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ORIGINAL PAPER

Identification of Key Beliefs Explaining Male Circumcision Motivation Among Adolescent Boys in Zimbabwe: Targets for Behavior Change Communication

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Abstract Male circumcision (MC) significantly reduces HIV acquisition among men, leading WHO/UNAIDS to recommend high HIV and low MC prevalence countries circumcise 80% of adolescents and men age 15–49. Despite significant investment to increase MC capacity only 27% of the goal has been achieved in Zimbabwe. To increase adoption, research to create evidence-based messages is greatly needed. The Integrated Behavioral Model (IBM) was used to investigate factors affecting MC motivation among adolescents. Based on qualitative elicitation study results a survey was designed and administered to a representative sample of 802 adolescent boys aged 13–17 in two urban and two rural areas in Zimbabwe. Multiple regression analysis found all six IBM constructs (2 attitude, 2 social influence, 2 personal agency) significantly explained MC intention ($R^2 = 0.55$). Stepwise regression analysis of beliefs underlying each IBM belief-based construct found 9 behavioral, 6 injunctive norm, 2 descriptive norm, 5 efficacy, and 8 control beliefs significantly explained MC intention. A final stepwise regression of all the significant IBM construct beliefs identified 12 key beliefs best explaining intention. Similar analyses were carried out with subgroups of adolescents by urban–rural and age. Different sets of behavioral, normative, efficacy, and control beliefs were significant for each sub-group. This study demonstrates the application of theory-driven research to identify evidence-based targets for the design of effective MC messages for interventions to increase adolescents' motivation. Incorporating these findings into communication campaigns is likely to improve demand for MC.

Keywords Voluntary medical male circumcision · Adolescent boys · Integrated Behavioral Model · Evidence based demand creation · Behavior change communication · Issues to focus communication campaigns · Behavioral theory

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Introduction

Adult medical male circumcision (MC) has been demonstrated to reduce HIV incidence among men by at least 60% [1–4]. The Zimbabwe Ministry of Health and Child Care (MOHCC) began a National MC Programme in 2009 with a goal to circumcise 80% of adolescents and men aged 15–49 by 2015. This translated to over 2.5 million circumcisions [5].

Although initial studies of willingness to get circumcised to prevent HIV found MC acceptability was high [6], MC uptake in sub-Saharan Africa has been challenging. As of the end of 2014, 14 priority countries had achieved an average of 44% of their 2015 targets [7–9]. In Zimbabwe,

while a cumulative total over 600,000 circumcisions have been conducted, only 353,032 adolescents and men aged 15 and older were circumcised by the end of 2015, achieving only 27% of the goal [8, 10, 11]. A total of 41% of circumcisions occurred among boys aged 14 and under [9]. Recent studies have found MC acceptability to be higher among younger men [12, 13]. Because men over age 18 have been slower to adopt circumcision in many countries [12, 14, 15], country programs began to focus on adolescent boys [16, 17]. Based on modeling of impact and cost-effectiveness, in 2014, Zimbabwe shifted its priority target ages to circumcise 80% of boys and men aged 13–29 by 2017 [5, 18].

Targeting adolescents for circumcision is important because it provides a number of benefits. Adolescent HIV prevalence rates in Zimbabwe are 3.4% among 15–19 year olds and since the median age of sexual onset among men is 20.6, adolescents are unlikely to be sexually active [19]. Data from a recent cohort study of adult men shows mean age of sexual onset as 19.3 (SD 3.2) [20]. Thus, the MC procedure is unlikely to interrupt their sex lives, a potential barrier for adult men Additionally, resuming sexual activity prior to full healing is unlikely to be a risk factor for adolescent boys, while this risk behavior has been observed among adult men [21, 22]. Adolescents will also have the benefit of protection conferred by MC for their entire sexual lives.

Despite the advantages of adolescent circumcision, only four studies have been carried out to identify factors specifically associated with MC acceptance or motivation among adolescent boys. One survey in Botswana asked boys age 13–18 to select the main reason they would, and main reason they would not, want to be circumcised [13]. Motivation for circumcision was associated with the percentage of boys who selected 'protection from other illnesses' as the main reason for circumcision, and who selected 'concern about health problems during/after procedure' as the main reason for not getting circumcised. A survey in Rwanda also asked respondents about the main reason to get circumcised and main reason to not get circumcised, and concluded that boys under age 19 were afraid of pain [12]. A qualitative study within the context of an MC program roll out in schools in South Africa found boys' reported MC facilitators were reduction in HIV acquisition, better hygiene, and improved sexual desirability and performance, while barriers related to pain, complications, healing, and timing [23]. There are four important limitations of these studies. First, in the surveys, lists of reasons were not based on direct input from adolescent boys. Second, respondents were asked to select from a list of facilitators and barriers the *one* main factor affecting their MC motivation. Our survey of adult men found that multiple factors affect motivation to get circumcised, and they vary among different groups of men [24]. Third, the research in South Africa used convenience samples. Lastly, all four studies asked adolescents to declare what is affecting their willingness to get circumcised. Unfortunately, people are not very good judges of what actually affects their motivation or behavior [25]. A more appropriate approach would be to measure belief strengths with respect to outcomes of MC and then empirically determine which outcome beliefs are the strongest in explaining motivation. One study used this method to identify beliefs that best explain MC intention among males aged 13–29 in Swaziland [26]. This study was limited because beliefs measured in the survey were not developed with input from target group adolescents, and since few participants were under age 18, analyses could not be conducted separately for adolescents.

A major reason that research has shown that demand creation in this group, and among adult men in general, have not been successful in translating acceptability of circumcision to adoption is that communication interventions have not been evidence-based [14, 15, 27, 28]. Evidence-based information targeting applicable issues for MC communication strategies are needed to increase demand and uptake of MC.

To overcome the barriers to circumcision among adolescent boys, there is a need to develop evidence-based MC communication messages focused on issues that are *specifically* relevant to them. However, detailed information about what issues drive adolescents' circumcision intentions is lacking. Developing messages without a strong evidence basis to encourage adolescents to adopt MC, will run into the same fundamental obstacles of communication campaigns among adult men which failed to quickly generate the needed high circumcision uptake. To provide a base for effective circumcision messages, we conducted rigorous behavioral theory driven research in Zimbabwe to identify beliefs best explaining MC motivation. Once identified, these beliefs can be targeted in communication campaigns to increase motivation for MC. Results of research among adult men have been reported previously [24]. This paper presents the results of our survey of adolescent boys age 13–17, which identified behavioral model constructs and key beliefs that predict intention, that can be the basis for messages to increase MC motivation among adolescents.

Methods

Theoretical Framework

We applied the Integrated Behavioral Model (IBM) as the theoretic framework for this study to identify and

understand the specific factors that best explain adolescent boys' level of motivation to uptake MC (see Fig. 1) [29, 30]. This model includes constructs from several well established theories, including the Theory of Reasoned Action, Theory of Planned Behavior, Health Belief Model, and Social Cognitive Theory [31, 32]. Decades of research has shown that the strongest determinant of behavior is one's motivation or intention to engage in that behavior [31]. The IBM focuses on three constructs that are determinants of intention: attitude, social influence and personal agency. Each of these constructs is in turn composed of two components. Attitude includes: (1) experiential attitude, one's emotional or affective response to the idea of performing the behavior, and (2) instrumental attitude, cognitively based beliefs about positive or negative consequences or attributes of the behavior. These components capture the 'thinking fast (emotional) and thinking slow (cognitive)' aspects of attitudes [33]. Social influence is captured by two normative components: (1) beliefs about other's expectations for the person to engage in the behavior (injunctive norm), and (2) beliefs about what others are doing regarding the behavior (descriptive norm). Personal agency consists of: (1) beliefs about self-efficacy to accomplish the behavior despite obstacles or barriers, and (2) perceived control consisting of beliefs about the effect of facilitators and barriers on the performance of the behavior. Other factors including a person's characteristics and experiences are considered to impact intention indirectly via these key constructs. Our primary goal was to identify the key beliefs underlying the five belief-based components that best explain MC motivation because these beliefs may be most conducive to change. Key beliefs predicting intention can be targeted with relevant persuasive messages using appropriate channels to change behavior.

Study Design

The study consisted of two phases: (1) a questionnaire development phase, and (2) a representative sample cross-sectional survey of adolescent boys in Zimbabwe. The survey allowed us to quantitatively measure the issues that were identified in the qualitative phase to explain circumcision intention.

Questionnaire Development

The survey questionnaire for this study was developed by carrying out a qualitative elicitation study [30]. A representative sample of 32 adolescent boys aged 13–17, recruited through household based sampling from four urban and rural areas of Zimbabwe representing both Shona and Ndebele ethnic groups, participated in interviews designed to elicit specific issues with respect to each of the IBM constructs. Participants were asked questions to elicit: (1) feelings about getting circumcised; (2) positive

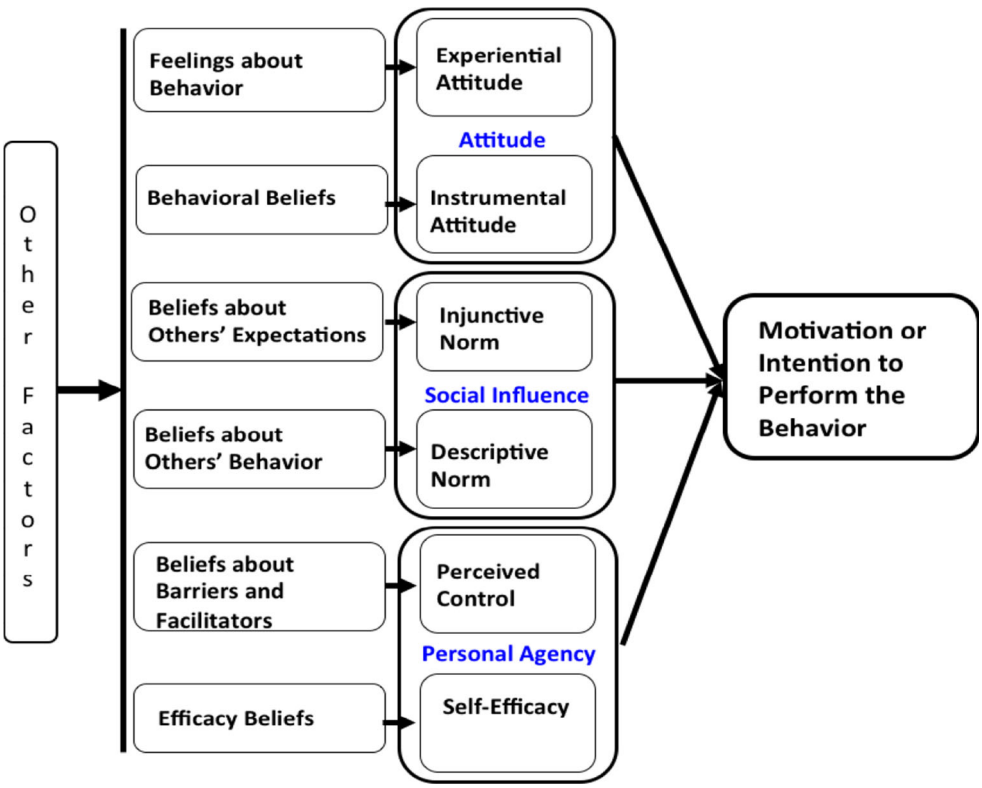

Fig. 1 Integrated Behavioral Model

and negative beliefs about getting circumcised; (3) sources of normative influence about getting circumcised; and (4) factors that may make it easier or harder to get circumcised. Interview responses were content analyzed to identify specific issues with respect to each IBM construct. The content analysis resulted in the identification of 19 feelings expressed, 39 positive and negative beliefs about getting circumcised, 21 sources of normative influence, 18 facilitators and 19 constraints.

The quantitative questionnaire was designed based on the qualitative results. Examples of construct measures are shown in Table 1. Feelings about getting circumcised were assessed with 19 adjective pairs (e.g., good/bad, healthy/unhealthy) measured on 5-point bipolar semantic differential scales. The 39 positive and negative behavioral beliefs about getting circumcised were measured on 5-point bipolar agree-disagree scales. Of these, five beliefs were answered only by boys age 16 and 17 because they focused on sexual pleasure and girlfriends. In Zimbabwe these questions would either be irrelevant or hypothetical for most boys below age 16, given average age of sexual onset. Injunctive norm beliefs were measured by asking respondents to rate how strongly they agree or disagree that each of the 21 sources of influence would encourage them to get circumcised. Two of these beliefs were only asked of boys age 16 and 17, as they asked about girlfriends and girlfriends' family. Descriptive norm beliefs were measured by asking respondents to rate how strongly they agree versus disagree that each of four types of people (people like you, closest male friends, brothers, other male relatives) would get circumcised. Injunctive and descriptive normative beliefs were measured on five-point bipolar agree–disagree scales. Control beliefs were assessed by asking respondents to rate how difficult versus easy each of the 37 facilitators or barriers make it to get circumcised. Ratings were made on five-point scales ranging from 'extremely difficult' to 'extremely easy'. Efficacy beliefs were measured for each of the 19 barriers. Respondents rated their degree of certainty that they could get circumcised if they wanted to, if faced with each barrier. Ratings were made on 5-point scales ranging from 'extremely certain I could not' to 'extremely certain I could'. Control beliefs and efficacy beliefs concerned with girlfriends were asked only of boys age 16 and 17. Finally, Intention to get circumcised was measured by asking boys to rate how strongly they agree versus disagree that they will get circumcised if the MOHCC began a national MC program with MC offered to boys age 13–17 at no cost. This rating was made on a five-point scale ranging from 'strongly disagree' to 'strongly agree'. Qualitative interviews and quantitative surveys were translated to Shona and Ndebele and back-translated to ensure translation validity.

Sampling Procedures

The sample of adolescent boys for the quantitative survey was enrolled through schools since nearly all adolescent males age 13–17 in Zimbabwe are in school. The goal was to recruit 800 boys of approximately equal numbers across the 5-year age range. The sampling strategy was designed

Table 1 Measures of IBM constructs

IBM construct	Measure	Example of question	Response scale				
			−2	−1	0	+1	+2
Experiential attitude	Affect	Your getting circumcised would be (good/bad; healthy/unhealthy; smart/out of step, etc.):	Extremely bad	Quite bad	Neither/not sure	Quite good	Extremely good
Instrumental attitude	Behavioral belief	If you were to get circumcised, *it would give you peace of mind*	Strongly disagree	Somewhat disagree	Neither/not sure	Somewhat agree	Strongly agree
Injunctive norm	Normative belief	How strongly do you agree or disagree that *your mother* would encourage you to get circumcised?	Strongly disagree	Somewhat disagree	Neither/not sure	Somewhat agree	Strongly agree
Descriptive norm	Descriptive belief	How strongly do you agree or disagree that *your closest friends* would get circumcised?	Strongly disagree	Somewhat disagree	Neither/not sure	Somewhat agree	Strongly agree
Perceived control	Control belief	*If people describe circumcision as painful*, how much would this make it easy or difficult for you to get circumcised?	Extremely difficult	Quite difficult	Neither/not sure	Quite easy	Extremely easy
Self-efficacy	Efficacy belief	*If you wanted to get circumcised*, how certain are you that you could get circumcised *if you would be attended to by female nurses*?	Extremely certain I could not	Quite certain I could not	Neither/not sure	Quite certain I could	Extremely certain I could

to recruit boys from randomly selected classes in randomly selected schools to efficiently obtain a representative sample with minimal clustering. Respondents were recruited using a four-stage probability sampling strategy. Four geographic areas in Zimbabwe: Harare, Bulawayo, Mutoko District, and Matobo District, were selected at the first stage and included urban and rural areas representing both main ethnic groups in Zimbabwe. Harare and Bulawayo are Zimbabwe's two largest cities, with Harare in the Shona ethnic area and Bulawayo in the Ndebele ethnic area. Mutoko and Matobo Districts are rural areas, with Mutoko being primarily Shona and Matobo being Ndebele. Approximately 200 adolescent boys were to be recruited from each of these four geographic areas.

For the second stage, the Ministry of Education provided a listing of all public/government schools teaching upper grades (Forms 1–5), that are boys only or mixed gender schools in each of the four study sites. This provided a school sampling frame of 45 schools in Harare, 30 in Bulawayo, 44 in Mutoko, and 20 in Matobo. In Zimbabwe, Forms 1–5 generally correspond to ages 13–17, in urban areas. In rural areas most schools include only Forms 1–4, and Form 4 tends to include 17 year olds. To select approximately equal numbers of boys per Form per school, the sampling strategy selected slightly more schools in rural than urban areas. We randomly selected eight schools in each urban site and ten schools in each rural site, with alternates identified in the event that selected schools were unable to participate. The Headmaster of each school was contacted and asked for permission to randomly select boys in the school and to conduct interviews on MC.

At the third sampling stage, one class per Form was randomly selected from each school and rosters acquired. In schools with Forms 1–5, five classes were selected. In schools with Forms 1–4, four classes were selected. Finally, in the fourth sampling stage, from each selected class roster, five boys were randomly selected and recruited, with two exceptions regarding Form 5. In the two urban sites, a few schools did not include Form 5 classes. Therefore, in urban schools with Form 5, proportionately more boys were recruited from the selected Form 5 class in order to include approximately equal numbers per Form. In the two rural sites, four of the 20 schools selected included Form 5 classes. In these four schools we selected four (rather than five) students per class in each of Forms 1–5. If any selected student was absent or declined to participate, another student was randomly selected to replace him. These sampling procedures resulted in 202 boys participating in the survey in Harare, and 200 boys participating in each of the other three sites, for a total of 802 survey participants. Boys were interviewed by a multi-lingual trained and experienced study team, and chose the language they preferred for the interview.

All sampling, recruitment, and survey procedures were reviewed and approved by the Institutional Review Boards of the US and Zimbabwe collaborating institutions. The Headmaster of each school, as "loco parentis," provided consent for all boys in the school to participate in the survey. All boys signed an informed assent form if they agreed to participate, and received a $3 incentive.

Analytic Procedures

Descriptive analyses were carried out on demographic, MC knowledge and HIV risk perception measures. Means are reported for continuous variables. Percentages are reported for categorical variables (Table 2).

Our primary analytic goal was to identify IBM measures, and their concomitant beliefs, that best explain MC motivation. This analysis determines which constructs drive intention, providing a method to target relevant constructs and beliefs in communication campaigns and interventions. We applied an analytic strategy that has been used and described in prior publications [24, 29, 34–36]. We first carried out internal consistency analyses and computed Cronbach's alpha for the questionnaire items measuring each IBM construct. Construct scores were then computed by taking the mean of the items underlying each construct. Before computing experiential attitude, items were recoded so positive adjectives in each pair were associated with higher scores. Experiential attitude was then computed as a mean of the 19 items (Cronbach's $\alpha = 0.94$). Before computing instrumental attitude, behavioral beliefs concerning negative outcomes were reflected so a higher score was associated with greater disagreement that the outcome will occur, indicating a more positive attitude. Instrumental attitude toward getting circumcised was then computed as the mean of the 34 and 39 behavioral beliefs for the younger and older groups respectively (Cronbach's $\alpha = 0.88$, $\alpha = 0.77$). Injunctive Norm was computed as the mean of the 18 and 20 normative beliefs for younger and older boys respectively (Cronbach's $\alpha = 0.96$, $\alpha = 0.96$). Descriptive Norm was computed as the mean of four descriptive norm beliefs (Cronbach's $\alpha = 0.91$, $\alpha = 0.92$). Perceived Control was computed as the mean of the 36 and 37 control beliefs for the younger and older boys respectively (Cronbach's $\alpha = 0.93$, $\alpha = 0.93$). Self-efficacy was computed as the mean of the 18 and 19 efficacy beliefs that assessed behavioral certainty under various constraints (Cronbach's $\alpha = 0.92$, $\alpha = 0.93$).

After confirming internal consistency of the constructs, the IBM model was tested by regressing MC intention on the computed IBM constructs and including perceived risk of HIV acquisition. A three-step hierarchical regression was used. At step 1, forward stepwise regression was used with

Table 2 Respondent characteristics

Characteristic	Study sites				
	All N = 774	Harare N = 199	Mutoko N = 198	Bulawayo N = 183	Matobo N = 194
Age (%)					
13	18.5	12.1	16.2	23.0	23.2
14	19.8	15.6	22.2	20.8	20.6
15	19.5	20.6	19.7	19.1	18.6
16	21.4	21.3	23.7	19.1	21.1
17	20.8	30.2	18.2	18.0	16.5
Age [mean (sd)]	15.1 (1.4)	15.4 (1.4)	15.1 (1.4)	14.9 (1.4)	14.9 (1.4)
Years of school [mean (sd)]	9.5 (1.4)	9.8 (1.4)	9.3 (1.4)	9.6 (1.5)	9.2 (1.3)
Ethnicity (%)					
Shona	62.6	95.5	99.0	44.8	8.8
Ndebele	33.0	1.5	0	47.5	85.1
Other	4.3	3.0	1.0	7.6	6.1
Religion (%)					
Christianity	95.1	98.5	91.4	98.4	92.3
Other	0.7	0.5	0.5	0.5	1.5
None	4.1	1.0	8.1	1.1	6.2
Knowledge of circumcision (%)					
Surgical removal of foreskin	84.5	83.4	76.3	97.3	82.0
Teaching about sex and STIs	64.6	65.8	55.1	69.4	68.6
Rite of passage	37.3	36.7	38.4	22.4	51.5
Seen/heard MC promotional info from any source (%)	60.6	67.8	38.9	90.7	46.9
Billboard advert	15.2	28.6	2.5	30.1	0.5
TV or radio	34.6	53.3	18.7	57.4	10.3
Flyer	6.8	5.5	3.5	14.2	4.6
Health clinic	7.4	4.5	7.1	14.2	4.1
Perceived risk of HIV acquisition (5-point scale) [mean (sd)]	2.5 (1.2)	2.3 (1.2)	2.7 (1.2)	2.4 (1.2)	2.6 (1.2)

the five belief-based components of the IBM constructs. This analysis identifies the significant constructs that include mutable beliefs driving motivation, indicating which ones should be targeted in interventions. At step 2, experiential attitude was entered to test if additional variance was explained by affect [37]. This analysis determines whether attitudinal interventions should include both emotion-based and cognitive-based messages. At step 3, the effect of perceived HIV risk was tested as many implementers speculate that HIV risk is an important driver of intention. The entry criterion for the regression equation was an F-value with $p < 0.05$. The potential impact of clustering by school and ethnicity were assessed using mixed effects models and no significant clustering was found.

Analyses were next carried out to identify specific beliefs underlying the five belief-based IBM components (instrumental attitude, injunctive norm, descriptive norm, self-efficacy, perceived control) best explaining MC intention. This analysis specifies which beliefs will be the best foci for intervention messages. For each IBM construct component significantly associated with intention, we conducted forward stepwise regression using the beliefs making up the construct as the independent variables. This identified the beliefs underlying each IBM construct providing significant independent contribution to explaining MC motivation. The variance inflation factor was used to check for multicollinearity but no belief items were found to be entirely subsumed by other beliefs underlying each construct. After the strongest belief predictors of intention from within each construct were identified, they were then included as independent variables in a final stepwise regression analysis. This resulted in an overall final model of key mutable beliefs across the IBM belief-based constructs best explaining MC motivation, providing important information for communication strategies that may use wide-ranging communication approaches.

The analytic procedure was first carried out for the total sample of all adolescent boys to identify the most important beliefs to target in communication campaigns that would include a broader based mass media approach for wider reach. The same analytic procedure was next conducted separately with four subsamples: younger boys aged 13–15, and older boys aged 16–17, in urban versus rural locations. The results to these subsample analyses can point to whether adolescent audiences need to be segmented by these demographic factors. The age split chosen was applied because older boys are likely to be in a different life stage than younger boys, possibly having girlfriends and considering what they will do after finishing secondary school. We expected that the drivers of MC motivation would be different for younger versus older boys. We also split groups by urban and rural location because we found urban–rural differences in determinants of MC motivation among adult men [24].

Results

Survey Sample Participants

Of the 36 schools initially selected at the second stage of sampling, the Headmasters of one school in Harare and three schools in Bulawayo declined to participate because they chose not to act as loco parentis, while four rural school Headmasters (1 in Mutoko, 3 in Matobo) declined because they are small annex schools with few boys in the age range required. These schools were replaced by alternate schools as noted previously. At the fourth stage of sampling a total of 951 boys were randomly selected from schools, with replacement of those who were unavailable or declined. Of these, 145 boys were absent from the school at the time the interview team visited to conduct interviews, resulting in an adjusted sample size of 806 who were asked to participate. Of these, 802 boys participated in interviews for a survey participation rate of 99.5%.

Sample Characteristics

After ensuring that boys understood what circumcision is, each boy was asked whether he was circumcised. Three percent [27] of boys reported that they were circumcised, so they did not complete the survey questions on beliefs and motivation to get circumcised. The 775 uncircumcised boys were asked the IBM questions to assess factors concerning their motivation to get circumcised. One boy was dropped from the analysis because the data on the dependent variable, intention to get circumcised, was missing. Table 2 presents demographic and other characteristics of the survey participants by study site and total sample.

Participants were on average aged 15 with 9.5 years of education. The largest difference in the age distribution of participants across sites was in Harare where 30.2% of the respondents were 17 years old compared to 18% in Mutoko and Bulawayo and 16.5% in Matobo. This is most likely due to the sampling strategy where we selected more students from Form 5 in urban schools to adjust for fewer rural Form 5 classes, in order to have approximately equal age distribution in total across sites. Although half of the participants were selected from Shona areas and half from Ndebele areas of the country, 63% of participants were Shona, 33% Ndebele, and 4% of other ethnicity. The unequal distribution is due to greater heterogeneous mix of ethnicities in Bulawayo, the largest city in the Ndebele region. This distribution closely approximates national ethnic distributions in Zimbabwe [19]. Knowledge of MC varied across sites with over 97% of respondents in Bulawayo but closer to 80% in other sites being aware that MC involves the surgical removal of the foreskin. Exposure to MC information also varied by site with those in the urban settings being much more likely than rural areas to have seen/heard any promotional information about MC and also much more likely to have seen/heard information about MC on a billboard or on radio/TV. In all sites the number of participants who had heard about MC via a health clinic was low, ranging from 4.1% in Matobo to 14.2% in Bulawayo. Risk of HIV acquisition was also assessed, and generally shows that boys tended to have mid-range perceptions of risk of HIV acquisition.

Multiple Regression Results: Overall Sample

On the first step of regression analysis for the overall sample of 774 survey participants, the five computed belief-based IBM constructs were used as independent variables to explain MC intention (Table 3). The purpose of this analysis is to determine which constructs should be incorporated into or the foci of interventions. For example, if attitudes are significant, but norms are not, this indicates that norm-based interventions will not motivate adolescents. Intention to get circumcised was significantly explained ($R = 0.69$, $p < 0.001$) by instrumental attitude ($\beta = 0.24$, $p < 0.001$), injunctive norm ($\beta = 0.12$, $p < 0.007$), descriptive norm ($\beta = 0.17$, $p < 0.000$), self-efficacy ($\beta = 0.18$, $p < 0.000$), and perceived control ($\beta = 0.12$, $p < 0.006$). In the second step, experiential attitude ($\beta = 0.46$, $p < 0.000$) entered and increased the variance accounted for by 5%. Perceived risk did not enter and had zero correlation with intention and all IBM constructs. The analysis revealed not only that all IBM constructs play a significant role in explaining circumcision motivation, but reveal their importance as well. Perceived

Table 3 IBM constructs explaining MC intention

Step	IBM constructs	All N = 774 (R = 0.69) β (p)	Young urban N = 211 (R = 0.71) β (p)	Young rural N = 236 (R = 0.70) β (p)	Older urban N = 171 (R = 0.67) β (p)	Older rural N = 156 (R = 0.67) β (p)
1	Attitude (instrumental)	0.24 (0.000)	0.30 (0.000)	0.31 (0.000)	0.26 (0.003)	NS
	Injunctive norm	0.12 (0.007)	0.32 (0.000)	0.23 (0.000)	NS	NS
	Descriptive norm	0.17 (0.000)	NS	NS	0.26 (0.001)	0.46 (0.000)
	Self efficacy	0.18 (0.000)	0.20 (0.002)	0.28 (0.000)	NS	NS
	Perceived control	0.12 (0.006)	NS	NS	0.26 (0.004)	0.29 (0.000)
2	Attitude (experiential)	(R = 0.74)	(R = 0.77)	(R = 0.73)	(R = 0.76)	(R = 0.73)
		0.46 (0.000)	0.50 (0.000)	0.35 (0.000)	0.70 (0.000)	0.40 (0.000)
3	Perceived risk	NS	NS	NS	NS	NS

risk for HIV does not enter as an important predictor, thus was dropped from further analyses.

We next conducted regression analyses on the beliefs underlying the five IBM belief-based constructs that were significant, to identify specific beliefs that best explain MC intention. These analyses identified beliefs that most strongly predicted intention, which can be targets for messages to increase motivation. Five separate stepwise regression analyses were carried out with the beliefs underlying each model construct. Results for the total sample of boys are shown in the first column of Table 4. The belief items that were only asked of older boys were excluded from these analyses in order to conduct the analyses on the total sample.

Behavioral Beliefs

All but two of the 34 behavioral beliefs were significantly correlated with MC intention. For the overall sample, nine beliefs (4 positive, 5 negative) entered the regression equation with each providing significant independent contribution toward explaining MC intention (R = 0.66). Results indicate that boys who are motivated to get circumcised believe not only that circumcision is healthy but that they would be better role models for future sons, and would derive a sense of achievement. Concerns focus on acceptability of how their bodies will look after circumcision and issues associated with healing.

Normative Beliefs

All 18 normative beliefs were significantly correlated with MC intention. Six beliefs concerned with support from family, brothers, religion/church, people in the community, closest friends, and media entered the regression equation (R = 0.61). MC-motivated adolescents perceive wide general social support for getting circumcised.

Descriptive Norm Beliefs

All four descriptive norm beliefs were significantly correlated with MC intention. Three beliefs, concerned with whether brothers, other family members, and closest friends would get circumcised, entered the regression equation (R = 0.58). Thus, close social network members could serve as important models for adolescents.

Efficacy Beliefs

All 18 efficacy beliefs were significantly correlated with MC intention, with five entering the regression equation to explain MC intention (R = 0.64). Based on these results, adolescents' efficacy about getting circumcised likely could be enhanced if services were local, carried out by male nurses, and if messages focused on reducing perceptions that their culture and friends would be against circumcision, and that pain can be managed.

Control Beliefs

All 36 control beliefs were significantly correlated with MC intention. Eight of these beliefs (3 facilitators, 5 barriers) entered the regression equation to explain MC intention (R = 0.62). Thus, results indicate that encouraging adolescent circumcision by using cultural icons to show their support for circumcision and emphasizing that their friends are likely to get circumcised would reinforce facilitators. Concerns about complications of the circumcision procedure would also need to be addressed.

Final Overall Regression Model

In the third analytic step we ran stepwise regression and included all the beliefs across the model constructs found to be significant in the previous five regression analyses. The first column of Table 5 lists the beliefs that entered the

Table 4 IBM construct beliefs explaining MC intention

Behavioral beliefs about getting circumcised	All (R = 0.66) β (p)	Young urban (R = 0.70) β (p)	Young rural (R = 0.68) β (p)	Older urban (R = 0.73) β (p)	Older rural (R = NA) β (p)
Will make it easier to have your sons MC	0.20 (0.000)	0.26 (0.000)	0.12 (0.056)	0.36 (0.000)	
Inappropriate to change the way God created you	−0.17 (0.000)	−0.27 (0.000)	−0.22 (0.000)	−0.19 (0.005)	
Will give you a sense of achievement	0.13 (0.000)	0.14 (0.034)	0.13 (0.034)		
You would be/feel ashamed	−0.11 (0.003)		−0.19 (0.003)		
Will protect you from STIs	0.10 (0.003)				
Means you will live a long and healthy life	0.09 (0.016)				
Your penis will become ugly	−0.08 (0.025)				
Wound healing would be painful	−0.07 (0.038)		−0.16 (0.006)		
May take too long to heal	−0.07 (0.050)	−0.18 (0.002)			
Will protect you from HIV		0.18 (0.003)			
Pain from previous infections could be reignited		0.17 (0.006)			
You may lose potency		−0.14 (0.015)			
Penis will be clean and protect you from bacterial infections			0.16 (0.011)		
Will still have to use condoms all the time			0.12 (0.025)		
Would lead you to be tempted to have more sex partners				−0.15 (0.038)	
Girlfriend may think you will seek pleasure from others (older boys only)				0.25 (0.002)	
Might not heal properly, cause disfigurement				−0.19 (0.002)	
Sex would not feel as good (older boys only)				0.16 (0.015)	
It would be less protective than other prevention methods				−0.19 (0.002)	
Will cause girls to shun you (older boys only)				−0.14 (0.039)	
Friends may laugh at you and you will be embarrassed				−0.26 (0.002)	

Normative beliefs about who would encourage you to get circumcised:	All (R = 0.61) β (p)	Young urban (R = 0.68) β (p)	Young rural (R = 0.63) β (p)	Older urban (R = NA) β (p)	Older rural (R = NA) β (p)
Your family	0.24 (0.000)	0.39 (0.000)	0.21 (0.009)		
Your brothers	0.16 (0.001)	0.19 (0.006)			
Your religion/church	0.11 (0.006)				
People in your community	0.09 (0.025)		0.21 (0.002)		
Your closest friends	0.09 (0.042)		0.19 (0.007)		
The media (TV, radio)	0.07 (0.032)				
Your culture		0.19 (0.005)	0.15 (0.021)		

Descriptive norm beliefs about who would get circumcised:	All (R = 0.58) β (p)	Young urban (R = NA) β (p)	Young rural (R = NA) β (p)	Older urban (R = 0.59) β (p)	Older rural (R = 0.61) β (p)
Your brothers	0.24 (0.000)			0.21 (0.044)	0.61 (0.000)
Your closest friends	0.28 (0.000)			0.42 (0.000)	
Your other male relatives	0.10 (0.045)				

Efficacy beliefs—if you wanted to get circumcised, how certain are you that you could if:	All (R = 0.64) β (p)	Young urban (R = 0.60) β (p)	Young rural (R = 0.73) β (p)	Older urban (R = NA) β (p)	Older rural (R = NA) β (p)
MC is available in local, including rural, clinics	0.26 (0.000)	0.31 (0.000)	0.30 (0.000)		
People describe the process as painful	0.23 (0.000)	0.24 (0.001)	0.21 (0.001)		
Your friends are against MC	0.16 (0.000)		0.16 (0.015)		

Table 4 continued

Efficacy beliefs—if you wanted to get circumcised, how certain are you that you could if:	All (R = 0.64) β (p)	Young urban (R = 0.60) β (p)	Young rural (R = 0.73) β (p)	Older urban (R = NA) β (p)	Older rural (R = NA) β (p)
Your culture is against MC	0.11 (0.003)		0.19 (0.003)		
You would be attended to by female nurses	0.10 (0.002)		0.18 (0.004)		
Your religion does not accept MC		0.16 (0.016)			
You do not know exactly how MC prevents HIV		0.14 (0.026)			
You did not know where to go for MC			−0.17 (0.001)		

Control beliefs—facilitators/barriers to getting circumcised:	All (R = 0.62) β (p)	Young urban (R = NA) β (p)	Young rural (R = NA) β (p)	Older urban (R = 64) β (p)	Older rural (R = 0.63) β (p)
People describe the process as painful	0.20 (0.000)			0.26 (0.000)	
If local chiefs/village heads support MC	0.20 (0.000)			0.25 (0.000)	
Being able to discuss it with friends	0.16 (0.000)			0.23 (0.001)	
If clinic staff explain how MC helps prevent HIV	0.15 (0.000)				
If there were reported cases of complications	0.10 (0.005)				
If your friends are against MC	0.09 (0.006)			0.16 (0.018)	
If your culture was against MC	0.08 (0.028)				0.25 (0.000)
If you did not know where to go for MC	−0.06 (0.048)				
Being able to discuss it with parents or family					0.25 (0.001)
HIV being in your community					0.23 (0.003)
If it is available in local, including rural, clinics					0.20 (0.009)

regression equation for the overall sample. Four behavioral beliefs (2 positive, 2 negative), two injunctive norm beliefs, one descriptive norm belief, two efficacy beliefs, and three control beliefs (2 facilitators, 1 barrier) provided significant independent explanation of MC intention (R = 0.73). The results show that MC-motivated boys believe they could serve as role models for sons, and believe in the health benefits of circumcision. Complications related to healing and pain would have to be addressed in messaging. Discussion with individuals in boys' closest social networks could support circumcision decisions. In addition, messages reinforcing that adolescents' social networks and local chiefs support or would get circumcisions speaks to issues predicting their circumcision motivation. The overall model findings reveal issues predicting intention which could be targeted using mass media approaches directed at all adolescents.

Multiple Regression Results: Age by Urban/Rural Subgroups

The above regression analysis procedures were next conducted separately for four survey sub-samples: (1) younger boys (aged 13–15) in urban areas (N = 211), younger boys in rural areas (N = 236), older boys (aged 16–17) in urban areas (N = 171), and older boys in rural areas (N = 156). The regression results are shown in the last four columns of Tables 3, 4, and 5.

The six computed IBM construct scores were significantly correlated with MC intention for each of the four sub-samples of boys. On the first regression step, the five computed belief-based IBM constructs were included in forward stepwise regression to explain MC intention for each adolescent subgroup (Table 3). MC intention was significantly explained by instrumental attitude, injunctive norm, and self-efficacy for both younger urban ($R = 0.71$, $p < 0.001$) and younger rural ($R = 0.69$, $p < 0.001$) boys. Instrumental attitude, descriptive norm, and perceived control significantly explained MC intention among older urban boys ($R = 0.67$, $p < 0.001$), while descriptive norm and perceived control significantly explained MC intention among older rural boys ($R = 0.67$, $p < 0.001$). On the second step, experiential attitude entered for all subgroups and increased the variance accounted for by between 4 and 11%. Perceived risk did not enter the equation for any of the subgroups. Subgroup analyses show that different IBM constructs should be targeted in interventions for the different adolescent groups. For example, messages based on

Table 5 Final model: IBM beliefs explaining MC intention

IBM construct	Belief	All (R = 0.73) β (p)	Young urban (R = 0.77) β (p)	Young rural (R = 0.76) β (p)	Older urban (R = 0.74) β (p)	Older rural (R = 0.69) β (p)
Behavioral beliefs	Inappropriate to change the way God created you	−0.10 (0.001)	−0.20 (0.001)			
	Will make it easier to have your sons MC	0.12 (0.000)	0.16 (0.004)		0.28 (0.000)	
	Means you will live a long and healthy life	0.08 (0.005)				
	May take too long to heal	−0.06 (0.026)	−0.15 (0.004)			
	Will protect you from HIV		0.11 (0.027)			
	You would be/feel ashamed			−0.19 (0.000)		
	Penis will be clean and protect you from bacterial infections		0.15 (0.006)	0.12 (0.031)		
	Will still have to use condoms all the time			0.12 (0.012)		
	Wound healing would be painful			−0.11 (0.024)		
	It would be less protective than other prevention methods				−0.15 (0.006)	
Normative beliefs	Your family	0.09 (0.019)	0.27 (0.000)	0.20 (0.001)		
	People in your community	0.07 (030)				
Injunctive norm	Your brothers		0.15 (0.016)			
Descriptive norm	Your brothers	0.12 (0.000)				0.42 (0.000)
	Your closest friends				0.31 (0.000)	
Efficacy beliefs	If people describe the process as painful	0.16 (0.000)	0.18 (0.000)	0.23 (0.000)		
	If your friends are against MC	0.11 (0.001)				
	If you would be attended to by female nurses			0.24 (0.000)		
Control beliefs	If local chiefs/village heads support MC	0.10 (0.001)				
	Being able to discuss it with friends	0.06 (0.048)			0.19 (0.001)	
	If there were reported cases of complications	0.07 (0.014)				
	If people describe the process as painful				0.20 (0.001)	
	If your culture was against MC					0.16 (0.012)
	HIV being in your community					0.15 (0.029)
	Being able to discuss it with parents or family					0.18 (0.010)

attitudinal beliefs are unlikely to resonate with older rural boys as attitude was not significant for this group, yet they would be important for younger and older urban boys.

We next examined the underlying beliefs within each significant belief-based IBM construct to identify those beliefs that best explain MC intention for each subgroup. These analyses were conducted to determine whether different specific issues and which specific issues are predictors of intention to get circumcised among subgroups of adolescents. For the younger boys, separate stepwise regression analyses were carried out with the beliefs underlying instrumental attitude, injunctive norm, and self-efficacy. Likewise, among the older urban boys, regression was carried out with the beliefs underlying instrumental attitude, descriptive norm, and perceived control. For older rural boys, the regression analysis was conducted with the beliefs underlying descriptive norm and perceived control. Table 4 lists the beliefs entering each of these regressions along with their beta weights. These findings highlight the importance of audience segmentation, as different IBM constructs were predictive of intention for younger and older boys, and by urbanicity.

Behavioral Beliefs

Younger Urban Boys Seven behavioral beliefs (3 positive, 4 negative) entered the stepwise regression to explain MC intention among younger urban boys ($R = 0.70$). These

results indicate that messages reducing the perception that MC procedures may create complications and focusing on the benefits, such as reduction of HIV acquisition, and being an example for sons, as well as providing a sense of achievement would be important for this younger urban group. Interestingly, this is the only subgroup where messages in regards to the HIV prevention effects of MC may resonate.

Younger Rural Boys Seven behavioral beliefs (4 positive, 3 negative) entered the regression equation for younger rural boys ($R = 0.68$). Three of these beliefs were the same as for younger urban boys. The other four behavioral beliefs that entered were unique to younger rural boys. Results for young rural boys have some similarities to young urban boys, but also highlight differences, denoting that messages should be tailored specifically to the specific beliefs of each group of adolescents. These would include ameliorating fears of shame or stigma and worry about healing. Encouraging condom use should be standard for all individuals in Zimbabwe, but our results indicate that specific messages for these young rural boys who get circumcised will need to be developed.

Older Urban Boys Of the nine behavioral beliefs that entered the stepwise regression among older urban boys ($R = 0.73$), two were the same as for younger boys. The other seven behavioral beliefs were unique to older urban boys. These results indicate that older urban boys especially will need messages tailored specifically to them, given the unique set of additional beliefs that entered their regression equation. Older urban boys in our sample are definitely thinking about their upcoming sexual experiences. They have concerns around stigma from girls and friends, think that they may be tempted into risk compensation behavior, and feel that sex may not feel as good. They are also concerned about healing, and understand that MC may be less protective than other HIV prevention methods. These negative beliefs would need to be countered with persuasive messages.

Normative Beliefs

Regression analysis of normative beliefs was conducted only for younger boys, as the injunctive norm model component was not significant for older urban or older rural boys. Among *younger urban* boys, MC intention was significantly explained ($R = 0.68$) by three normative beliefs. MC intention for *younger rural* boys was significantly explained ($R = 0.63$) by four normative beliefs. Injunctive norms, those beliefs about who encourages circumcision include family, brothers, friends, culture and the community, and are important for younger but not older boys. Messages for older boys about normative support for circumcision may not be effective. By contrast results for younger boys show they can be motivated by what significant others think they ought to be doing.

Descriptive Norm Beliefs

Regression analysis of descriptive norm beliefs was only conducted among older boys. The descriptive norm beliefs that closest friends and brothers would get circumcised significantly explained ($R = 0.59$) MC intention for *older urban* boys. Among *older rural* boys, one descriptive norm belief that brothers and would get circumcised was significant in explaining ($R = 0.61$) MC intention. Our results with older boys contrast with younger boys, in that older boys are not driven by individuals in their social networks encouraging a circumcision, rather they seem to be driven by what they perceive others in their social networks are actually doing. These differences between younger and older boys in terms of normative influence imply subtly different approaches to messaging around normative beliefs for boys depending on their ages.

Efficacy Beliefs

Regression analysis of efficacy beliefs was conducted only for younger urban and rural boys, as self-efficacy did not enter the model for older boys. Two significant beliefs were common across both groups, while the remaining beliefs that entered each analysis differed across groups.

Younger Urban Boys Four efficacy beliefs explained ($R = 0.60$) MC intention among younger urban boys. These indicate that younger urban boys would be motivated to have an MC if they were confident of: services available in local clinics, information about the procedure and how it prevents HIV, and religion not being against MC.

Younger Rural Boys MC intention among younger rural boys was significantly explained ($R = 0.73$) by six efficacy beliefs, four additional beliefs compared to younger urban boys. Results indicate that making services available locally, informing of location of services, and attendance by male nurses would increase efficacy around MC for these boys. In addition, focusing on the support of culture and peers would also increase efficacy, and likely increase intention for MC.

Control Beliefs

Regression analysis of control beliefs was conducted only among older urban and rural boys, with four control beliefs (2 facilitators, 2 barriers) significantly explaining ($R = 0.64$) MC intention among *older urban boys* and four different control beliefs significantly explaining ($R = 0.63$) MC intention among *older rural boys* (3 facilitators, 1 barrier).

These results indicate that these facilitators and barriers differ among older boys depending on where they live, creating implications for message tailoring based on urbanicity.

Final Subgroup Regression Models

We next carried out a final stepwise regression analysis for each subgroup to identify the beliefs across the five model constructs that are the strongest in explaining MC intention. These analyses yield core beliefs that lend themselves to broader messaging strategies, such as via mass media channels for example. In each regression, for each subgroup of boys, we included all beliefs underlying each model construct found to be significant in the previous regression analyses. The beliefs that entered the final regression equations for each of the subgroups varied substantially with little duplication across groups (Table 5).

Younger Urban Boys Five behavioral beliefs, two injunctive norms, and one efficacy belief significantly explained MC intention among younger urban boys ($R = 0.77$). MC motivation for this group was affected by the beliefs about body image, healing, hygiene, protection from HIV, and serving as a role model for sons. Support from family and brothers, and perceived efficacy about pain were also significant. *Notably, this is the only subgroup where the belief about the HIV prevention aspects of circumcision was significant.*

Younger Rural Boys Four behavioral, one normative, and two efficacy beliefs were significant for this sub-group ($R = 0.76$). As with the young urban boys, family support and perceived efficacy about pain were significant. Additionally, the efficacy belief about getting circumcised despite being attended to by female nurses was significant for young rural boys. Three of the four significant behavioral beliefs were completely different from the results for young urban boys. Young rural boys' MC motivation was affected by behavioral beliefs about body image, healing, protection from bacterial infections, and still having to use condoms all the time.

Older Urban Boys MC intention among older urban boys was explained by two behavioral beliefs about MC being less protective than other prevention methods and serving as a role model for sons, the descriptive norm with respect to closest friends, and two control beliefs concerned with being able to discuss MC with friends, and people describing MC as painful ($R = 0.74$).

Older Rural Boys One descriptive norm and three control beliefs best explained MC motivation among older rural boys ($R = 0.69$). Whether brothers would get circumcised was important for this group. Additionally, the control beliefs concerning culture being against MC, HIV being in the community, and being able to discuss MC with parents and family were significant.

These results for the segmented groups of boys especially highlight how each group based on age and urbanicity will need to have messages specifically tailored to them. While some commonalities in beliefs exist about social support, other beliefs diverge into different issues for each unique group of boys.

Discussion

The success of efforts to circumcise adolescent boys will depend on developing effective communication campaigns to motivate them to get circumcised. This will require understanding and targeting mutable beliefs that best explain variation in boys' motivation to get circumcised. The few previous studies that investigated factors affecting adolescent MC motivation have important limitations noted previously. Our study applied rigorous theory-driven methods in identifying specific evidence-based targets for MC communication materials and messages for adolescent boys. This research provides important improvements over previous adolescent MC studies. The methods described establish a systematic approach to identifying beliefs that can be targets for behavior change messaging. We included a qualitative phase where we asked specific open-ended questions among a representative sample of target-aged boys to elicit beliefs with respect to each IBM construct, and these findings were used to design our quantitative survey. In the survey, we did not ask adolescents to tell us what factors affect their motivation. Instead, we measured the strength with which each boy held each belief, and then conducted analyses to determine which beliefs best explained variance in MC intention.

We applied the IBM, based on multiple strong behavioral theories, to carry out this survey among adolescent boys in Zimbabwe. Analysis of the overall sample found that all three IBM constructs and their components (experiential and instrumental attitude, descriptive and injunctive norm, self-efficacy and perceived control) provide significant independent explanation of MC motivation. This suggests that communication interventions to increase MC uptake among adolescent boys may be most effective if they target *all* six IBM components. These results also suggest that messaging focusing on reduction of HIV risk would *not* be effective in increasing adolescents' intention to get circumcised. Other research also shows that focusing on health benefits of behaviors do not drive adolescents' adoption of those behaviors [38].

We found that all but two of the beliefs underlying the five belief-based IBM components were significantly

correlated with MC motivation, and large proportions of beliefs were significant in each of the model component regression analyses. The final model (Table 5) identified four behavioral, three injunctive norm, one descriptive norm, two efficacy, and three control beliefs that best explained MC motivation for the overall sample. Thus, a mass media campaign for adolescent boys may be expected to be most effective if it targets these twelve beliefs across the IBM components. Targeting three or four beliefs per message and switching them periodically would ensure the messages remain fresh, and are still evidence-based. Because experiential attitude (affect) significantly increased the variance explained among all groups, designing messages with an emotional 'hook' will also increase their effect. Our overall sample results also showed that HIV risk perception did not predict intention. The protective effect of MC for HIV prevention was only salient for younger urban boys. One set of beliefs that cross-cut multiple IBM constructs were those associated with the procedure. It may be that non-surgical procedures for circumcision will work better than surgical procedures for boys. Our research shows a non-surgical device is safe and effective in circumcising teens [39].

With respect to message development, attention should not necessarily be paid *only* to those twelve individual items that entered the final model of predictors of MC intention. There was high correlation among many of the IBM construct beliefs. Thus, items that are highly correlated may not have entered the final regression model due to their collinearity with other items that entered the model first. These high correlations between items in the model with those that did not enter may be leveraged to consider a broader variety of beliefs to target for effective messaging. This is especially useful if one selects beliefs that may be more amenable to change.

For example, one strong predictor of MC intention among adolescents is the belief that MC would be "inappropriate because it would be changing the way God created you." This could be an effective target for messaging. This belief is highly correlated with the beliefs "You would be uneasy because of being different from others" ($r = 0.50$), "You would feel ashamed" ($r = 0.48$), and "Your penis will become ugly" ($r = 0.47$). These three beliefs were also strongly correlated with MC intention ($r = 0.42$–0.46). Similarly, the belief that getting circumcised "will make it easier to have your sons circumcised" entered the final model, and is strongly correlated with several other positive beliefs (e.g., "will give you a sense of achievement," "will protect you from bacterial infections") that were also strongly correlated with MC intention. A communication campaign designed to target correlated beliefs that share variance may be more effective since the messaging may be complementary and resonate more with the target population [40].

The results of our subgroup analyses suggest that in addition to a broad communication campaign designed for all adolescent boys, more targeted communication messages for each subgroup is necessary. Different IBM components and their underlying beliefs are important to target to change motivation and increase uptake for younger versus older boys in urban versus rural locations in Zimbabwe. Messages should be tailored to the specific attitude, normative, and personal agency belief items that predict intention among these different groups of adolescents. One would expect that rather than targeting all constructs for all groups of boys, messages tailored to the specific demographic are more likely to yield changes in motivation among the different groups of boys. Audience segmentation based on age and urbanicity will be important in designing messages for adolescent boys to ensure appropriate targeting of the right issues with these different segments.

Although all model components were significantly correlated (all >0.52) with MC intention for all four groups, collinearity among model components resulted in some not entering the regression equation. For example, among older rural boys, descriptive norm entered the stepwise regression first ($R = 0.66$). Subsequently, instrumental attitude did not enter due to its strong correlation with descriptive norm ($r = 0.78$). This suggests that a communication strategy may consider complementary targeting of behavioral beliefs in addition to descriptive norm beliefs. For example, for older urban boys one might train peers who have been circumcised to target significant behavioral beliefs in persuasive communications. Discussions with families drove intentions among some groups, thus parents could also be targets of communication campaigns. Interventions regarding sexual risk behaviors with adolescents show the importance of incorporating parents [37, 41, 42].

The final model analyses to identify the strongest beliefs explaining motivation among the four subgroups found some overlapping beliefs but many differences. This suggests the potential benefits of different messages tailored to the subgroups of adolescent boys will be important to increase MC motivation for these subgroups. The behavioral belief that MC "will make it easier to have sons circumcised" was significant for urban boys (both younger and older). Young urban boys was the only group for whom protection from HIV and healing time were significant. Young rural boys' MC motivation was explained by a completely different set of behavioral beliefs including "you would feel ashamed," "protect from bacterial infections," and "wound healing would be painful". Young rural boys' motivation was also affected by the efficacy

belief concerned with being attended to by female nurses, which may be consistent with their concern about feeling ashamed. Control beliefs concerning "if culture was against MC" and "being able to discuss it with parents and family" were significant only for older rural boys. Injunctive norm beliefs were significant for younger boys, while descriptive norm beliefs were significant for older boys, regardless of urbanicity. The strength of the IBM is that it can specify these attitudinal, social normative and personal agency influences, show which ones are specific to different groups of boys, and point to distinctive messaging that can be created for each.

Determining the most effective and complementary sets of messages requires additional implementation research to ensure messages change intentions and behaviors. The next steps toward developing an evidence-based MC communication program for adolescent boys will involve: (1) designing messages based on these research findings, (2) integrating those messages into cohesive posters, radio spots, or other media presentation including via social media, (3) testing the messages in small groups for recall and impact, and (4) evaluating the effect of the communication materials on the targeted beliefs and on MC uptake in a community. A systematic consideration of the correlations among IBM constructs and underlying beliefs that did not enter our regression analyses due to collinearity will be important for message design. This will require careful attention to which beliefs may be most amenable to change, and selection of sets of beliefs that can be targeted in a complementary way to resonate with the target group.

Though some research shows that using social cognitive theory-based versus non-theory-based interventions among adolescents in sub-Saharan Africa, may not increase their effectiveness in changing adolescent behavior [43], more recent research does show that social cognitive factors can play a significant role among sub-Saharan African adolescents' decisions about safer sexual behaviors [44]. Incorporating evidence-based messaging into programs that target adolescents to increase uptake of MC may result in higher uptake if messages target the beliefs most relevant to adolescents. This was a lesson learned with adult MC campaigns [45]. If programs also target sexual and reproductive health issues important to adolescents, uptake of circumcision as it relates to these broader issues may be higher [16]. It is clear from our research and that of others who have implemented programs, that adolescents require specific programs tailored to their needs, as well as communication campaigns based on issues most likely to impact their motivation. This will likely increase MC uptake. This is particularly important, as the new PEPFAR guidelines for MC programs require that the majority (60%) of circumcisions be among 18–29 year old men as the highest priority group, with adolescents 13–17 as the second highest priority. Surgical procedures for younger adolescents cannot use the efficient forceps guided method, making it logistically more difficult for MC programs to target adolescents. Thus, targeting the right age groups with the right messages, and the right programs, will go a long way to enhancing the uptake for country MC programs. With adolescents, parents likely also play a significant role in circumcision adoption. Thus, research to determine issues that are drivers of parents' intentions to get their boys circumcised, that are then incorporated into communication campaigns, will also increase boys' circumcision rates.

There are several limitations of this study. First, it is possible that sampling from schools may have resulted in a less representative sample of adolescent boys than a household-based sample. However, our elicitation work for this study found that it is very difficult to find adolescent boys at their homes during the day. Most adolescents in Zimbabwe are in school. Additionally, household sampling would have required broad community sampling to attain the same level of diversity of boys sampled from schools. Nearly all boys in our target age range are in school, and we obtained very high survey participation rates among all ages targeted. Thus, we are confident that our school-based sample is as or more representative than one that could have been obtained via household-based sampling.

Second, we did not measure MC behavior and did not identify behavioral determinants. Our goal in this study was to determine specific issues that would be important to target in communication campaigns, thus assessing behavior was not part of the study design, nor was there sufficient funding to assess MC uptake over time. Meta-analyses and reviews of diverse behavioral domains show that intentions predict behavior [31, 46–49], thus we expect that the behavioral, normative, self-efficacy and control beliefs we measured which predict intention, can affect behavior if targeted in communication campaigns. Third, these derivation results would need to be validated with additional samples. However, as circumcision programs roll out, one would expect that beliefs underlying attitudes, norms, and personal agency would change over time. Thus, a more appropriate approach might be to monitor target group beliefs, and periodically change campaign messaging to ensure campaigns remain current and relevant. Fourth, the results are specific to Zimbabwe, and may not generalize to other sub-Saharan Africa countries.

MC programs in sub-Saharan Africa have been implemented for several years and much of their initial focus was on expansion of capacity. It is now clear that capacity has outpaced demand, as uptake of circumcision among men has been slower than anticipated even in countries where circumcision trials were conducted, and numbers dropped in all countries from 2014 to 2015 [8, 15, 39, 50]. Messages that initially focused on the HIV risk-reduction benefits of MC proved to engender insufficient demand with the result

being that most priority country programs did not meet their 2015 MC goals [8]. Zimbabwe, and other sub-Saharan African countries, began to target adolescent boys to increase MC numbers because boys are accessible in schools [16, 17]. A large proportion of circumcisions conducted in priority countries by 2013 were conducted among boys 10–19 [51].

A key contribution of this research is the testing of a comprehensive behavioral model for predicting intentions that points to a research strategy that should increase circumcision demand if the results are used as a basis for the development of messages. This study demonstrates a research strategy and methods that can be applied to the design of specific messages driving intentions among teens in relation to MC intention. This method could be used in other countries to inform design of MC communication in those countries. Translating research results from this method to messages that resonate with target audiences, change IBM constructs, change intention, and increase circumcision uptake needs additional formative research. Quantitatively testing messages is a crucial part in the process of designing communication campaigns among adolescents to increase MC adoption [24, 25, 30].

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Compliance with Ethical Standards

Conflict of interest Danuta Kasprzyk, Mufuta Tshimanga, Deven Hamilton, Gerald Gorn, and Daniel Montaño each declares that he/she has no conflict of interest.

Ethical Approval All procedures performed in this study involving human subjects were in accordance with the ethical standards of the US institutional IRB and the Medical Research Council of Zimbabwe, and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Written informed consent was obtained from all individual participants included in the study.

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