Use of lotteries for the promotion of voluntary medical male circumcision service: a discrete choice experiment among adult men in Tanzania

Running title: Role of lotteries for promoting male circumcision

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ABSTRACT

Voluntary medical male circumcision (VMMC) is effective in reducing the risk of HIV. However, countries like Tanzania have high HIV prevalence but low uptake of VMMC. We conducted a discrete choice experiment to evaluate the preferences for VMMC service attributes in a random sample of 325 men aged 18 years or older from the general population in two Tanzanian districts, Njombe and Tabora. We examined the preference for financial incentives in the form of a lottery ticket or receiving a guaranteed transport voucher for attendance at a VMMC service. We created a random parameters logit model to account for individual preference heterogeneity and a latent class analysis model for identifying groups of men with similar preferences to test the hypothesis that men who

reported sexually risky behaviors (i.e. multiple partners and any condomless sex in the last 12 months) may have a preference for participation in a lottery-based incentive. Most men preferred a transport voucher (84%) over a lottery ticket. We also found that offering a lottery-based financial incentive may not differentially attract those with greater sexual risk. Our study highlights the importance of gathering local data to understand preference heterogeneity, particularly regarding assumptions around risk behaviors.

Key words: Lotteries; Tanzania; Voluntary Medical Male Circumcision; Discrete Choice Experiment

INTRODUCTION

Voluntary medical male circumcision (VMMC) is an established method for HIV prevention among heterosexual men [1-3] and is an essential component of HIV prevention strategies in countries with generalized HIV epidemics, reducing female-to-male HIV acquisition by 60-70% [4-6]. Further it is estimated that an 80% increase in coverage of VMMC services across sub-Saharan Africa (SSA) would prevent up to six million new HIV infections and three million deaths by 2025 [7]. Although VMMC is highly cost-effective as a one-off procedure conferring partial life-long protection, compared with other antiretroviral (ARV)-based prevention strategies like pre-exposure prophylaxis which incurs recurrent costs and requires continued adherence [8], the public health impact depends on males choosing to become circumcised.

By the end of 2016, it was estimated that nearly 15 million men had been circumcised, which fell short of WHO and UNAIDS target of 20 million men circumcised by 2016 [9]. To maximize the HIV-related benefits of VMMC, current service delivery models need to be strengthened to include hard-to-reach populations such as older men (i.e. those above 20), men living in rural areas, or men with risky sexual behaviors [10]. We chose the study setting of Tanzania as an example of how older men from rural areas have suboptimal uptake of VMMC i.e although 72% of men were circumcised by 2012 nationwide, VMMC coverage was low (49%) in both Njombe and Tabora [10]. In addition, at the time of the study, Tanzania was among the countries which had set ambitious targets for VMMC,[11] and had a mature VMMC program. However, like other countries in Eastern and Southern Africa, demand-side barriers to VMMC include shame associated with services co-located with younger men, perceived inappropriateness of circumcision after puberty and perception it is only for sexually

promiscuous men [12-16]. Several strategies have been implemented to address these barriers, including campaigns that account for social norms, use of peer promoters and increasing health workforce to meet client demands [15, 16]. Additionally, offering financial incentives for eligible males may be another strategy to increase VMMC uptake [17]. Present-bias leads to more value being placed on immediate rather than delayed benefits, and therefore financial incentives may provide an important 'nudge' for men to undergo circumcision [18, 19]. Therefore, vouchers or conditional cash transfer programs have been trialed by programs to improve the uptake of VMMC [17, 20]. A review of 16 studies concluded the benefits of cash payments for increasing uptake of VMMC is not universal but is highly context dependent [21]. It is therefore important to explore the contextual effects of offering financial incentives before scaling this up in Tanzania.

Financial incentives offered through a lottery are different from guaranteed financial incentives such as transport vouchers or conditional cash transfer programs. The first distinction is that the possibility of winning a significant prize may play a role in motivating behavior change. When offered an incentive to complete a task, the size and nature of the incentive may be weighed against the expected value and costs of the task outcomes [22]. A recent study in South Africa reported multiple benefits of using a lottery to increase the uptake of workplace HIV counselling and testing [23]. The lottery (with a prize of 2000 Rand, or ~$150 USD) created positive emotions and excitement and generated an environment of greater readiness to test for HIV. It also mitigated HIV stigma and discrimination by lowering barriers, providing a reason to participate, as there was a company-wide accepted reason to talk about HIV testing and the prize. The authors described a 'supportive group pressure' was generated by the lottery.

The second distinction of offering a lottery is that while everyone receives the health intervention (i.e. VMMC), only one or a few people will get the prize, compared with receiving a guaranteed voucher or cash transfer (i.e. a 'sure thing'). There are multiple theories, rooted in behavioral economics, relevant to the choices of people who are offered an uncertain incentive to affect a health-seeking behavior. For example, according to expected utility theory [24], people seek to maximize utility when making a decision. Therefore, people who are risk-averse are ready to gamble only if the expected payout is sufficiently higher than the certain price of participation. Conversely, people who are risk-tolerant are ready to gamble even if the price is higher (to a certain point), than the expected value of the gamble. If individuals exhibiting risk-tolerant behaviors in financial domains are also more likely to be risk-tolerant in other domains, for example engaged in risky sexual behaviors (i.e. condomless sex, multiple partners), providing the option of a lottery as part of an intervention delivery may be an effective targeting mechanism to attract higher risk people. However, according to prospect theory, a potential loss may also affect utility more than the gain of the same item, so men may be averse to the possibility of having something taken away (i.e. other men winning the lottery) compared to not participating in the lottery or receiving something that is guaranteed (i.e. transport vouchers) [19].

The aim of the study was to estimate the preferences of men for participation in VMMC in two regions of Tanzania with high HIV prevalence (Njombe 14.8%, Tabora 6.4%, Tanzania national average 5.1%) [10, 25] but low circumcision coverage (both Njombe and Tabora 49%)

[10]. We also assessed the utility of offering a lottery ticket versus a transport voucher to increase VMMC uptake. In particular, we were interested in whether men who reported risky sexual behaviors were more likely to prefer participating in a lottery than men with lower reported sexual risk behavior. There is a possibility that men may compartmentalize their risk-tolerant behaviors, separating sexual behaviors from financial decision-making [26]. To test the hypothesis that risk-tolerant people (in terms of sexual behaviors) are less averse to a risky gain through a lottery, we conducted a discrete choice experiment (DCE) to allow quantitative estimation of user preferences [27-29]. We incorporated non-monetary benefits to test the relative importance of these factors over the offer of financial incentives for men to undergo VMMC. This information may influence policies considering the value of introducing a lottery to encourage uptake of VMMC services.

METHODS

Data and measures

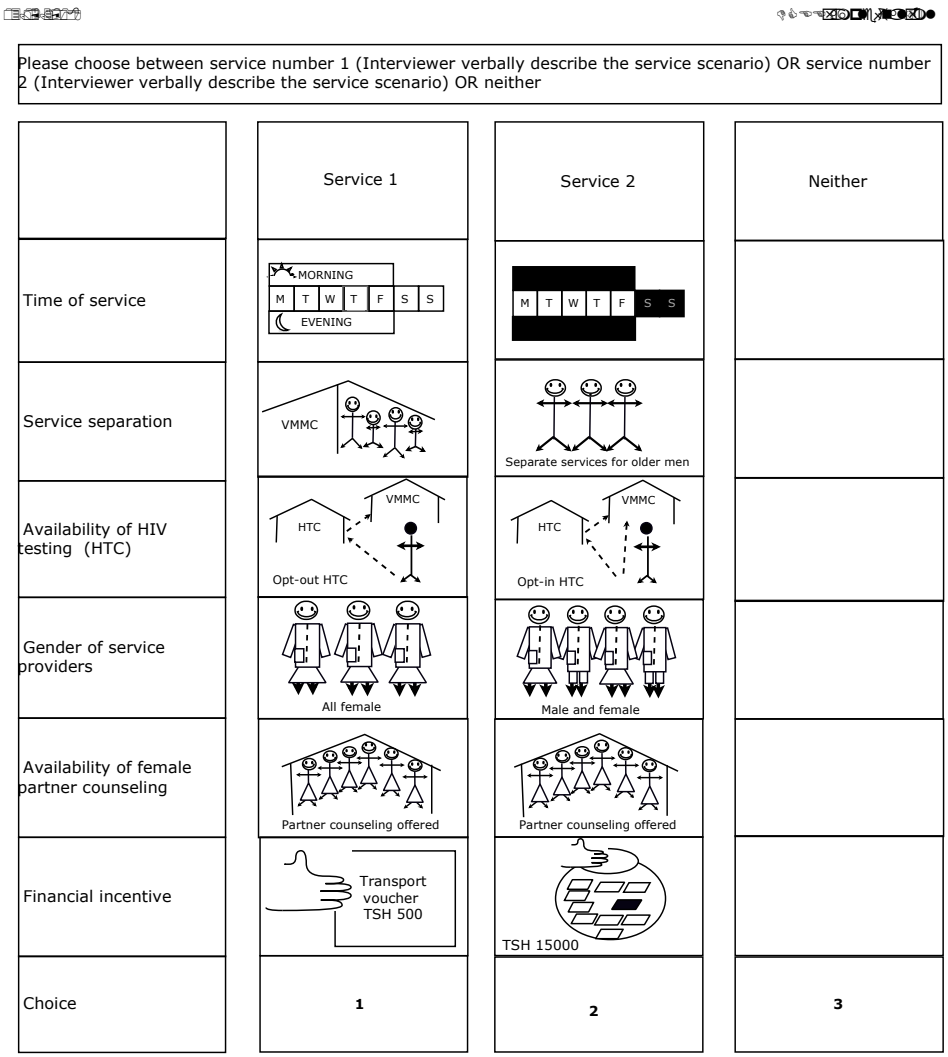
The data used in this study were from the work for a cluster-randomized controlled trial which recruited men aged 18 years and older from 20 community sites in Njombe and Tabora in Tanzania [30]. The trial was registered at clinicaltrials.gov, number NCT02376348. In this study, we report our findings of the DCE conducted as part of the baseline survey from February to March 2014. The researcher-assisted pen-and-paper survey was completed among a convenience sample of 159 (uncircumcised and circumcised) men in Njombe and 166 men in Tabora in 2014. More details about sample size calculations and recruitment methodology are found in Appendix 1. The formative research included a literature review of studies in sub-Saharan Africa to identify attributes related to VMMC service preferences. To

refine the attributes and levels for the DCE and to check for comprehensibility of the images used in the DCE, we conducted individual interviews with 30 men, and focus group discussions with 20 men and women in total. These interviews focused on understanding the barriers and facilitators to access VMMC services are described in more detail elsewhere [13]. A pilot study of further 54 men provided priors for the d-efficient DCE design, generated using NGENE 1.1 software [31].

The attribute and levels tested in the DCE are as follows, with the attribute listed first followed by the levels in parentheses: 1) time of service (normal working hours [reference], extended hours and weekends); 2) service separation (all clients together [reference], separate waiting areas for younger and older men, separate services for younger and older men); 3) gender of service providers (male and female [reference], all male, all female); 4) availability of HIV testing (opt-out [reference], no testing, opt-in); 5) availability of female partner counselling (none[reference], partner counselling offered); and 6) financial incentive (no financial incentive [reference], lottery, transport voucher). For the lottery attribute, the options were a one in 10 chance of winning 5000 Tanzanian Schillings (Tzs, $2 USD i.e. expected value of $0.20), Tzs 15,000 ($6 i.e. expected value of $0.60) or Tzs 45,000 ($18 i.e. expected value of $1.80). The guaranteed transport voucher value was Tzs 500 ($0.20), Tzs 1500 ($0.60) or Tzs 4500 ($1.80). These chosen levels enabled comparisons between the lottery and transport voucher using the same expected values. We checked for comprehensibility during the formative research phase to ensure that men understood each attribute. Choice sets included pictures to illustrate the concepts, which is also a recommended way to communicate risk [32]. An example of a choice set is shown in Figure 1.

Each man answered the unlabelled DCE which contained nine choice sets, consisting of three alternatives: two sets of alternative VMMC services with varying bundles of attribute levels and an opt-out option (i.e. would not attend the VMMC service). Prior to the DCE exercise, each attribute and its corresponding pictures were explained by the interviewer and a sample choice set was trialled to ensure the participant understood the DCE task. A range of background questions were also asked including age and details of their recent sexual behaviors: number of sexual partners in the preceding 12 months and whether a condom was used with the last sexual act. We created a “high sexual risk” variable for men who reported multiple partners and who had condomless sex. Data were also collected on sociodemographic factors including age, religion (Christian, Muslim, other), location (rural, urban), highest level of education attained (completed primary school, secondary school, or above secondary school) and circumcision status. For men who chose the ‘neither’ option, those who were not circumcised meant they would not attend a VMMC service, and those who were already circumcised would not choose the hypothetical VMMC options over their past VMMC service experience. We included both circumcised and uncircumcised men into the study to examine if there were key differences in preferences for VMMC service attributes between these two groups.

Figure 1 Example of a choice set administered by the interviewer to the participants using a paper form questionnaire. The English version presented here was translated in Swahili.



Statistical analysis

Descriptive statistics were used to summarize the socio-demographic characteristics of participants. Differences in characteristics by region were estimated using Pearson's χ-squared tests for categorical variables, and Wilcoxon rank-sum test for continuous variables. Polychoric principal components analysis (PCA) was used to create a wealth index from a series of socio-economic questions: whether the man or anyone in his household owned a

radio, television, mobile telephone, non-mobile telephone, refrigerator, bicycle, motorcycle, car, or agricultural land. In addition, participants were asked about what their homes were made of (cement blocks, bricks, or mud) and what their roof was made of (corrugated iron, thatch or grass). Effects coding was used to analyze categorical attributes [33] (e.g. 1 and -1 for a dichotomous variable), which imposes a central utility of 0, thus the utilities represent *relative* preferences. Consequently, utility value for the omitted levels are calculated as: – 1*∑coefficient of non-omitted levels in the attribute.

Several models were built to explore the effect of the preference for lottery on the choices men made between the set of alternatives. First, a multinomial logit (MNL) model was estimated for the main intervention effects [34].

$$\boldsymbol{U_i = V_i + \varepsilon_i}$$

$\boldsymbol{U_i}$ is the utility for choosing the alternative *i*. $\boldsymbol{V_i}$ is the observable component of the utility estimated by the analyst, and $\boldsymbol{\varepsilon_i}$ is error or unobserved component by the analyst representing heterogeneity in individuals or errors associated with measurement or model specification**.**

$$\boldsymbol{V_i = \beta_n x_{ni} + \beta_z Z_{ni} + \varepsilon_{ni}}$$

$\boldsymbol{\beta_n}$ are the coefficients to be estimated to describe the marginal impact of the service attribute $\boldsymbol{x_{ni}}$, and $\boldsymbol{\beta_z}$ are the coefficients to be estimated to describe the marginal impact of sociodemographic characteristics $\boldsymbol{Z_{ni}}$, and $\boldsymbol{\varepsilon_{ni}}$ is the random error term of the individual *n*. We conducted a latent class analysis (LCA) with interactions with risky sexual behaviors. The latent class model estimates separate parameter vectors and variances for each class, which allows for preference heterogeneity across the classes while assuming homogeneity within classes, to identify groups of men with similar preferences with one another.

To allow for unobserved heterogeneity across individuals, we used a random parameter logit (RPL) model, which relaxes the assumptions of Independence of Identically Distributed (IID) error components (i.e. homogenous preferences), and Independence of Irrelevant Alternatives (IIA) (i.e. proportional substitution). An RPL model accommodates correlated error terms across individuals that arises from the panel nature of the data, and allows more flexible variance-covariance structures for the unobservable components of the model. Rather than having a fixed β, the β'_n coefficients of an RPL model varies over decision makers in the population with density $f(\beta|\vartheta)$, where ϑ refers to the parameters of the distribution (e.g. mean and covariance of β).

$$\boldsymbol{V_i = \beta'_n x_{ni} + \beta_z Z_{ni} + \varepsilon_{ni}}$$

We sampled using normal distributions [35], and estimated the model with 1000 Halton draws. To assess model fit, different model specifications were compared using the log likelihood ratio test and Akaike's Information Criteron (AIC) [34]: the lower these values were, the better fit the model had to the data. More details of the statistical methods used are found here[36]. The DCE data were modelled using NLOGIT 5 software. Though we present the full model results, we focus our discussion on exploring the role of lotteries and sexual behavior on preferences for VMMC services.

Ethical approval was obtained from the London School of Hygiene and Tropical Medicine Research Ethics Committee, the Tanzanian National Health Research Ethics Committee and the Centers for Disease Control and Prevention Institutional Review Board.

RESULTS

Table 1 summarizes the sociodemographic characteristics of the study population by region. There were significant differences in the religion of men (96% Christians in Njombe compared to 51% in Tabora; p<0.001), wealth (men in Njombe were wealthier than those in Tabora; p<0.001) and proportion of men who reported sexually risky behaviors in the preceding 12 months (13% in Njombe compared to 24% in Tabora; p=0.01).

Table 1 Sociodemographic characteristics of men participating in the DCE in Tanzania, *N*=325.

	Njombe (*N*=159) n(%) or median [IQR]	**Tabora (*N*=166) n(%) or median [IQR]**	**P value**
Median age	27 [23-38]	26 [22-35]	0.38
Living in rural region	85 (54)	81 (49)	0.40
Religion			
- Christian	153 (96)	85 (51)	
- Muslim	2 (1)	40 (24)	
- Other	4 (3)	41 (25)	<0.001
Highest educational attainment			
- Primary education or no education	123 (78)	130 (79)	
- Secondary education	31 (20)	32 (19)	
- Above secondary education	4 (3)	3 (2)	0.28
Median wealth index*	4 [3-5]	1 [1-3]	<0.001
Sexually risky#	21 (13)	40 (24)	0.01
No condoms during last sex	67 (50)	96 (61)	0.05

Partners in last 12 months			
- One	81 (61)	77 (49)	
- Two	28 (21)	37 (24)	
- Three	15 (11)	25 (16)	
- Four or more	8 (6)	18 (11)	0.37
Circumcised	107 (67)	109 (66)	0.76

IQR = interquartile range
*wealth index was created using polychoric principal components analysis, resulting in quintiles with the highest number indicating higher relative wealth
[#] men who reported more than one partner in the last 12 months and no condoms used during their last sex

Table 2 summarizes the results from the random parameter logit model (RPL), with trade-offs between preferences consistent with the MNL model. Appendix 2 shows the main effects MNL and RPL models but the RPL model has a lower Akaike information criteria, indicating better model fit. In addition, the statistically-significant standard deviations suggest that preference heterogeneity exists among individuals. The RPL model shows that men preferred separate waiting areas for younger and older men, availability of HIV testing, male service providers, partner counselling in the community and transport voucher. Figure 2 highlights the strength of preferences for lotteries and transport vouchers. Consistent with economic theory, the higher the expected value, the greater the utility, irrespective of the payment mode. A sure pay-off (vouchers) were greatly preferred to the same expected value under uncertainty.

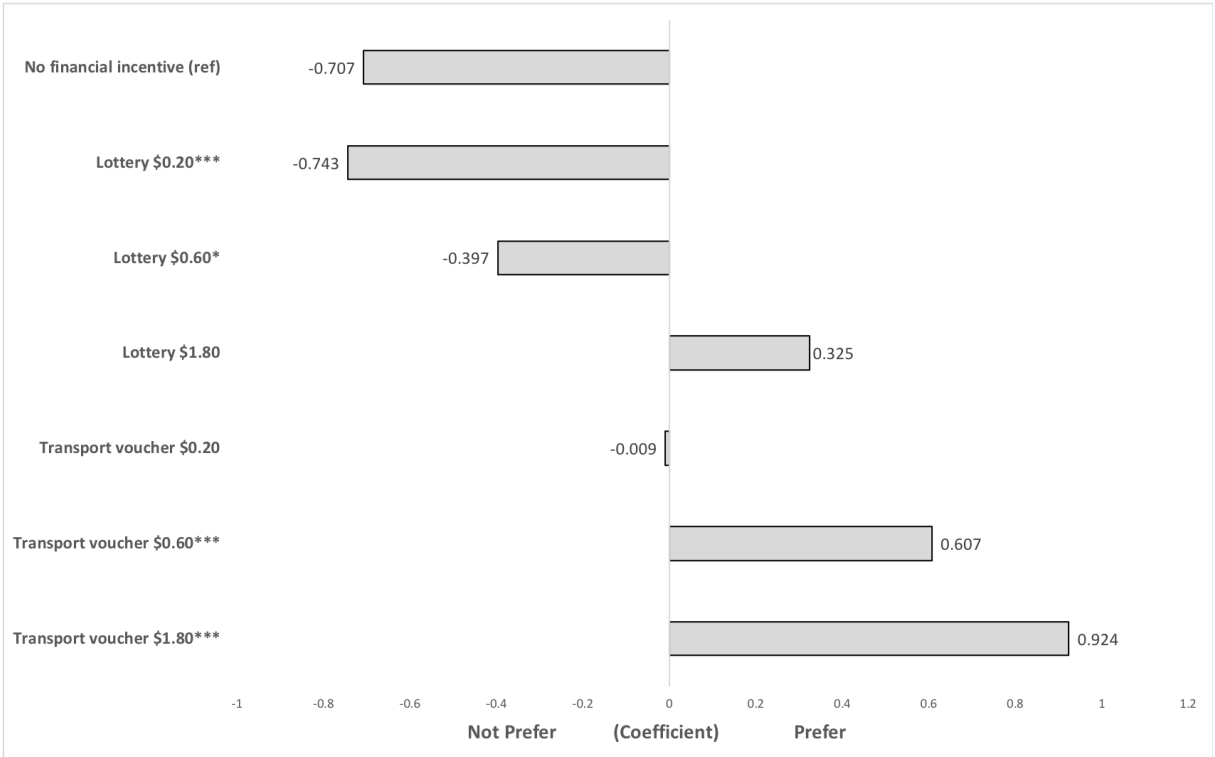
Table 2 Random parameter logit model of men's preference for VMMC service attributes in Tanzania, *N*=325.

	Coefficient		Standard error
Time of service			
Normal working hours and days (reference)	–0.019	n/a	
Extended hours and weekend service	0.019		*0.061*
Service separation			
Standard service with all clients together (reference)	–0.355	n/a	
Separate services for younger and older men	–0.037		*0.082*
Separate waiting areas for younger and older men	0.392	***	*0.102*
HIV testing			
Opt-out (reference)	0.523	n/a	
Opt-in	0.368	***	*0.125*
Not available	–0.891	***	*0.179*
Gender of service provider			
Either male or female (reference)	0.038	n/a	
Male only	0.403	***	*0.108*
Female only	–0.441	***	*0.105*
Partner counselling in the community			
Not available (reference)	–0.861	n/a	
Available	0.861	***	*0.139*
Financial incentive			
No financial incentive (reference)	–0.707	n/a	
Lottery[#] $USD 0.20	–0.743	***	*0.182*
Lottery[#] $0.60	–0.397	*	*0.220*
Lottery[#] $1.80	0.325		*0.251*
Transport voucher $0.20	–0.009		*0.186*
Transport voucher $0.60	0.607	***	*0.197*
Transport voucher $1.80	0.924	***	*0.337*
Opt out of alternatives presented	–6.898	***	*0.956*
Circumcised	–0.406		0.428
Interactions			
Sexually risky*Lottery[#] $0.20	–0.223		*0.158*
Sexually risky*Lottery[#] $0.60	0.418	**	*0.180*
Sexually risky*Lottery[#] $1.80	0.062		*0.208*
Sexually risky*Transport Voucher $0.20	0.112		*0.168*
Sexually risky*Transport Voucher $0.60	–0.228		*0.180*
Sexually risky*Transport Voucher $1.80	–0.341		*0.275*
Standard deviations			
Waiting areas by age	0.527	***	*0.089*
HIV testing opt in	0.313	***	*0.113*

No HIV testing	0.633	***	*0.110*
Male provider	0.588	***	*0.093*
Female provider	0.372	***	*0.119*
Partner counselling	0.850	***	*0.087*
Lottery[#] $0.20	0.361	**	*0.162*
Lottery[#] $0.60	0.215		*0.215*
Lottery[#] $1.80	0.261		*0.190*
Transport Voucher $0.20	0.171		*0.164*
Transport Voucher $1.80	0.419	**	*0.189*
Log-likelihood function	–1,953.1		
Akaike information criteria/N	1.384		

[#] Expected value for lottery e.g. expected value of lottery with one in ten chance of winning $2 is $0.20; * p value <0.10, ** p value <0.05, *** p value <0.01

Figure 2 Random parameters logit model showing utility coefficients of preferences for lottery and transport voucher for men in Tabora and Njombe, Tanzania (n=325).



ref = reference level, * p value <0.10, ** p value <0.05, *** p value <0.01

The latent class analysis grouped men into two classes (Table 3). Class 1 (containing 83.5% of the sample) were men who preferred the VMMC service over the option to not attend the

VMMC service (ß= –4.060, p<0.01). These men were more likely to live in Tabora and showed a preference for a transport voucher over a lottery ticket. Men belonging to Class 2 (containing 16.5% of the sample) were more likely to opt out of the VMMC service and were men with higher sexual risk behaviors. However, these men were ambivalent towards any financial incentives and preferred service attributes that potentially improved privacy i.e. male only providers and separate waiting areas.

For both the RPL and LCA models, we also examined for heterogeneity according to other demographics (age, wealth index, religion, rural/urban and education level) but did not find any statistically significant differences in preferences (data not shown).

Table 3 Latent class analysis of men's preference for VMMC services in Tanzania, *N*=325.

	Class 1			Class 2		
	Coefficient		SE	Coefficient		SE
Time of service						
Normal working hours and days (ref)	–0.009			0.082		
Extended hours and weekend service	0.009		*0.025*	–0.082		*0.115*
Service separation						
Standard service with all clients together (ref)	–0.213			–0.577		
Separate services for younger and older men	0.020		*0.037*	0.066		*0.158*
Separate waiting areas for younger and older men	0.193	***	*0.044*	0.511	***	*0.151*
HIV testing						
Opt-out (ref)	0.254			0.124		
Opt-in	0.282	***	*0.068*	0.430	**	*0.155*
Not available	–0.536	***	*0.100*	–0.554	***	*0.197*
Gender of service provider						
Either male or female (ref)	0.076			0.077		
Male only	0.214	***	*0.040*	0.764	***	*0.150*
Female only	–0.290	***	*0.038*	–0.687	***	*0.170*
Partner counselling in the community						
Not available (ref)	–0.487			–0.679		
Available	0.487	***	*0.058*	0.679	***	*0.138*
Financial incentive						
No financial incentive (ref)	–0.459			0.079		
Lottery[#] $0.20	–0.381	***	*0.101*	–0.207		*0.240*
Lottery[#] $0.60	–0.411	***	*0.136*	–0.290		*0.239*
Lottery[#] $1.80	0.270	*	*0.161*	–0.399		*0.358*
Transport Voucher $0.20	–0.166		*0.107*	0.202		*0.227*
Transport Voucher $0.60	0.381	***	*0.090*	0.417		*0.284*
Transport Voucher $1.80	0.766	***	*0.208*	0.198		*0.352*
Opt-out of alternatives presented	–4.015	***	*0.243*	1.870	***	*0.157*
Circumcised	–0.229		*0.237*	0.000		*0.128*
Percentage of men in the class	(83.7%)			(16.3%)		
Theta in class probability model						
Sexually risky	–0.489	**	*0.246*			
Living in Njombe	1.500	***	*0.482*			
Log Likelihood function	-2080.4					
Akaike information criteria/N	1.447					

Ref = reference level; SE= Standard error; [#] Expected value for lottery e.g. expected value of lottery with one in ten chance of winning $2 is $0.20; * p value <0.10, ** p value <0.05, *** p value <0.01

DISCUSSION

This study adds to the growing body of research that seeks to encourage the uptake of VMMC as part of HIV prevention strategies. According to our latent class analysis, we found that the majority of men preferred a transport voucher over participating in a lottery. There was no evidence from our study that men reporting higher sexual risk behavior preferred

participating in lotteries compared with men reporting lower sexual risk behavior. On the contrary, sexually risky men were ambivalent to financial incentives and preferred the provision of non-monetary incentives.

The majority of men (84%) in our study preferred the option of receiving a guaranteed transport voucher, suggesting that most men were financially risk-averse [37]. Our study revealed differential preferences for financial incentives with the same expected value, suggesting that lottery-based incentives need to much greater to give the same utility of receiving a guaranteed transport voucher. These findings are consistent with other research demonstrating that the psychological discomfort associated with participation in a risky gamble with the perception of potential loss results in people being more sensitive to losses than gains of an equal value [19]. These stated preferences of risk aversion to lotteries is borne out by real world examples of lotteries not making any statistically-significant difference in uptake of VMMC in Kenya [17] or in Tanzania [38]. This may be explained by the desire to offset the opportunity costs associated with VMMC [20], and avoid the regret of missing out on receiving a certain financial reward, albeit small. Our findings are consistent with other research reporting that people were averse to using lotteries to promote health behaviors [39, 40] which may be related to a perceived "unfairness" of an uncertain reward contingent on behavioral change [41].

Another explanation of our findings are that men's motivations for participating in VMMC may not be affected by the prospect of potential financial gain. Other motivators have been described, such as protecting their female partners from cervical cancer or sexually transmitted infections [2]. Therefore, program planners must be careful to avoid reward undermining, when offering a financial reward (i.e. an external motivation) may decrease their internal motivation to undergo circumcision. Our findings suggest that other non-

financial attributes of the VMMC services may have more impact on men's health seeking behaviors compared to the offer of a financial incentive, particularly for men who are more likely to opt-out of participating in VMMC and report higher sexual risk behaviors. In our study, men reported strong preferences for service attributes not related to financial incentives, such as the availability of age-specific services (i.e. VMMC services targeted to older men), HIV testing and partner counselling services. This is consistent with other studies reporting that providing men with the option of attending a VMMC service with these extra non-financial interventions increased the uptake of VMMC [30].

We did not find any supporting evidence that lottery-based incentives were preferred by sexually risky men, particularly for those living in Njombe. This supports the hypothesis that there may be a compartmentalization of risk behaviors: sexual risk and financial risk were treated differently by these men, a finding that is consistent with other research [42]. Whilst much research have focused on risk attitudes in the domain of financial mental accounting [26, 43], little, if any research have examined interactions between the mental accounting of finances with sexual and other risky behaviors. This is an area that warrants further research to confirm our findings.

Our conclusions are different from a study from Lesotho that evaluated the impact of low ($USD 50) and high ($USD 100) value lotteries where men were eligible for a lottery if they tested negative to syphilis and trichomoniasis in the week before the lottery draw [44]. They found that lotteries were most valued by those with ex ante risky sexual behaviors. However, unlike our study, there was no option of a certain financial reward (i.e. transport voucher). Other studies have found that when participants were offered options of either receiving a certain reward or participating in a lottery, most people preferred the certain reward [45]. Therefore, the Lesotho trial's finding that sexually risky men were more likely to

participate in the lottery may be due to the offer of any financial reward compared to no financial reward, rather than a preference for participation in a lottery over receiving a certain financial incentive. Further studies are needed to clarify whether using lotteries can attract sexually risky men to attend VMMC services.

These discrepancies between our findings and those from Lesotho underscore that context shapes risk attitudes, and accounting for how individuals' risk attitudes might vary across domains (e.g. finances, leisure, career, health, education)[46] is an important consideration when tailoring strategies that seek to improve uptake of health interventions among 'risky' individuals.

The strengths of the study include the use of a DCE to examine the preferences for participating in a lottery compared to the certainty of a transport voucher. This allowed us to explore how men traded off between the type of financial incentives, and the interaction of financial incentives with sexual risk behaviors. Beyond just predicting choices, a DCE reveals the relative importance of various VMMC attributes in comparison with offering financial incentives. In particular, by using the RPL model to account for the panel structure of the data, we provide more reliable standard errors and move away from proportional substitution. By allowing coefficients to vary randomly across individuals, the RPL model allowed for unobserved preference heterogeneity. As individuals may struggle to understand the concept of risk, we were meticulous in how we framed the risk of the lottery and communicated risk in a way that people understood lotteries (i.e. you have a 1 in 10 chance to win).

Our study has some limitations. First, inherent in stated preference research, we do not know how men will actually behave when faced with the choice of VMMC. Although this was part of an RCT, the final intervention package of the RCT did not include lotteries in their intervention arm, so we were not able to evaluate if the offer of transport vouchers over lotteries impacted VMMC uptake [30]. It is important to note however that although DCEs report stated preferences, they have been shown to provide accurate predictions of behavior [47, 48]. A recent systematic review and meta-analysis for the external validity of DCEs concluded that stated preferences from DCEs produce reasonable predictions of health-related behaviors [49]. DCEs have been successfully used to inform sexual health interventions but more research would be helpful to support their external validity in other settings [50-52]. Second, a potential reason for why we did not find an association between risky sexual behaviors with men who preferred a lottery may be due to only two questions that asked about men's sexual behavior, and there is a possibility of social desirability bias when reporting sexual behaviors. We did not ask whether condomless sex was with their regular or casual partner. There is a possibility that men in committed monogamous relationships may have different preferences to those who are not. Further sexual health information would help stratify sexual risk more accurately in future studies. Third, our sample included both circumcised and non-circumcised, to conceptualize hypothetical situations of their ideal VMMC service. The circumcised men perhaps had an advantage by being able to tie the hypothetical scenarios, such as having separate waiting areas or having all male health care providers, to their actual experiences. The reason for inclusion of circumcised men was also a pragmatic one as it was not possible for us to do a physical assessment to ascertain whether the men were circumcised or not. Previous studies have shown that self-report of circumcision status is not accurate, requiring a physical examination to be certain, which was

not part of the study protocol.[53] Nevertheless, we tested for preference heterogeneity by conducting an interaction analyses between those reporting to have already been circumcised and not, and found no statistically significant differences in preferences. Appendix 2 shows that men who opted out of VMMC did not differ significantly by circumcision status. Appendix 3 shows no significant effect of circumcision status on preferences, except that men who reported being circumcised less liked a male only circumcision service compared with a strong positive utility among men who reported being uncircumcised. Our results should be validated using independent samples in the future.

Our study findings can be used to inform demand creation strategies for VMMC services. In the setting of Tanzania, our study suggests that focusing on attributes of service modalities, such as offering services only for adult men, offering HIV testing and partner counseling, would be more effective at increasing uptake among adult clients compared to a lottery-based financial incentive. Indeed, a cluster-randomized controlled trial that promoted VMMC services with an intervention arm that included increased privacy in facilities and better engagement with female partners confirmed our findings by reporting increases in VMMC uptake using these interventions in Tabora [30]. For VMMC programs designed in other countries, we recommend that a DCE or other preference-based assessments are conducted to provide context-specific strategies to attract high-risk men to VMMC services. It is important to gather local data to examine how men may trade-off between financial incentives, and the costs and benefits of providing extra services. The World Health Organization encourages a patient-centred approach, recognizing the need to adapt interventions to different populations to maximize uptake, as we account for preference heterogeneities [54]. Finally, beyond applications for promoting VMMC services, our study highlights the potential role of financial-based incentives (lotteries or vouchers) to attract

individuals at higher risk for HIV and other infectious diseases, to participate in healthier behaviors (e.g. improving testing uptake, linkage to care).

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DECLARATION OF CONFLICTING INTERESTS

All authors declare they have no conflicting interests.

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Appendix 1 Sampling Procedure for formative study

We used a multistage cluster sampling design. At the first stage, we generated a list of all districts in the region that had received VMMC outreach services from MCHIP in the last 12 months. One district from each region was selected purposively into the study. In each selected district a list of all sites that had offered VMMC outreach campaign in the last twelve months was generated. We stratified the sites by residence (rural, urban).

In the second stage, we randomly selected one rural site and one urban site from each stratum to participate in the study. In the third stage, a list of all sub-villages/streets in the selected rural and urban sites was generated. Three sub-villages were selected randomly to participate in the study. The sub-village/mtaa leaders were then asked to develop a list of residents aged 18+ years who were then invited to meet the study team. When they presented, they were assessed for eligibility and consented if they were eligible and agreed to participate in the study. Some of these participants took part in the participatory group discussions (PGD) while others took part in the DCE or both. Circumcision status was not a criterion for selection.

The teams also visited the health facility and listed the names and telephone contacts of all men who were circumcised in the previous seven weeks and aged 20-34 years at the time of circumcision from the VMMC register. The aim was to select circumcised participants for in-depth interviews (IDI). From the list, four individuals were randomly selected, with two additional potential participants listed as a reserve in cases of refusals or unavailability. These potential participants were contacted and invited to talk to the study team at a convenient location. When the potential participants presented at the location, we provided information about the study, and we assessed the participant's comprehension. The individuals were then requested to provide consent if they were willing to take part in the study. We acknowledge and thanked anyone who refused to participate and replaced them with one of the participants in the reserve in the list. The men who consented for study participation were interviewed and then requested to bring in other men who were aged 18+ years for DCE. Again, circumcision status was not a criterion for participants referred by their peers.

This procedure continued until we reached 325 participants.

Sample size determination

Due to lack of optimal method for determining DCE the sample size, we determined the sample size using a method suggested by Johnson and Orme[55] that the sample size required for the main effects depends on the number of choice tasks (t), the number of alternatives (a), and the number of analysis cells (c) according to the following equation:

$$N > \frac{500c}{(t \times a)}$$

Therefore N>100 based on the calculations below:

$$N > \frac{500 \times 6}{(16 \times 2)}$$

Based on the aforementioned method, we got a sample size of 325 participants which would yield reasonably precise estimates of utility levels, given the use of 16 choice tasks, two active alternatives, and a maximum number of levels within a single attribute of six. We continued recruitment until we reached this goal.

634 **Appendix 2 Men's preference for VMMC service attributes in Tanzania comparing outputs from the MNL and RPL models, *N*=325.**

	MNL		RPL	
	Coefficient	*Standard error*	Coefficient	*Standard error*
Time of service				
Normal working hours and days (reference)	–0.001		–0.019	
Extended hours and weekend service	0.001	*0.024*	0.019	*0.061*
Service separation				
Standard service with all clients together (reference)	–0.227		–0.355	
Separate services for younger and older men	0.032	*0.035*	–0.037 ***	*0.082*
Separate waiting areas for younger and older men	0.195 ***	*0.039*	0.392 ***	*0.102*
HIV testing				
Opt-out (reference)	–0.141		0.523	
Opt-in	0.147 ***	*0.043*	0.368 ***	*0.125*
Not available	–0.288 ***	*0.054*	–0.891 ***	*0.179*
Gender of service provider				
Either male or female (reference)	0.065		0.038	
Male only	0.245 ***	*0.037*	0.403 ***	*0.108*
Female only	–0.310 ***	*0.036*	–0.441 ***	*0.105*
Partner counselling in the community				
Not available (reference)	–0.354		–0.861	
Available	0.354 ***	*0.032*	0.861 ***	*0.139*
Financial incentive				
No financial incentive (reference)	–0.162		–0.707	
Lottery[#] $USD 0.20	–0.176 **	*0.069*	–0.743 ***	*0.182*
Lottery[#] $ 0.60	–0.126	*0.077*	–0.397 *	*0.220*
Lottery[#] $ 1.80	–0.126	*0.092*	0.325	*0.251*
Transport voucher $ 0.20	0.077	*0.070*	–0.009	*0.186*
Transport voucher $ 0.60	0.270 ***	*0.077*	0.607 ***	*0.197*
Transport voucher $ 1.80	0.243 ***	*0.109*	0.924 ***	*0.337*
Opt out of alternatives presented	–1.239 ***	*0.061*	–6.898 ***	*0.956*
Circumcised	–0.093	*0.059*	–0.406	*0.428*
Log likelihood function	–2645.6		–1940.0	
Akaike information criteria/N	1.820		1.379	

635 [#] Expected value for lottery e.g. expected value of lottery with one in ten chance of winning $2 is $0.20; * p value <0.10, ** p value <0.05, *** p value <0.01

Appendix 3 Men's preference for VMMC service attributes in Tanzania (MNL model of interactions with circumcision status), *N*=325.

	Coefficient		Standard error
Time of service			
Normal working hours and days (reference)	-0.005		
Extended hours and weekend service	0.005		
Service separation			
Standard service with all clients together (reference)	-0.321		
Separate services for younger and older men	0.177	***	0.041
Separate waiting areas for younger and older men	0.144	***	0.046
HIV testing			
Opt-out (reference)	0.116		
Opt-in	0.144	***	0.046
Not available	-0.260	***	0.058
Gender of service provider			
Either male or female (reference)	0.045		
Male only	0.288	***	0.040
Female only	-0.333	***	0.039
Partner counselling in the community			
Not available (reference)	-0.347		
Available	0.347	***	0.035
Financial incentive			
No financial incentive (reference)	-0.167		
Lottery# $USD 0.20	-0.151	**	0.073
Lottery# $ 0.60	-0.094		0.082
Lottery# $ 1.80	-0.144		0.097
Transport voucher $ 0.20	0.095		0.074
Transport voucher $ 0.60	0.271	***	0.083
Transport voucher $ 1.80	0.190		0.117
Opt out of alternatives presented	-1.231	***	0.061
Interactions			
Time of service			
Extended hours and weekend service*Circumcision	-0.021		0.025
Service separation			
Separate services for younger and older men*Circumcision	-0.023		0.037
Separate waiting areas for younger and older men*Circumcision	0.053		0.041
HIV testing			
Opt-in*Circumcision	0.006		0.046
Not available *Circumcision	-0.079		0.058
Gender of service provider			
Male only*Circumcision	-0.125	***	0.040
Female only*Circumcision	0.065	*	0.038
Partner counselling in the community			
Available*Circumcision	0.033		0.035
Financial incentive			
Lottery# $USD 0.20*Circumcision	0.032		0.090
Lottery# $ 0.60*Circumcision	0.021		0.096
Lottery# $ 1.80*Circumcision	0.185		0.120
Transport voucher $ 0.20*Circumcision	-0.317	*	0.180
Transport voucher $ 0.60*Circumcision	-0.300	*	0.169
Transport voucher $ 1.80	0.140		0.177
Log likelihood function	-2633.6		

Akaike information criteria/N	1.822

[#] Expected value for lottery e.g. expected value of lottery with one in ten chance of winning $2 is $0.20;

* p value <0.10, ** p value <0.05, *** p value <0.01