Factors Associated with Low Uptake of Voluntary Medical Male Circumcision as HIV-Prevention Strategy among Men Aged 18–49 Years from Nyanza District, Rwanda

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Background: Voluntary medical male circumcision (VMMC) is an effective biomedical intervention against HIV in developed and developing countries. However, there is low uptake of VMMC due to various factors, which hinders achievement of health-policy goals to increase uptake. Numerous campaigns offering the procedure free of charge exist in developing countries, but such initiatives seem to bear little fruit in attracting men to these services. This study assessed risk factors associated with the low uptake of VMMC among men in Nyanza district, Southern Province, Rwanda.

Methods: A cross-sectional study was conducted among adult males in Nyanza. A total of 438 men participated in individual interviews. Bivariate and multivariate logistic regression models were used with 95% confidence intervals and \( p \leq 0.05 \) taken as statistically significant.

Results: Our results indicated that a low update of VMMC was highly prevalent (35.8%). A majority (84.7%) of participants had heard about VMMC, its complications, advantages in preventing penile cancer, sexually transmitted infections, and HIV, condom use after circumcision, abstinence for 6 weeks after circumcision, and improving penile hygiene. Religion and education were significant factors in low uptake. Catholics were less likely to undergo VMMC than Muslims (OR 7.19, 95% CI 1.742–29.659; \( p = 0.01 \)). Those of other faiths were less likely to undergo VMMC than Muslims (OR 6.035, 95% CI 1.731–21.039; \( p = 0.005 \)). Participants with secondary education were less likely to undergo VMMC than those with primary education only (OR 1.4, 95% CI 0.74–2.64; \( p = 0.03 \)). Having no formal education decreased the odds of being uncircumcised (OR 0.37, 95% CI 0.14–0.977; \( p = 0.045 \)) when compared to those with primary education.

Conclusion: Uptake of VMMC remains low in Nyanza, but most men had sufficient knowledge about it. Education, religion, and marital status were major factors in the low uptake. Programs targeting peer influences and parents need to be prioritized.

Keywords: low uptake, VMMC, HIV/AIDS, prevention, men, adult, male circumcision

Background

HIV/AIDS is a public health burden worldwide. Strategies to prevent and treat such diseases as HIV/AIDS, malaria, tuberculosis, hepatitis, Ebola, and other communicable diseases remain an unfinished public health agenda of the UN’s Sustainable Development Goals and World Health Organization (WHO).1,2 To achieve this goal of promoting health through prevention of behavioral risks leading to HIV/AIDS, different health-care
interventions have been developed on a global scale. The Joint United Nations Programme on HIV/AIDS (UNAIDS) and the WHO recommend the implementation of safe voluntary medical male circumcision (VMMC) as an appropriate health strategy for preventing HIV/AIDS and other sexually transmitted infections (STIs). Studies have indicated that communities that use voluntary male circumcision (VMMC) effectively are more likely to have low rates of HIV than those that do not. Accessibility of VMMC in most countries, particularly in low- and middle-income countries, is influenced by religious, sociocultural, and medical factors. Low accessibility of VMMC remains in many countries of the world, and this is a grave public health concern in low- and middle-income countries. Implementation of VMMC has been reported to be a serious health problem among elders acting as guardians of community culture. Studies have documented that VMMC is an effective intervention against HIV infection — 60%. Data show that 80% (20.3 million) had been provided VMMC intervention by 2015. Implementation has taken place in African countries with HIV prevalence. It is expected that 3.4 million new VMMCs could prevent the spread of HIV in the period 2015–2025.

Studies conducted in Kenya, Uganda, and Tanzania have demonstrated that the prevalence of HIV/AIDS differs by community. Low sociodemographic status, age, residence, religion, and marital status are the main factors associated with this barrier to the prevention and treatment of STIs. HIV is a public health concern in eastern and southern African countries, and it is highly prevalent in communities not providing VMMC programs. Moreover, the household’s be collectively reduced, taking into account the different involvement, having the circumcised friend or relative as well as being encouraged by the friend or family relative were found to be the cause of accessing to the VMMC. Factors driving low uptake of VMMC are fear of losing family revenue, fear of pain, and fear of receiving wounds.

Studies conducted in the US have shown a strong association between preference for VMMC and high socioeconomic status, whereas low uptake is associated with low socioeconomic status. In contrast, demographic and health surveys in sub-Saharan African countries have shown no consistent association with socioeconomic status. For example, in Tanzania, higher rates of circumcision were observed among men with higher levels of education, higher socioeconomic status, and living in urban areas, whereas in Lesotho circumcision was a public health burden among men with no education, in the lowest wealth quartile, and living in rural areas. The same factors were assessed for determining why the uptake was low. The more males possess adequate knowledge regarding VMMC and the burdens of HIV/AIDS, the more they become motivated to get circumcised. Many factors may be associated with low uptake and high prevalence of STIs. Intervening factors are those that may influence uptake indirectly when other factors play an important role in pursuing MMC for the purpose of HIV prevention.

The growing problem on which this study focuses is how to increase MC uptake as an HIV-prevention strategy, given the high prevalence of HIV infection, a pressing challenge in the health sector. One of the greatest impediments to MC uptake following HIV outbreaks is community reluctance to pursue other interventions for the prevention of heterosexually acquired HIV infection in men when HIV prevalence is high. Long distance to health facilities, fear of pain, biased information from health facilities, discouragement from friends, long healing period, and mandatory HIV testing before MC is carried out are factors associated with low uptake. How to address these attitudes and behaviours while encouraging healthy ones and increase MC uptake has thus become a difficult task.

To reduce HIV infection among communities, it is generally contended that prevention strategies require important supplementary approaches for the anticipation of heterosexually acquired HIV infections in men in regions where HIV prevalence is high. In this regard, the current discourse points to solutions delivered and built from partner initiatives. Notably, the particular role of VMMC is a commonly understood medical technique that has been approved by the WHO as an additional prevention strategy against HIV. Empirical investigation in this regard is thus worth undertaking, notably in Rwanda, where the culture does not favor MC. VMMC is considered part of a comprehensive HIV-prevention package for heterosexually acquired infections in men. It is a cost-effective HIV-prevention measure, and large-scale uptake of VMMC in populations with high HIV prevalence and a low circumcision rate has a considerable impact on the HIV epidemic and provides a cost-effective strategy. VMMC performed by well-trained clinicians among traditionally noncircumcising communities prevents HIV transmission by up to 60%.
Nyanza is one of the eight districts of Rwanda’s Southern Province, and has low uptake of VMMC when compared to other provinces (17.3%). It has - the second-highest HIV prevalence after Kigali (3.2%). Nyanza has high STI prevalence on a national level, is eighth in HIV prevalence nationally, has a low MC rate (15%), and VMMC uptake is the lowest nationwide. Although the accessibility of VMMC in Nyanza is very low, little is known about factors influencing its uptake. This study is unique in that population from the target studies area. The results of the current study will be important in designing appropriate strategies to reinforce VMMC uptake with the objective of long-term impact on HIV control in Nyanza. Building on the aforementioned literature, this study aimed to determine the prevalence and risk factors contributing to the low uptake of VMMC in Nyanza.

**Conceptual Framework**

Figure 1 shows a conceptual framework that indicates the relationships among mainly independent and outcome variables. The framework of this study was designed using prior studies documenting that VMMC is associated with factors categorized into three classes namely: sociodemographic

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**Figure 1** Conceptual framework of variables used in this study, is, independent, intervening and outcome variables. We used three classes of independent variables. (A) Sociodemographic variables were age, education, area of residence, religion, marital status, and monthly income. (B) Knowledge on VMMC comprised subjects having heard about VMMC, MC complications, abstinence after circumcision, condom use after MC, MC reducing the risk of getting STIs, MC reduces the risk of penile cancer, MC improves penile hygiene. (C) socio-cultural factors and other factors including attitudes and behavior regarding MC (fear of losing foreskin, fear of pain, fear of injection), stigma. Intervening variables were accessibility of services, availability of services, distance to facilities, traveling costs, and waiting time to receive service at the facility. The outcome variable was low uptake of VMMC.

**Abbreviations:** MC, male circumcision; VMMC, medical male circumcision; STIs, sexually transmitted infections.
variables (age, education, residence, religion, marital status, and monthly income), knowledge on VMMC (heard about it, MC complications, need for abstinence and Mcondom use after MC, reduction of risk of getting STIs and penile cancer, and improvement in penile hygiene), and other factors, including attitudes and behavior regarding MC (fear of losing foreskin, phobia of pain and stigma). Intervening variables are accessibility of services, availability of services, distance from household to health facility, transport, unaffordability, and recovery period too long.

**Methods**

**Study Design**

The study design used was a cross-sectional survey among males aged 18–49 years in Nyanza district, Southern Province, Rwanda.

**Study Settings and Participants**

Nyanza has low MC prevalence (17.1%) compared to other provinces of Rwanda. It has 17 health facilities: Nyanza District Hospital and 16 health centers where VMMC is carried out. It covers 672 km². The population of Nyanza is 323,719, (166,069 female and 157,650 males), among which 73,514 males comprised our study population. Nyanza has the highest prevalence of STIs nationwide —18%. It is also has the eighth-highest of HIV prevalence nationwide (3.1%) and low coverage of MC (15%).

The target group for the study was all men 18–49 years old present in Nyanza at the time of data collection, whether they lived in Nyanza or not. The eligibility criterion was no severe psychiatric history that could affect participation. Those unwilling to provide consent were excluded.

**Study Variables**

The dependent variable was uptake of VMMC. Independent variables were sociodemographic characteristics (age, marital status, residence, monthly income, religion, and education), knowledge on VMMC (heard about it, complications related to the operation, reduction in risk of penile cancer, improvement in penile hygiene, reduction of risk of catching STIs, and abstinence required after VMMC).

**Sample Size and Sampling**

For sample size calculation, we used Yamane’s formula:

\[ n = \frac{N}{1+Ne^2} = \frac{73514}{1+73514(0.05)^2} = 397.8 \approx 398 \]

where \( N \) is the target population (males aged 18–49 years), \( n \) the size of the sample, and \( e \) the margin error (5% or 0.05). We added 5% to the minimum sample size (398 respondents) for participants who might not take part for such reasons as withdrawal. Therefore, the total sample size was 438.

Using all sectors of Nyanza that had a higher rate of population than the other seven remaining sectors, the study population was disproportionately recruited from that population. We used stratified and simple random sampling for indicating the sample of each stratum the formula. The sample was proportionally divided according to the population of each sector of Nyanza. A structured questionnaire was used for data collection. Investigators were based at health centers where we expected many recruits to meeting the inclusion criteria, and data were collected for 2 weeks (September 2–16, 2019). Table 1 indicates the sample size for each sector (stratum), computed using the of Bluman’s formula:

\[ n_s = \frac{N_s}{N} \]

\[ n_s = \frac{N_{yanza}}{N} \]

where \( n_s \) is the sample size of the stratum, \( N_s \) the total population of each sector (stratum), and \( N \) the general population of the whole district.

**Data Collection and Procedures**

Simple random sampling was used in data collection and the structured questionnaire was utilized. Data collectors attended 2 days of training on the data-collection process and materials for data collection. The questionnaires used was adopted from previous research on knowledge of VMMC and validated by the investigators in a pilot study in Gasabo, Remera. After collecting data from the pilot, the investigators adjusted questions for better comprehension. Data collected were coded, entered into SPSS 24 to be analyzed, then stored on an external

| Table 1 Sectors of Nyanza | Residents Aged 18–49 Years | Sample |
|---------------------------|---------------------------|--------|
| 1 Busasamana               | 11,167                    | 67     |
| 2 Busoro                   | 7,616                     | 44     |
| 3 Cyabakanyi               | 4,562                     | 28     |
| 4 Kibirizi                 | 6,984                     | 41     |
| 5 Kigoma                   | 7,618                     | 45     |
| 6 Mukindo                  | 12,542                    | 75     |
| 7 Muyira                   | 7,646                     | 46     |
| 8 Nyazo                    | 5,883                     | 35     |
| 9 Nyagisozi                | 5,498                     | 33     |
| 10 Rwabicuma               | 3,998                     | 24     |
| Total                      | 73,514                    | 438    |

Notes: Fourth Rwanda Population and Housing Census, 2012 (NISR).
disk. Completed questionnaires were kept in a closed cupboard to maintain confidentiality. Data were stored electronically, and password-protected software was used according to University of Rwanda rules and regulations regarding research. The time taken to complete the questionnaire was 20–30 minutes.

Data Analysis
Data were entered into Excel, categorized, then analyzed using SPSS 24. Both descriptive and analytical analyses were performed. In the descriptive analysis, frequencies and percentages were computed to summarize the sociodemographic characteristics of the participants. Based on MC prevalence, descriptive statistics were compiled and frequencies and proportions calculated. For knowledge on VMMC, participants who had answered at least four of the questions correctly were considered to have sufficient knowledge. Descriptive statistics were also computed and frequencies and proportions derived. Bivariate logistic regression was performed to indicated factors associated with VMMC uptake. Binary logistic regression analysis was performed to determine associations between dependent and independent variables. Independent variables with $p<0.2$ on bivariate logistic regression were fitted to binomial multivariate logistic regression analyses that utilized both full models, and reduced models were used with ORs to determine factors associated with VMMC uptake. Binomial multivariate regression was applied to identify the factors contributing to low VMMC uptake. Associated factors in the full model were exported to the reduced models. Statistical significance established as $p<0.05$.

Ethics
This study was carried out in accordance with the Declaration of Helsinki. Ethics approval was sought from the Institutional Review Board, College of Medicine and Health Sciences (IRB, CMHS), University of Rwanda (No.425/CMHS IRB/2019). After receiving this clearance, the local leaders authorized the researchers to carry out the study. Participants were informed of the purpose of the study, that there was no compensation, and asked if they would consent. They were able to withdraw from the study any time, and were informed that they would not be penalized for doing so. Confidentiality and privacy were ensured throughout the research. The right to autonomy and self-determination were taken into consideration throughout. The study team explained to the interviewees that the information would be for research purposes only and would not be shared. Researcher, data collector and participants signed consent forms. Questionnaires were anonymous, numbered in order of evaluation, and did not contain identifiers of the participants.

Results
Sociodemographic Characteristics
A total of 438 participants were enrolled: >67% were married, and 20.3% aged 23–27 years. A majority (83.3%) had attended at least primary school, and >87% were Catholic. A majority (81.3%) unemployed, students, or neither self-employed nor employed ("others"), with 89.1% reporting low monthly incomes (<RWF50,000) and 96.8% residing in Nyanza (Table 2).

| Table 2 Sociodemographic Characteristics (n=438) |
|-------------------------------------------------|
| Characteristics                                | frequency (n) | %      |
| Age                                            |               |        |
| 18–22 years                                    | 49            | 11.2   |
| 23–27 years                                    | 89            | 20.3   |
| 28–32 years                                    | 73            | 16.7   |
| 33–37 years                                    | 87            | 19.9   |
| 38–42 years                                    | 85            | 19.4   |
| 43 years and above                             | 55            | 12.6   |
| Marital status                                 |               |        |
| Single                                         | 125           | 28.5   |
| Married                                        | 294           | 67.1   |
| Separated/divorced                             | 19            | 4.3    |
| Religion                                       |               |        |
| Catholic                                       | 382           | 87.2   |
| Muslim                                         | 13            | 3      |
| Other                                          | 43            | 9.8    |
| Education                                      |               |        |
| Primary                                        | 365           | 83.3   |
| Secondary and higher                           | 53            | 12.1   |
| Illiterate                                     | 20            | 4.6    |
| Employment                                     |               |        |
| Unemployed, student, and other                 | 356           | 81.3   |
| Self-employed                                  | 45            | 10.3   |
| Employed                                       | 37            | 8.4    |
| Monthly income (RWF)                           |               |        |
| Below 50,000                                   | 391           | 89.3   |
| 50,000–100,000                                 | 38            | 8.7    |
| 100,000 and above                              | 9             | 2.1    |
| Area of residence                              |               |        |
| Nyanza                                         | 424           | 96.8   |
| Outside Nyanza                                 | 14            | 3.2    |
Prevalence of VMMC Uptake by Sociodemographic Characteristics

VMMC uptake was 35.8%, and varied based on sociodemographic status. The highest VMMC uptake (7.5%) was found in those aged 33–37 years. Concerning marital status, the highest VMMC uptake was found in those who were married. Similarly, there was high VMMC uptake among respondents who were Catholic. In sum, 53.7% of uncircumcised participants had attended primary school, and there was high VMMC uptake among the unemployed, students, and others. More than 53.2% had monthly incomes <RWF50,000, >62% were residents of Nyanza (Table 3).

Table 3 Uptake of VMMC by Sociodemographic Characteristics

| Characteristics          | Circumcised (n=157) | Uncircumcised (n=281) |
|--------------------------|---------------------|-----------------------|
|                          | n  | %   | n   | %   |
| Age                      |    |     |     |     |
| 18–22 years              | 17 | 3.9 | 32  | 7.3 |
| 23–27 years              | 32 | 7.3 | 57  | 13.0|
| 28–32 years              | 28 | 6.4 | 45  | 10.3|
| 33–37 years              | 33 | 7.5 | 54  | 12.3|
| 38–42 years              | 24 | 5.5 | 61  | 13.9|
| 43–49 years              | 23 | 5.3 | 32  | 7.3 |
| Marital status           |    |     |     |     |
| Single                   | 39 | 8.9 | 86  | 19.6|
| Married                  | 114| 26.0| 180 | 41.1|
| Separated/divorced       | 4  | 0.9 | 15  | 3.4 |
| Religion                 |    |     |     |     |
| Catholic                 | 127| 29.0| 255 | 58.2|
| Muslim                   | 9  | 2.1 | 4   | 0.9 |
| Other                    | 21 | 4.8 | 22  | 5.0 |
| Education                |    |     |     |     |
| Primary                  | 130| 29.7| 235 | 53.7|
| Secondary and higher     | 15 | 3.4 | 38  | 8.7 |
| Illiterate               | 12 | 2.7 | 8   | 1.8 |
| Employment               |    |     |     |     |
| Unemployed, student, and | 123| 28.1| 233 | 53.2|
| other                    |    |     |     |     |
| Self-employed            | 18 | 4.1 | 27  | 6.2 |
| Employed                 | 16 | 3.7 | 21  | 4.8 |
| Monthly income (RWF)     |    |     |     |     |
| Below 50,000             | 138| 31.5| 253 | 57.8|
| 50,000–100,000           | 15 | 3.4 | 23  | 5.3 |
| 100,000 and above        | 4  | 0.9 | 5   | 1.1 |
| Area of residence        |    |     |     |     |
| Nyanza                   | 149| 34.0| 275 | 62.8|
| Outside Nyanza           | 8  | 1.8 | 6   | 1.4 |

Knowledge-Level Variables

A large majority (95.7%) of participants had heard about circumcision in different settings. In sum, 92.5% those circumcised knew that one needed to abstain from sexual activity for 6 weeks after the circumcision operation, and 89% mentioned the need for condom use after the operation. A large majority (97%) were aware of VMMC and indicated that they knew it was a medical operation that reduced the risks of catching STIs, including HIV, 89.7% of indicated that they knew VMMC contributed to reducing the risk of developing penile cancer, and 98.9% responded that VMMC was important for improving penile hygiene. Though some complications like infections, insufficient foreskin removal, and excessive foreskin removal are rare following circumcision, a majority (82%) answered that bleeding was the most complication. A majority (84.7%) were knowledgeable about VMMC (Table 4).

Knowledge Level by Sociodemographic Characteristics

Participants’ knowledge differently varied based on sociodemographic status. Among knowledgeable participants, 19.5% were aged 33–37 years and 38%–42%, respectively, whereas among participants who were not knowledgeable, a majority were aged 18–22 years. A majority of participants were married (61%), while single men represent 8% of the sample. A majority (78.1%) of those knowledgeable about VMMC were Catholic. The Among participants who were knowledgeable, a majority (71.2%) had had a primary education only, while among the unknowledgeable, 12.1% had had a primary education only. A majority (75.1%) of those knowledgeable about VMMC were unemployed, students, and others. Among participants not knowledgeable about MC, a majority (8%) were self-employed. Among knowledgeable participants, a majority (77.4%) had monthly incomes <RWF50,000, and among the unknowledgeable, this figure was 11.9%. The results also demonstrated that a majority (83.6%) of the knowledgeable resided in Nyanza (Table 5).

Bivariate Analysis of VMMC Uptake

Bivariate logistic analysis indicated that marital status, residence, age, monthly income, employment status, and being knowledgeable about VMMC were not significantly associated with being uncircumcised. Significant associations were found between circumcision and
Table 4 Knowledge-level Variables

| Variables                          | n   | %   |
|------------------------------------|-----|-----|
| Heard about VMMC                   |     |     |
| Yes                                | 419 | 95.7|
| No                                 | 19  | 4.3 |
| Need to abstain for 6 weeks after circumcision |     |     |
| Yes                                | 405 | 92.5|
| No                                 | 33  | 7.5 |
| Need for condom use after VMMC     |     |     |
| Yes                                | 390 | 89.0|
| No                                 | 48  | 11.0|
| VMMC reduces the risk of STDs      |     |     |
| Yes                                | 425 | 97.0|
| No                                 | 13  | 3.0 |
| VMMC reduces the risk of penile cancer |      |     |
| Yes                                | 393 | 89.7|
| No                                 | 45  | 10.3|
| VMMC improves penile hygiene       |     |     |
| Yes                                | 433 | 98.9|
| No                                 | 5   | 1.1 |
| VMMC causes complications           |     |     |
| Infection                          | 27  | 6.2 |
| Bleeding                           | 359 | 82.0|
| Insufficient foreskin removed      | 26  | 5.9 |
| Excessive foreskin removed         | 16  | 3.7 |
| I do not know                      | 10  | 2.3 |
| Knowledge about VMMC               |     |     |
| Knowledgeable                      | 371 | 84.7|
| Not knowledgeable                  | 67  | 15.3|

Abbreviations: VMMC, voluntary medical male circumcision; STDs, sexually transmitted diseases.

Multivariate Analysis of VMMC Uptake
On multiple logistic regression, religion and education were also significantly associated with low VMMC uptake. Being Catholic increased the likelihood of low VMMC uptake compared to Muslims (OR 7.19, 95% CI 1.742–29.659; p=0.01). Followers of other religions were less likely to have low VMMC uptake than Muslims (OR 6.035, 95% CI 1.731–21.039; p=0.005). Those with no formal education were less likely to have low VMMC uptake than those with primary education (OR 0.37, 95% CI 0.14–0.977; p=0.045). Those who were married were less likely to have low VMMC uptake of (OR 0.536, 95% CI 0.326–0.882; p=0.014) than those who were single (Table 7).

Discussion
VMMC uptake in Nyanza was 35.8%. This is relatively higher than the national prevalence (30%) reported in the 2014/2015 Rwanda Demographic and Health Survey, but lower than that in other areas such as in north Africa.
and >62% found in sub-Saharan Africa.\textsuperscript{22,27,28} A majority of participants were aged 23–27 years, and it was in this group that VMMC uptake was low compared to other age-groups.

VMMC uptake was significantly associated with socio-demographic variables. Religion was significantly associated with low VMMC uptake. This result is supported by similar research indicating that religion was associated with uptake, especially in the uncircumcised, in Kenyan communities.\textsuperscript{5} Catholics were almost 7.2 times more likely to have low VMMC uptake of than Muslims. This finding is similar to other research reporting that religion and sociocultural beliefs make for difficulties with VMMC uptake within uncircumcised communities.\textsuperscript{5} Our results revealed that those with no formal education were less likely to have low VMMC uptake than those with primary education. This result is supported by prior research indicating that education had a significant influence on

\textbf{Table 6 Bivariate Analysis of VMMC Uptake}

| Variables                  | Circumcised | Uncircumcised | 95% CI               | p    |
|----------------------------|-------------|---------------|----------------------|------|
| Age                        |             |               |                      |      |
| 18–22 years                | 17          | 32            | Ref                  |      |
| 23–27 years                | 32          | 57            | 0.946                | 0.882|
| 28–32 years                | 28          | 45            | 0.854                | 0.681|
| 33–37 years                | 33          | 54            | 0.869                | 0.707|
| 38–42 years                | 24          | 61            | 1.350                | 0.435|
| 43–49 years                | 23          | 32            | 0.739                | 0.457|
| Marital status             |             |               |                      |      |
| Single                     | 39          | 86            | Ref                  |      |
| Married                    | 114         | 180           | 0.72                 | 0.141|
| Separated/divorced         | 4           | 15            | 1.7                  | 0.372|
| Religion                   |             |               |                      |      |
| Muslim                     | 9           | 4             | Ref                  |      |
| Catholic                   | 127         | 255           | 4.52                 | 0.014*|
| Other                      | 21          | 22            | 2.36                 | 0.203|
| Education                  |             |               |                      |      |
| Primary                    | 130         | 235           | Ref                  |      |
| Secondary and higher       | 15          | 38            | 1.4                  | 0.03*|
| Illiterate                 | 12          | 8             | 0.37                 | 0.034*|
| Employment status          |             |               |                      |      |
| Unemployed, student, and other | 123   | 233           | Ref                  |      |
| Self-employed              | 18          | 27            | 1.443                | 0.295|
| Employed                   | 16          | 21            | 1.143                | 0.767|
| Monthly income (RWF)       |             |               |                      |      |
| Below 50,000               | 138         | 253           | Ref                  |      |
| 50,000–100,000             | 15          | 23            | 0.84                 | 0.61 |
| 100,000 and above          | 4           | 5             | 0.68                 | 0.57 |
| Area of residence          |             |               |                      |      |
| Nyanza                     | 149         | 275           | Ref                  |      |
| Outside Nyanza             | 8           | 6             | 0.41                 | 0.101|
| Knowledge about VMMC       |             |               |                      |      |
| Knowledgeable              | 135         | 236           | Ref                  |      |
| Not knowledgeable          | 22          | 45            | 1.17                 | 0.577|

\textbf{Note:} \*p<0.05.
\textbf{Abbreviation:} VMMC, voluntary medical male circumcision; Ref, reference.
A majority (84.7%) of participants were highly knowledgeable. This result was contradicts previous studies, wherein VMMC knowledge was lower and led to low VMMC uptake. The results of this study revealed no significant association between being knowledgeable and low VMMC uptake. In agreement with prior research, our results revealed that being married decreased the likelihood of low VMMC uptake compared to those who were single. We found no significant associations among residence, age, or employment status. This challenges earlier research documenting age, type of residence, and employment status to be significant contributing factors to low VMMC uptake. Our results revealed that those with no formal education were less likely to have low VMMC uptake than those who had attended primary schools, in contrast to research

| Table 7 Multivariate Analysis of the of VMMC Uptake |
|---------------------------------|-------------------------|---------------------|-------------------------|-------------------------|
|                                | Full Model              | Reduced Model       |                         |                         |
|                                | OR                      | 95% CI              | p-ν                      | OR                      | 95% CI              | p-ν                      |
| **Age**                        |                         |                     |                          |                         |                     |                          |
| 18–22 years                    | Ref.                    |                     |                          |                         |                     |                          |
| 23–27 years                    | 0.702                   | (0.230,2.147)       | 0.54                     |                         |                     |                          |
| 28–32 years                    | 0.45                    | (0.127,1.597)       | 0.22                     |                         |                     |                          |
| 33–37 years                    | 0.521                   | (0.145,1.869)       | 0.32                     |                         |                     |                          |
| 38–42 years                    | 0.759                   | (0.210,2.748)       | 0.67                     |                         |                     |                          |
| 43–49 years                    | 0.463                   | (0.123,1.736)       | 0.25                     |                         |                     |                          |
| **Marital status**             |                         |                     |                          |                         |                     |                          |
| Single                         | Ref.                    |                     |                          |                         |                     |                          |
| Married                        | 0.568                   | (0.333,0.969)       | 0.04*                    | 0.536                   | (0.326,0.882)       | 0.014*                   |
| Separated/divorced             | 1.448                   | (0.418,5.017)       | 0.56                     | 1.394                   | (0.419,4.634)       | 0.588                     |
| **Religion**                   |                         |                     |                          |                         |                     |                          |
| Muslim                         | Ref.                    |                     |                          |                         |                     |                          |
| Catholic                       | 7.19                    | (1.742,29.659)      | 0.01*                    | 6.035                   | (1.731,21.039)      | 0.005*                   |
| Other                          | 2.581                   | (0.597,11.153)      | 0.2                      | 2.544                   | (0.659,9.820)       | 0.175                     |
| **Education**                  |                         |                     |                          |                         |                     |                          |
| Primary                        | Ref.                    |                     |                          |                         |                     |                          |
| Secondary and higher           | 1.425                   | (0.702,2.895)       | 0.33                     | 1.477                   | (0.768,2.841)       | 0.243                     |
| No formal education            | 0.353                   | (0.126,0.988)       | 0.05*                    | 0.37                    | (0.140,0.977)       | 0.045*                   |
| **Employment status**          |                         |                     |                          |                         |                     |                          |
| Unemployed, student, and other | Ref.                    |                     |                          |                         |                     |                          |
| Self-employed                  | 0.876                   | (0.267,2.881)       | 0.83                     |                         |                     |                          |
| Employed                       | 0.812                   | (0.291,2.267)       | 0.69                     |                         |                     |                          |
| **Monthly income (RWF)**       |                         |                     |                          |                         |                     |                          |
| Below 50,000                   | Ref.                    |                     |                          |                         |                     |                          |
| 50,000–100,000                 | 1.165                   | (0.465,2.919)       | 0.74                     |                         |                     |                          |
| 100,000 and above              | 1.046                   | (0.217,5.050)       | 0.96                     |                         |                     |                          |
| **Area of residence**          |                         |                     |                          |                         |                     |                          |
| Nyanza district                | Ref.                    |                     |                          |                         |                     |                          |
| Outside Nyanza                 | 0.445                   | (0.123,1.607)       | 0.22                     |                         |                     |                          |
| **Knowledge about VMMC**       |                         |                     |                          |                         |                     |                          |
| Knowledgeable                  | Ref.                    |                     |                          |                         |                     |                          |
| Not knowledgeable             | 1.25                    | (0.529,2.953)       | 0.61                     |                         |                     |                          |

Note: *p≤0.05.
Abbreviation: VMMC, voluntary medical male circumcision.
indicating that those with formal education were less likely to undergo VMMC.\textsuperscript{33–35}

Knowledge about VMMC was not found to be significantly associated with uptake; however, it was found that the majority of the participants were knowledgeable about VMMC in terms of knowing about possible VMMC complications and advantages of VMMC, such as reducing the risk of penile cancer. These results contrast with prior studies documenting that lack of adequate knowledge about VMMC was an important factor in low VMMC uptake in Botswana, heightening the risk of STI and HIV/AIDS spread.\textsuperscript{5,36}

Limitations
The study has several limitations. First, it was limited to those aged 18–49 years. Second, it was vulnerable to bias, because the circumcision status was self-reported and respondents could not provide all circumcision information for various reasons. These expected biases were controlled by safeguarding confidential interviews, and proportional sampling was crucial in enroll a suitable sample size from each of the recruited strata from Nyanza.

Conclusion
Like other studies conducted in African countries, the current study showed that adults were mostly knowledgeable about VMMC and knew the advantages of VMMC for health. VMMC prevalence in the area was higher than the national figure, while low uptake was associated with religion and education. Accomplishing the high national VMMC targets in Rwanda will be an important contributor to furthering the HIV decline in Nyanza.

We recommend that the Ministry of Health and partner-increase the accessibility of VMMC through strong awareness and mobilization initiatives in the community of Nyanza. This goal should be achieved by creating more awareness about the safety and quality of services in government health facilities. In addition, providing health education in public and private institutions reinforcing that VMMC reduces female-to-male transmission risk of HIV and prevents STIs could lead to increased uptake of VMMC services in Nyanza. Further research is needed on uptake variables nationwide. There is a need in Rwanda for illuminating the influences of VMMC on STI and HIV prevention, treatment, and care. We recommend further research at a national level.

Abbreviations
MMC, medical male circumcision; NGO, nongovernmental organization; STIs, sexually transmitted infections; UNAIDS, Joint United Nations Programme on HIV/AIDS; VMMC, voluntary MMC; WHO, World Health Organization.

Data Sharing Statement
The data sets used in this research are available from the corresponding author. All data generalized or analyzed in this study may be shared upon permission being granted by the corresponding author.

Ethics Approval and Consent to Participate
Ethics approval with the reference number (N\textsuperscript{0}:425/CMHS IRB/2019) was granted by the Institutional Review Board of the College of Medicine and Health Sciences, University of Rwanda. District authorities provided permission to conduct data collection in their districts. Participants were informed about the aim of the study, and all provided oral and written informed consent. Confidentiality and privacy were preserved by ensuring that the interviews were performed in private spaces comfortable for the participants. Codes for the participants were safeguarded to conceal identities, and the researchers handled all records securely through the use of locked files.

Consent for Publication
Consent to publish the results from this study was obtained from the participants.

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Author Contributions
Both authors made a significant contribution to the work reported, whether in conception, study design, execution, data acquisition and interpretation, or in all these areas, took part in drafting, revising, or critically reviewing the article,
gave final approval to the version to be published, agreed on the journal to which the article has been submitted, and agree to be accountable for all aspects of the work.

Disclosure
The authors report no conflicts of interest in this work.

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