AIDS and Behavior (2020) 24:967–974
https://doi.org/10.1007/s10461-019-02531-7

ORIGINAL PAPER

Men's Beliefs About the Likelihood of Serodiscordance in Couples with an HIV-Positive Partner: Survey Evidence from Rural Uganda

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Published online: 9 May 2019

Abstract
Few studies in sub-Saharan Africa have assessed men's knowledge about the likelihood of serodiscordance in couples with an HIV-positive partner and how this is affected by antiretroviral therapy (ART). Using a Likert scale and probabilistic scale, we elicited beliefs of 2532 rural Ugandan men about the likelihood of seroconcordance in married couples with an HIV-positive female partner who is either taking ART or not taking ART. Logistic regression analyses explored associations between beliefs and various health behaviors. Probabilistic scale responses were consistent with Likert scale responses. Seroconcordance was believed to be likely in the scenarios without ART and with ART, with mean seroconcordance likelihood of 8.1 and 6.6, respectively, on a scale of 0–10. The majority of participants (57%) believed the likelihood of seroconcordance was lower in the scenario with ART. The results suggest a need for enhanced education among men about serodiscordance in stable relationships and about the preventive effects of ART.

Keywords HIV prevention · Antiretroviral treatment · Beliefs · Serodiscordant relationships · Men · Uganda

Introduction

High prevalence of HIV serostatus discordance in stable heterosexual relationships in sub-Saharan Africa (SSA) is widely believed to be a significant contributor to new HIV infections in the region [1]. Studies indicate that roughly 5% of couples in the general population and about 50% of couples with at least one HIV-positive adult are serodiscordant, including couples in which the HIV-positive partner is female [1–3]. The high prevalence of HIV serodiscordance illustrates the value of couples testing interventions that can increase awareness of partner status as well as the importance of achieving high uptake of effective HIV prevention strategies such as early antiretroviral therapy (ART), pre-exposure prophylaxis (PrEP), consistent condom use and medical male circumcision.

Despite the high prevalence of serodiscordance, there is limited awareness of partner status and low utilization of couples testing in many countries [4]. In particular, uptake of various HIV prevention and treatment services tends to be particularly low among men, who are less likely to engage with the health system and more likely to be unaware of their HIV status compared with women [5, 6]. A number of demand- and supply-side factors may contribute to lower utilization of HIV testing and other prevention services among men. One factor that may contribute to lower utilization of HIV services by men but has been understudied is men's beliefs about the likelihood of serodiscordance in heterosexual couples and the ways in which these beliefs are influenced by whether or not an HIV-positive partner is taking ART. A few surveys conducted in SSA have documented that individuals have limited knowledge about the possibility of HIV serodiscordance. For instance, studies conducted in South Africa and Zambia suggest only 30–40% of individuals are aware about the possibility of serodiscordance in couples [7, 8]. Other studies have supported such a finding by noting that 'proxy testing' is common among men, with own

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HIV status being inferred from their female partners' HIV status [9]. Additionally, despite evidence from randomized trials that ART can dramatically reduce HIV transmission risk [10] and the subsequent policy shift towards universal ART, few studies have quantitatively assessed how the ART status of an HIV-positive person in a stable relationship is associated with beliefs about serodiscordance in the relationship.

We used novel survey techniques in rural Uganda to elicit men's beliefs about HIV serodiscordance in married, heterosexual couples in scenarios with and without ART being taken by the HIV-positive partner.

Methods

Study Design

This study used data collected at the start of a randomized controlled trial investigating the comparative effectiveness of different incentive strategies for promoting uptake of community-based HIV testing among men (NCT02890459) [11]. From April to June 2016, we enrolled participants from villages in four rural parishes in Mbarara District, in southwestern Uganda. We first enumerated all community residents in a door-to-door census. Enrollment was offered to adult men (aged ≥ 18 years) who had been living in the community for ≥ 6 months in the past year and did not intend to move away in the next 3 months. Men who provided written informed consent to participate in the trial were administered a structured baseline questionnaire by a team of trained research assistants. The questionnaire elicited information on demographic and economic characteristics as well as health and sexual behavior.

Measurement of Beliefs About Seroconcordance

In the baseline questionnaire, we sought to assess participants' beliefs about seroconcordance in married, heterosexual couples in which the wife is HIV-positive. We were specifically interested in studying how these beliefs varied in scenarios where the wife was and was not taking ART. As such, participants were asked about the likelihood of a man being HIV-positive in two hypothetical scenarios: one in which the man's wife is HIV-positive and not on ART and another in which she is on ART. The following specific questions were presented to participants: (1) if a man's wife is HIV-positive and not taking any ART medicines, how likely do you think it is that the man is also HIV positive? and (2) if a man's wife is HIV-positive and taking ART medicines, how likely do you think it is that the man is also HIV-positive? Beliefs were measured using a 4-category Likert scale, an approach that is commonly used to measure beliefs in various surveys, as well as a probabilistic scale from 0 to 10 (0 = no chance of seroconcordance, 10 = 100% chance of seroconcordance). We used the probabilistic scales because several studies have shown that compared to Likert scales, they allow for greater interpersonal comparability of responses and are more sensitive to changes in one's beliefs between scenarios [12, 13]. Interpersonal comparability can be greater than in Likert scales because the verbal categories used in the latter scale (such as "somewhat likely") may be interpreted differently across individuals, a limitation that probabilistic scales do not have. Probabilistic scales also enable assessment of changes in beliefs between scenarios because the response options are less coarse than for the Likert scale. Research assistants were trained to emphasize that the scenarios presented were hypothetical and that we sought to assess participants' beliefs about the likelihood of the man being HIV-positive.

Strategies for Eliciting Probabilistic Beliefs

To make it easier for participants to provide responses that reflected their probabilistic beliefs in the scenarios above, research assistants presented the following example to participants as an alternative way to think about the scenario: "Imagine ten couples where the woman is HIV-positive and not taking any ART medicines. How many of the men do you think are HIV-positive?" Some participants may find it easier to think about this scenario when reporting their probabilistic beliefs that the husband in a hypothetical married couple would be HIV-positive. Other studies have used similar approaches to measure individuals' beliefs about health and economic conditions. For example, various studies conducted in low-income countries by economists have measured individuals' probabilistic expectations about their future health and economic outcomes using visual aids such as rulers or tasks such as allocation of beans or stones [13]. These measurement strategies are designed to assess probabilistic beliefs and expectations in settings with low numeracy and they are similar to the approach we used in our study.

Following the baseline questionnaire, participants were randomized to study groups that received various economic incentives for HIV testing at community health campaigns (CHCs) held in their communities 2–4 weeks later. Participants' CHC attendance and completion of HIV testing at the CHC was recorded by study staff. Results of the randomized trial that assessed the comparative effectiveness of various incentives for HIV testing have been reported elsewhere [11].

Outcomes

The main outcome variables we examined were men's beliefs about the likelihood of seroconcordance in the scenarios with and without ART, as measured using the probabilistic scale ranging from 0 to 10. We also defined binary variables for both scenarios indicating certainty in the participant's belief about seroconcordance (response = 10). To assess how a participant's belief about the likelihood of seroconcordance changed in the scenario with ART, we calculated the difference in probabilistic scale responses between the scenarios without and with ART. A positive number ≤ 10 indicated that seroconcordance was less likely in the scenario with ART while a negative number ≥ − 10 indicated that seroconcordance was more likely. In addition, we examined beliefs as measured using the Likert scale in order to compare them to participants' responses for the probabilistic scale.

We also examined three HIV prevention behaviors that were assessed in the study: (a) HIV testing in the past 12 months, as measured in the baseline survey, (b) observed uptake of HIV testing at the CHCs held in the weeks after the baseline data were collected, and (c) participants' reports in the baseline survey that they were circumcised already or were "very likely" to go for circumcision in the future.

Statistical Analyses

Our analyses began by summarizing participants' beliefs in scenarios with and without ART, as measured by the Likert and the probabilistic scales, as well as the difference in probabilistic scale responses between the two scenarios. We also examined the distribution of probabilistic scale responses as well as the distribution of differences in the responses between the two scenarios. In addition, we examined the relationship between the probabilistic and Likert scale responses in each of the two scenarios in order to gain a more general understanding of these two ways of eliciting beliefs. This was done by calculating the mean of the probabilistic scale responses for each of the four Likert scale categories.

Since men's beliefs about seroconcordance could influence their utilization of preventive services for various reasons including an increase or decrease in their perceived need for HIV prevention or treatment, we conducted logistic regression analyses to examine the association between participants' beliefs in the two scenarios and the three HIV prevention behaviors. In these regression analyses, participants' beliefs were coded as a binary variable indicating whether they believed the likelihood of seroconcordance was 100% (response of 10 in the 0–10 scale). The regression analyses included controls for participant's age, education, marital status and the study group to which participants were randomized as part of the effectiveness trial of incentives for HIV testing.

Ethical Considerations

The study received ethical approval from Makerere University, the Ugandan National Council on Science and Technology, the University of California San Francisco and the University of Pennsylvania.

Results

A total of 2782 men were enumerated and 2532 men met eligibility criteria and were enrolled following informed consent. Among these participants, 2386 (94.2%) answered the seroconcordance questions and were included in analyses. Participants had a mean age of 38 years and 68.2% were married.

Table 1 summarizes participants' beliefs in the two hypothetical scenarios and their health behaviors. In the scenario in which a man's wife is HIV-positive and not taking ART, participants believed the man was very likely to be HIV-positive. The mean response using the probabilistic scale was 8.1 (standard deviation, sd 2.0), implying a seroconcordance probability of 81%. In the scenario in which a man's wife is HIV-positive and on ART, participants believed the man was somewhat less likely to be HIV-positive (mean seroconcordance likelihood 6.6, sd 2.4). The mean within-participant change in the likelihood of seroconcordance with ART was 1.4 on the 0–10 scale (sd 2.2), indicating that on average, participants believed seroconcordance was less likely in the scenario with ART.

Likert scale responses also indicated a belief that seroconcordance is very likely when the HIV-positive partner is not taking ART and less likely when she is taking ART (Table 1). Nearly 90% believed seroconcordance is "very likely" when the HIV-positive woman is not on ART, while 52% stated this in the scenario with ART and 43% stated it was "somewhat likely." Additionally, participants' responses using the probabilistic scale were largely consistent with their Likert scale responses. In the scenarios without ART and with ART, the mean seroconcordance likelihood was highest for those responding "very likely" and lowest for those responding "very unlikely" (Fig. 1). Similarly, the proportion who responded "very likely" was positively correlated with responses to the probabilistic scale (not shown).

The distribution of participants' responses using the probabilistic scale showed they believed there was a high probability the male partner would definitely be HIV-positive in both scenarios that were presented (Fig. 2, panels a, b). In the scenarios without ART and with ART, respectively, 31.0% and 16.4% believed seroconcordance

Table 1 Summary of participants' beliefs and health behaviors

Participants' beliefs as measured with probabilistic scale ranging from 0 to 10	
Likelihood of HIV seroconcordance without ART, mean (sd)	8.1 (2.0)
Likelihood of HIV seroconcordance with ART, mean (sd)	6.6 (2.4)
Reduction in likelihood of HIV seroconcordance with ART, mean (sd)	1.4 (2.2)
Likelihood of HIV seroconcordance without ART = 10, N (%)	738 (31.0)
Likelihood of HIV seroconcordance with ART = 10, N (%)	390 (16.4)
Likelihood of HIV seroconcordance lower in scenario with ART, N (%)	1348 (56.9)
Participants' beliefs as measured with Likert scale	
Likelihood of HIV seroconcordance, wife is HIV-positive and not taking ART, N (%)	
Very likely	2089 (87.6)
Somewhat likely	268 (11.2)
Very unlikely	29 (1.2)
Likelihood of HIV seroconcordance, wife is HIV-positive and taking ART, N (%)	
Very likely	1248 (52.3)
Somewhat likely	1026 (43.0)
Very unlikely	112 (4.7)
Health behaviors of participants	
Tested for HIV in past 12 months, N (%)	930 (38.9)
Tested for HIV at community health campaign, N (%)	1817 (76.1)
Circumcised already or "very likely" to be circumcised in future, N (%)	972 (40.7)

Likelihood of HIV seroconcordance refers to participants' responses about the chance that a man in a hypothetical married couple is HIV-positive if his wife is HIV-positive. Two scenarios were presented to participants: one in which the wife is not taking ART and another in which the wife is taking ART

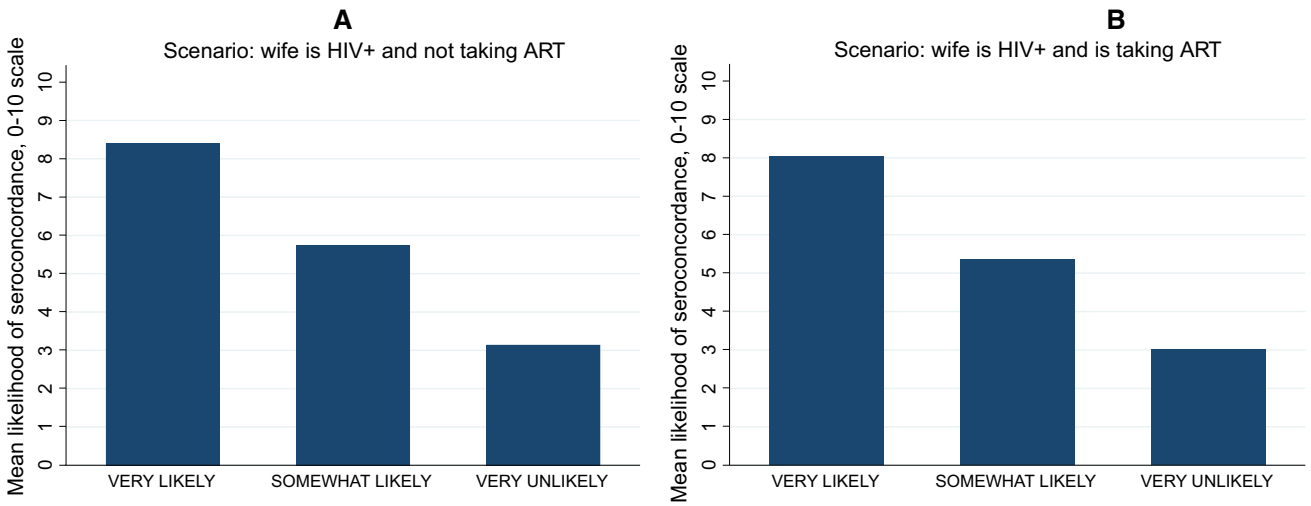

Fig. 1 Association between Likert scale and probabilistic scale responses to questions about perceived likelihood of seroconcordance. *Notes* the Y-axis shows the mean of participants' responses using the probabilistic scale ranging from 0 to 10 for each of the three Likert scale categories that were used to assess participants' beliefs about the likelihood of seroconcordance. **a** Beliefs for the scenario in which the HIV-positive partner is not taking ART and **b** beliefs for the scenario in which the HIV-positive partner is taking ART

was 100% likely (response of 10 on the 0–10 scale). Comparing within-participant differences in beliefs between the two scenarios (Fig. 2, panel c), 56.9% reported some reduction in seroconcordance likelihood in the scenario with ART but few reported large reductions. Additionally, 34.0% of participants reported no decline in the likelihood of seroconcordance while the remaining 9.1% reported an increase in the likelihood of seroconcordance in the scenario with ART.

Logistic regression analyses provided suggestive evidence that participants' beliefs about HIV seroconcordance were associated with their likelihood of engaging in HIV testing and seeking medical circumcision (Table 2). For instance, those who believed there was a 100% likelihood

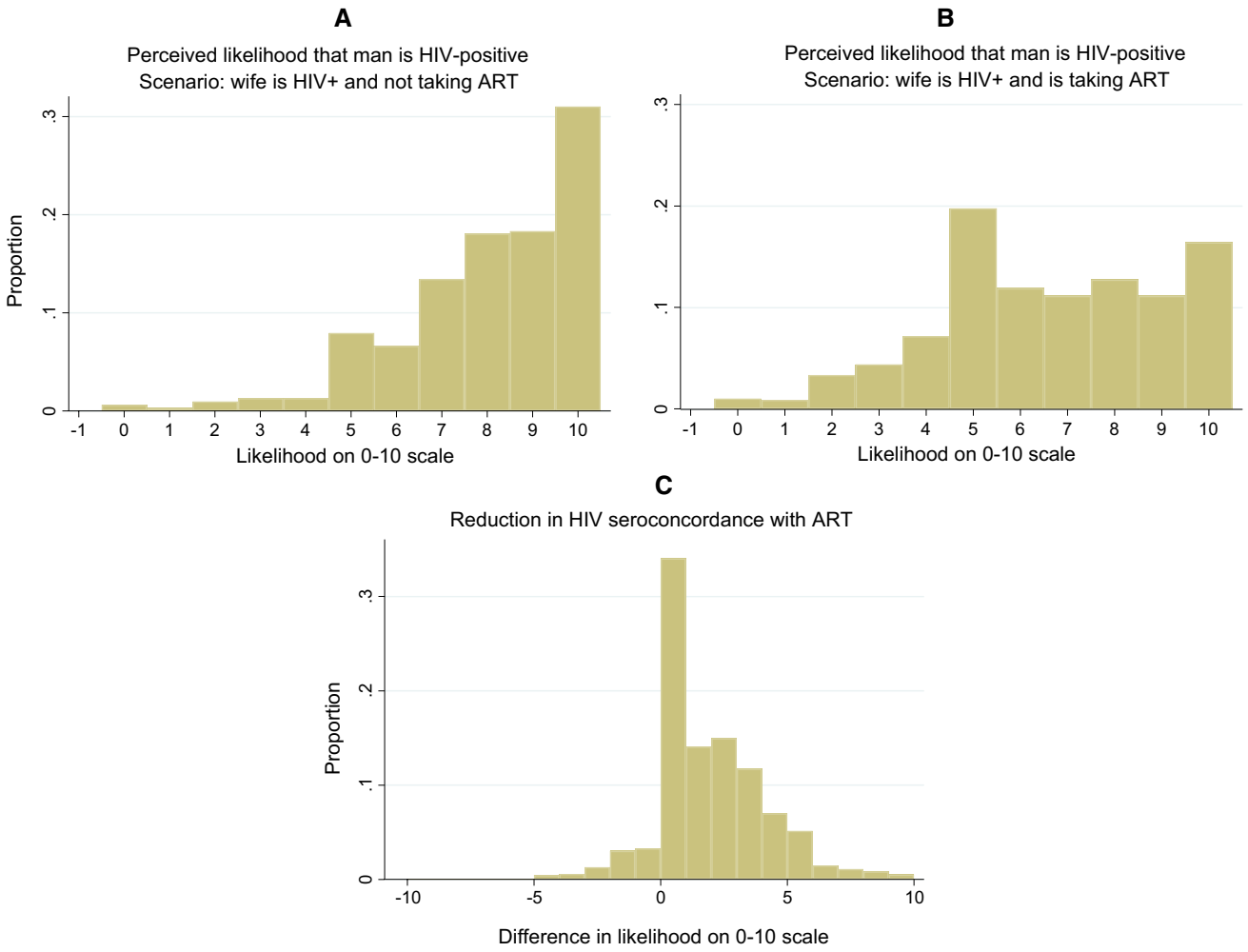

Fig. 2 Participants' beliefs about the likelihood of HIV seroconcordance in couples with an HIV-positive partner

Table 2 Association between beliefs about seroconcordance and health behaviors

	Tested for HIV in past 12 months			Tested for HIV at CHC			Circumcised already or very likely to be circumcised		
Chance of HIV seroconcordance without ART = 10	0.858 [0.713, 1.033]			0.928 [0.750, 1.148]			0.748** [0.616, 0.908]		
Chance of HIV seroconcordance with ART = 10		0.82 [0.649, 1.036]			1.109 [0.842, 1.461]			0.734* [0.573, 0.940]	
ART does reduce chance of HIV serodiscordance			1.093 [0.922, 1.297]			0.975 [0.801, 1.188]			1.133 [0.950, 1.352]
N	2372	2367	2364	2372	2367	2364	2372	2367	2364

Logistic regression model results; 95% confidence intervals in brackets. Model includes controls for participant age, education, marital status, and study group

*p < 0.05, **p < 0.01

of seroconcordance when the HIV-positive woman is taking ART were significantly less likely to be circumcised already or report they were "very likely" to be circumcised in near future (adjusted odds ratio, AOR 0.73, 95% CI 0.57–0.94). A similar association was found for those who believed there was a 100% likelihood of seroconcordance when the HIV-positive woman is not taking ART (AOR 0.75, 95% CI 0.62–0.91). Participants with such beliefs were also less likely to have been tested for HIV in the past 12 months, although the associations were not statistically significant (AOR 0.82, 95% CI 0.65–1.04). There was also no significant association between these beliefs and uptake of HIV testing at the CHC (AOR 1.11, 95% CI 0.84–1.46).

Discussion

In this large community-based survey in rural Uganda, men who were presented with hypothetical scenarios believed the likelihood of seroconcordance is very high in married couples with an HIV-positive female partner who is not taking ART. In comparison to estimates that about half of couples with at least one HIV-positive person are serodiscordant [1–3], our results suggest men underestimated the likelihood of serodiscordance. In addition, although men believed seroconcordance was less likely if the partner is taking ART, the reduction in the likelihood of seroconcordance was small in the scenario with ART. To our knowledge this is the first study to quantitatively assess men's beliefs about the risk of seroconcordance in couples with an HIV-positive partner in scenarios that do and do not include ART. Although the underlying reasons behind participants' responses warrant further study, the results reported here are suggestive of a need for further HIV prevention messaging about serodiscordance and about treatment as prevention. Men's beliefs in these domains are important because they may influence their demand for HIV prevention services, including HIV testing, medical male circumcision, and PrEP.

In the hypothetical scenarios that were presented to them, it is important to recognize that men's beliefs that the husband is very likely to be HIV-positive if the wife is HIV-positive and not taking ART may be driven by several factors. One possibility is that men over-estimated the transmission risk from an HIV-positive woman to her male partner. This suggests a knowledge gap that must be addressed by interventions designed to raise awareness about the possibility of serodiscordance. However, men's responses in our study may also be driven by an assumption that the husband was likely to have infected his wife. Other assumptions about the frequency of sexual intercourse and whether the husband has non-primary partners may also influence their beliefs about the husband's likelihood of being HIV-positive.

Another striking finding in this study was that 34% of men reported no decline in seroconcordance likelihood in the scenario with ART compared to the scenario without ART. Surprisingly, 9% of men reported an increase in seroconcordance in the scenario with ART compared to without ART; whether this was due to a misunderstanding of the question or lack of knowledge regarding HIV is unclear. Moreover, few participants believed the likelihood of seroconcordance in the scenario with ART was extremely low. One interpretation of the small decline in beliefs about the likelihood of seroconcordance in the scenario with ART is that participants are substantially underestimating the preventive benefits of ART. Following the World Health Organization's recommendation of universal ART for all HIV-positive persons, Uganda and other countries have revised their treatment guidelines accordingly, and the findings would suggest that the rapid scientific and policy advances regarding treatment as prevention have not been accompanied by comparable gains in knowledge about these benefits of ART. Although such results would be consistent with other studies showing limited awareness of treatment as prevention [14], it is important to note that men's beliefs may be driven by some other factors besides lack of knowledge about the prevention benefits of ART. It is possible, for example, that participants assumed ART adherence would be suboptimal, or that real-world effectiveness of ART would be reduced by various health system factors such disruptions to the supply of medicines. Such possibilities imply that the small differences in beliefs about the likelihood of seroconcordance when an HIV-positive partner is taking ART are not necessarily an indication that participants are unaware about the preventive effects of ART.

This paper also provides suggestive evidence that not knowing about the possibility of serodiscordance when one partner is HIV-positive and taking or not taking ART can partially explain men's lower uptake of prevention services such as HIV testing and medical circumcision. Our finding is also consistent with qualitative evidence that some men "proxy test" for HIV based on the test results of their female partners, who are generally more likely to access health services and get tested [9, 15]. Imperfect knowledge about the benefits of ART may also explain shortfalls in the observed rates in linkage to care and retention in care in many countries [16]. There are several explanations for the link between serodiscordance knowledge and health behaviors. The first is that those with correct knowledge about the possibility of serodiscordance may be more motivated to learn their HIV status and seek prevention or treatment. However, our findings do not imply a causal relationship between serodiscordance beliefs and behavior, and it is important to recognize the possibility of reverse causality or confounding. Those who sought prevention services may have learned about serodiscordance, or other variables may

be correlated with having correct beliefs and higher utilization of HIV prevention. Nonetheless, our findings suggest new avenues for research focused on beliefs held about serodiscordance and about treatment as prevention, including potential interventions to correct beliefs.

From a methodological perspective, our study demonstrates the feasibility and the value of eliciting beliefs using probabilistic scales. Participants' responses were consistent with those from Likert scales, but importantly, the probabilistic scale enabled us to observe greater interpersonal variation in beliefs and make quantitative assessments of the extent to which participants believe ART reduces the risk of HIV transmission in couples. Surveys that explore various aspects of HIV prevention and treatment should therefore consider making greater use of probabilistic scales.

Our study has limitations. First, the scenarios described to participants did not delineate factors that may have affected beliefs about seroconcordance risk such as the male partner's circumcision status, condom use by the couple, or the HIV-positive female partner's ART adherence. However, as an indication that these factors do not entirely explain participants' responses, we were able to show that those with incorrect beliefs were generally less likely to be circumcised or report that they are "very likely" to be circumcised in the future. Second, the survey lacked additional questions about men's beliefs about the risk of HIV transmission that would further unpack the reasons for their beliefs about seroconcordance. Future studies should explore these aspects of men's beliefs.

In summary, in this large community-based survey, rural Ugandan men believed seroconcordance was very likely in married couples with an HIV-positive female partner. They also believed there would be a small reduction in seroconcordance if the HIV-positive female partner was taking ART. The findings provide partial explanation for the low uptake of HIV prevention services among men and suggest that correcting men's beliefs about the likelihood of serodiscordance and increasing awareness about treatment as prevention are potentially valuable interventions for improving HIV prevention and treatment outcomes.

Acknowledgements We gratefully acknowledge our research staff, community advisory board members, and especially the communities and participants involved in this study.

Funding This study was funded by the National Institute of Mental Health at the National Institutes of Health (R01MH105254).

Compliance with Ethical Standards

Conflict of interest All authors declare that they have no conflicts of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the Ethical Standards of the Institutional and/or National Research Committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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

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