Shibutani T. Reference groups as perspectives. *Am J Sociol*. 1955;60:562-9. doi:10.1086/221630
- 74 Sherif M. *The concept of reference groups in human relations. Group relations at the crossroads*. Oxford, England: Harper; 1953.
- 75 Rosen JG, Carrasco MA, Traub AM, Kumoji EK. Barriers, benefits, and behaviour: Voluntary medical male circumcision ideation in a population-based sample of Zambian men. *Afr J AIDS Res*. 2021;20:314-23. Medline:34905454 doi:10.2989/16085906.2021.2006727
- 76 Masese R, Mwalabu G, Petručka P, Mapulanga P. Key challenges to voluntary medical male circumcision uptake in traditionally circumcising settings of Machinga district in Malawi. *BMC Public Health*. 2021;21:1957. Medline:34711179 doi:10.1186/s12889-021-11979-z
- 77 Tram KH, Bertrand JT. Correlates of male circumcision in Eastern and Southern African countries: establishing a baseline prior to VMMC scale-up. *PLoS One*. 2014;9:e100775. Medline:24955963 doi:10.1371/journal.pone.0100775
- 78 Spees LP, Ledikwe JH, Kleinman NJ, Ntsuape C, Semo B-w, Barnhart S, et al. Immediate motivators to seeking voluntary medical male circumcision among HIV-negative adult men in an urban setting in Botswana. *AIDS Educ Prev*. 2019;31:136-51. Medline:30917017 doi:10.1521/aeap.2019.31.2.136
- 79 Tusa BS, Weldesenbet AB, Tefera TK, Kebede SA. Spatial distribution of traditional male circumcision and associated factors in Ethiopia; using multilevel generalized linear mixed effects model. *BMC Public Health*. 2021;21:1423. Medline:34281503 doi:10.1186/s12889-021-11482-5

- 80 Carrasco MA, Rosen JG, Maile L, Manda R, Amzel A, Kiggundu V. Medically, traditionally, and dually circumcised men in Lesotho: Population-based measurements of HIV/STI infections, sexual risk behaviors, and service use patterns. *AIDS Behav.* 2020;24:2112-8. Medline:31927757 doi:10.1007/s10461-019-02776-2
- 81 Edossa ZK, Kumsa AT, Gebre MN. Male circumcision uptake and its predictors among sexually active men aged 15–59 years living in the highest HIV prevalence region of Ethiopia: evidence from 2016 Ethiopia demographic and health survey. *BMC Public Health.* 2020;20:1772. Medline:33228653 doi:10.1186/s12889-020-09918-5
- 82 Ortblad KF, Bärnighausen T, Chimbindi N, Masters SH, Salomon JA, Harling G. Predictors of male circumcision incidence in a traditionally non-circumcising South African population-based cohort. *PLoS One.* 2018;13:e0209172. Medline:30566506 doi:10.1371/journal.pone.0209172
- 83 Mwiinga K. Male circumcision in Lusaka, Zambia: Evidence from the Zambia Demographic and Health Survey. *South Afr J Demogr.* 2020;20:1-31. doi:10.2307/27027852
- 84 Filmer D, Pritchett LH. Estimating wealth effects without expenditure data—or tears: an application to educational enrollments in states of India. *Demography.* 2001;38:115-32. Medline:11227840
- 85 Smith ML, Kakuhikire B, Baguma C, Rasmussen JD, Bangsberg DR, Tsai AC. Do household asset wealth measurements depend on who is surveyed? Asset reporting concordance within multi-adult households in rural Uganda. *J Glob Health.* 2020;10:010412. Medline:32373331
- 86 Zou G. A modified poisson regression approach to prospective studies with binary data. *Am J Epidemiol.* 2004;159:702-6. Medline:15033648 doi:10.1093/aje/kwh090
- 87 StataCorp. Stata Statistical Software: Release 16. College Station, TX: StataCorp LLC; 2019.
- 88 Haneuse S, VanderWeele TJ, Arterburn D. Using the e-value to assess the potential effect of unmeasured confounding in observational studies. *JAMA.* 2019;321:602-3. Medline:30676631 doi:10.1001/jama.2018.21554
- 89 VanderWeele TJ, Ding P. Sensitivity analysis in observational research: introducing the e-value. *Ann Intern Med.* 2017;167:268-74. Medline:28693043 doi:10.7326/M16-2607
- 90 Lau FK, Jayakumar S, Sgaier SK. Understanding the socio-economic and sexual behavioural correlates of male circumcision across eleven voluntary medical male circumcision priority countries in southeastern Africa. *BMC Public Health.* 2015;15:813. Medline:26297202 doi:10.1186/s12889-015-2135-1
- 91 Yu H. Social stigma as a barrier to HIV testing: Evidence from a randomized experiment in Mozambique. *J Dev Econ.* 2023;161:103035. doi:10.1016/j.jdeveco.2022.103035
- 92 Perkins H, Craig DW. A multifaceted social norms approach to reduce high-risk drinking: lessons from Hobart and William Smith Colleges. Newton, MA: The Higher Education Center for Alcohol and Other Drug Prevention and the U.S. Department of Education, 2002.
- 93 Dempsey RC, McAlaney J, Bewick BM. A critical appraisal of the social norms approach as an interventional strategy for health-related behavior and attitude change. *Front Psychol.* 2018;9:2180. Medline:30459694 doi:10.3389/fpsyg.2018.02180
- 94 Lewis MA, Neighbors C. Optimizing personalized normative feedback: the use of gender-specific referents. *J Stud Alcohol Drugs.* 2007;68:228-37. Medline:17286341 doi:10.15288/jsad.2007.68.228
- 95 Labrie JW, Lewis MA, Atkins DC, Neighbors C, Zheng C, Kenney SR, et al. RCT of web-based personalized normative feedback for college drinking prevention: Are typical student norms good enough? *J Consult Clin Psychol.* 2013;81:1074-86. Medline:23937346 doi:10.1037/a0034087
- 96 Neighbors C, Rodriguez LM, Rinker DV, Gonzales RG, Agana M, Tackett JL, et al. Efficacy of personalized normative feedback as a brief intervention. *J Consult Clin Psychol.* 2015;83:500-11. Medline:26009785 doi:10.1037/a0039125
- 97 Lewis MA, Neighbors C. Social norms approaches using descriptive drinking norms education: a review of the research on personalized normative feedback. *J Am Coll Health.* 2006;54:213-8. Medline:16450845 doi:10.3200/JACH.54.4.213-218
- 98 Linkenbach JW, Perkins HW. Most of us are tobacco free: an eight-month social norms campaign reducing youth initiation of smoking in Montana. In: Perkins HW, editor. *The Social Norms Approach to Preventing School and College Age Substance Abuse: A Handbook for Educators, Counselors, and Clinicians.* San Francisco, CA: Jossey-Bass; 2003.
- 99 Perkins HW, Craig DW. A successful social norms campaign to reduce alcohol misuse among college student-athletes. *Journal of studies on alcohol.* 2006;67:880-9. Medline:17061005 doi:10.15288/jsa.2006.67.880
- 100 Perkins HW, Perkins JM. The Social Norms Approach: Confronting the “reign of error” as a successful strategy to reduce harmful drinking and drug use in college. In: Anderson D, Hall T, editors. *Leading Campus Drug and Alcohol Abuse Prevention: Grounded Approaches for Student Impact.* Washington, DC: National Association of Student Personnel Administrators; 2021. p. pp. 159-62, pp. 417-24.
- 101 Mortensen CR, Neel R, Cialdini RB, Jaeger CM, Jacobson RP, Ringel MM. Trending norms: a lever for encouraging behaviors performed by the minority. *Soc Psychol Personal Sci.* 2019;10:201-10. doi:10.1177/1948550617734615
- 102 McCoy SI, Fahey C, Rao A, Kapologwe N, Njau PF, Bautista-Arredondo S. Pilot study of a multi-pronged intervention using social norms and priming to improve adherence to antiretroviral therapy and retention in care among adults living with HIV in Tanzania. *PLoS One.* 2017;12:e0177394. Medline:28486553 doi:10.1371/journal.pone.0177394
- 103 Riley AH, Sood S, Wang H. Entertainment-Education (Effects). In: Ho EY, Bylund CL, Van Weert JCM, editors. *The International Encyclopedia of Health Communication.* USA: Wiley-Blackwell; 2023. p. 1-7.
- 104 Riley AH, Rodrigues F, Sood S. Social norms theory and measurement in entertainment-education: Insights from case studies in four countries. *Entertainment-Education Behind the Scenes: Palgrave Macmillan, Cham; 2021.*
- 105 Gauri V, Rahman T, Sen IK. Shifting social norms to reduce open defecation in rural India. *Behav Public Policy.* 2023;7:266-90. doi:10.1017/bpp.2020.46

- 106** Graupensperger S, Lee CM, Larimer ME. Leveraging dynamic norms to reduce alcohol use among college students: A proof-of-concept experimental study. *Alcohol Clin Exp Res*. 2021;45:2370-82. Medline:34846760 doi:10.1111/acer.14718
- 107** Sparkman G, Walton GM. Dynamic norms promote sustainable behavior, even if it is counternormative. *Psychol Sci*. 2017;28:1663-74. Medline:28961062 doi:10.1177/0956797617719950
- 108** Ross L, Greene D, House P. The “false consensus effect”: An egocentric bias in social perception and attribution processes. *J Exp Soc Psychol*. 1977;13:279-301. doi:10.1016/0022-1031(77)90049-X
- 109** Prentice DA, Miller DT. Pluralistic ignorance and alcohol use on campus: some consequences of misperceiving the social norm. *J Pers Soc Psychol*. 1993;64:243-56. Medline:8433272 doi:10.1037/0022-3514.64.2.243
- 110** Lanham M, L'Engle KL, Loolpapit M, Oguma IO. Women's roles in voluntary medical male circumcision in Nyanza Province, Kenya. *PLoS One*. 2012;7:e44825. Medline:23028634 doi:10.1371/journal.pone.0044825
- 111** Price JE, Phiri L, Mulenga D, Hewett PC, Topp SM, Shiliya N, et al. Behavior change pathways to voluntary medical male circumcision: Narrative interviews with circumcision clients in Zambia. *PLoS One*. 2014;9:e111602. Medline:25375790 doi:10.1371/journal.pone.0111602
- 112** Osaki H, Mshana G, Wambura M, Grund J, Neke N, Kuringe E, et al. “If you are not circumcised, I cannot say yes”: The role of women in promoting the uptake of voluntary medical male circumcision in Tanzania. *PLoS One*. 2015;10:e0139009. Medline:26402231 doi:10.1371/journal.pone.0139009
- 113** Muhamadi L, Ibrahim M, Wabwire-Mangen F, Peterson S, Reynolds SJ. Perceived medical benefit, peer/partner influence and safety and cost to access the service: client motivators for voluntary seeking of medical male circumcision in Iganga district eastern Uganda, a qualitative study. *Pan Afr Med J*. 2013;15:117. Medline:24255723 doi:10.11604/pamj.2013.15.117.2540
- 114** Odoyo-June E, Agot K, Mboya E, Grund J, Musingila P, Emusu D, et al. Agreement between self-reported and physically verified male circumcision status in Nyanza region, Kenya: Evidence from the TASCOS study. *PLoS One*. 2018;13:e0192823. Medline:29432444 doi:10.1371/journal.pone.0192823