Overestimating HIV infection: The Construction and Accuracy of Subjective Probabilities of HIV Infection in Rural Malawi

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Introduction

The AIDS epidemic caused a rapid mortality increase in eastern and southern Africa. Periods of rapid mortality change are often characterized by uncertainty about the magnitude of risk (Montgomery, 2000). People living in highly HIV-affected areas may have a reasonable idea of the risk they face from familiar illnesses, such as malaria, but uncertainties are likely to be particularly great when the deaths are due to AIDS, since the long latency period between infection and death makes it difficult to connect the source of infection with deaths a decade or so later. Virtually all living in highly AIDS-affected areas of sub-Saharan Africa know that HIV is sexually transmitted, and some have engaged in what they believe is risky sex or believe their sexual partner has engaged in risky sex. It would not be surprising, then, that many believe that they have already been infected.

In the low and middle-income countries of sub-Saharan Africa, people facing the tide of the epidemic have little alternative but to rely on their subjective assessment. UNAIDS and WHO estimate that in low or middle-income countries only 10% of people at risk of HIV infection have access to voluntary counseling and testing (VCT), (UNAIDS, 2004). The few VCT centers are concentrated in urban areas, making certainty particularly difficult for rural residents. Those who are promoting the expansion of VCT as a weapon in the battle against AIDS believe that it is critical for people to know their status accurately. The assumption is that knowledge of one's status will affect behavior: those who learn they are negative will be motivated to adopt stronger prevention methods, whereas those who learn they are positive will change their behavior so as not to infect others (Holbrooke, 2004). There is little evidence to support these predictions of behavioral change. It is, however, reasonable to believe that in the absence of testing facilities, subjective assessments are likely to drive behavior. As has been said, "If men define situations as real, they are real in their consequences." (Thomas and Thomas, 1928: 572).

In this paper, I use a unique dataset from rural Malawi that includes respondents' HIV status as well as their subjective likelihood of HIV infection. These data show that 9% of husbands and 16% of wives estimate a medium or high likelihood of currently infection. Actual prevalence was much lower: 7% of men and 8% of women were HIV positive. The difference between the measures of self-assessed and objective HIV status raises an important question: why are so many wrong? This in turn leads to questions about the construction of subjective assessments. I thus begin by asking what are the characteristics of individuals that lead them to believe they are, or are not, already infected? I then evaluate the accuracy of their subjective probabilities against the evidence provided by biomarkers for HIV: what proportion of the respondents accurately identifies their HIV status, either positive or negative? Lastly, I distinguish between those who overestimate their risk and those who underestimate it, and ask what characteristics of individuals are associated with these their error.

I find that both men and women appear to use a set of heuristic rules to formulate probabilities that they are, or are not, infected. These heuristics are gendered, consistent with what researchers know are the primary routes of HIV transmission in the heterosexual epidemic of sub-Saharan Africa. Men rely on their knowledge of their own sexual behavior, but also take into account their perception of the prevalence of AIDS in their community. Women, who as a group are particularly concerned about their husband's behavior, rely on their assessments of his fidelity, as well as being influenced by perceived HIV prevalence. Both men and women, however, are more likely to overestimate their risk than to underestimate it, and the same heuristics that are their basis for their subjective estimates are also associated with their overestimation of risk.

Background

When many are at risk but few are tested, how do individuals assess risk and likelihood of HIV infection? In one sense, this is a relatively simple exercise: individuals use their knowledge of HIV transmission and apply this knowledge to their past behavior, to arrive at an estimation of their likelihood of HIV infection. A variety of surveys show that respondents in the highly AIDS-affected areas of sub-Saharan Africa know that AIDS is transmitted through sexual contact, they are very worried about becoming infected, and they know infection can be prevented by abstinence before marriage and fidelity after, or by consistent condom use (Kengeya-Kayondo et al, 1999; United Nations, 2002). By combining this knowledge with knowledge of their own behavior, people can estimate their own risk—and, because they are so worried, they do.

Yet the accuracy of subjective probability of HIV infection is questionable for several reasons. Researchers in social psychology and economics have examined the assessment of risk under uncertainty and the influence of these assessments on subsequent decisions

(Heimer, 1988; Kahneman, Slovic and Tversky, 1982). This research suggests that individuals use a set of heuristic rules to process judgments and formulate probabilities for uncertain outcomes. Due to biases in the process of probability estimation under circumstances of uncertainty (Montgomery, 2000; Rabin, 1998; Kahneman, Slovic and Tversky, 1982), heuristics used by individuals may lead to an incorrect assessment of probabilities. In addition, human rationality may be biased not only because the cognitive capacity of the individual is limited, but also because reasoning is restricted to the environment from which the individual originates (Simon, 1982).

Some aspects of the epidemiology of HIV magnify uncertainty. Most common infections are characterized by symptoms that occur shortly after infection, thus permitting individuals to link their symptoms to the source of infection. HIV infection is well known to be quite different. Moreover, the invisibility of HIV contributes to uncertainty. In rural Malawi, 92% of women and 95% of men know that a healthy-looking person can still be infected with HIV (see table 1). Furthermore, the length of time between HIV infection and exhibiting symptoms of AIDS makes it difficult for individuals to connect the event when AIDS transmission occurred and the resulting infection.

Although general knowledge of AIDS transmission is widespread, this knowledge is incomplete in three ways relevant for assessing one's own risk. First, 97% of male and 95% of female residents of rural Malawi believe that there is a high or certain likelihood of HIV infection from unprotected sex one time with an infected person (from 2001 MDICP survey data). The actual likelihood of infection in the absence of an STI is approximately one in a thousand (95% confidence interval: 0.0008–0.0015 per act of intercourse) (Gray et al. 2001). Second, married individuals are likely to know what has been risky about their own behavior, but to know less about the behavior of their spouse. Their observation of their spouse's comings and goings is limited by gendered patterns of work and social interaction; although their social network partners supplement their observation, this information may be imprecise and limited in detail (Clark, 2005; Watkins 2005; Kohler, 1997). Finally, partly because they overestimate the likelihood of HIV transmission in one act of intercourse, Malawians also overestimate the prevalence of HIV in their village.

In this paper, I investigate the construction, accuracy, and biases of subjective HIV/AIDS infection probabilities in rural Malawi. First, I identify factors influencing self-assessed likelihood of HIV infection. In assessing their likelihood of HIV infection, I hypothesize that rural Malawians use a set of heuristics based on their own sexual behavior, their understanding of HIV transmission, and the perceived sexual behavior of their spouse. To test the accuracy of subjective likelihood of infection, I then compare these self-assessments with actual HIV infection.

Next, I investigate the reasons for discrepancies between these measures by identifying possible biases in the heuristics identified above. I expect to find that biases in the heuristics identified above lead to inaccurate subjective estimates of HIV infection. For men, infidelity and higher subjective estimates of HIV prevalence in the community will lead to biases in self-assessed probability of infection. These heuristics are important for women, but suspected spousal infidelity and worry about spouse's behavior will be the primary source of bias in heuristics for women. These biases occur because women may suspect that their husbands are unfaithful but are unlikely to know the frequency of infidelity and condom use in the extramarital relationship.

The data for the analysis come from the Malawi Diffusion and Ideational Change (MDICP) Project, a longitudinal survey of ever-married women and their spouses in rural Malawi. These data are unusually appropriate because they are longitudinal, include biomarkers, and offer a variety of measures of risk perception. In comparison, very few available datasets that measure HIV/AIDS risk perception in sub-Saharan Africa also have objective measures of HIV status. Even when HIV status is available, self-assessed HIV infection likelihood is sometimes measured using only one variable, a limitation that is seldom acknowledged (Kengeya-Kayondo et al, 1999)[1]. In addition, most studies are cross-sectional, thus preventing assessments of changes in likelihood of infection over time, and in other attitudes and behaviors related HIV risk.

Setting and Data

When all the countries of the world are ranked by their HIV prevalence, Malawi is the eighth highest, with an estimated national prevalence of 14.6% of adults infected. The epidemic in Africa is predominantly heterosexual, with men most likely to be infected by pre-marital and extramarital partners, and women most likely to be infected by their husbands (de Zousa, Sweat and Denison, 1996; Heise and Elias, 1995; King et al, 1993;

[1] Risk perception measured by "Do you think you are at risk of becoming infected with HIV?" with responses of "Yes," "No," "Don't know," and "Already infected." Question comes from a survey conducted in Masaka District, Uganda; funded by the Medical Research Council (UK).

McKenna et al., 1997; Bracher, Santow and Watkins 2003). The prevention programs have emphasized the dangers of extramarital partners for men, although they have not yet incorporated the dangers that ordinary wives face from their husbands. It is interesting that women's concern about the impact of her husband on her own HIV status is consistent with findings elsewhere that the greatest actual source of risk of contracting HIV for women in sub-Saharan Africa is their husband or regular partner.

The data for the analysis come from the second and third wave of the Malawi Diffusion and Ideational Change Project, a panel survey that examines the role of social networks in changing attitudes and behavior regarding family size, family planning, and HIV/AIDS in rural Malawi. The first round of the MDICP (MDICP-1) was carried out in the summer of 1998, and interviewed 1541 ever-married women of childbearing age and 1065 husbands of the currently married women in three Malawi districts: Balaka in South, Mchinji in the Center and Rumphi in the North. In 2001 and 2004, the second and third rounds of the survey (MDICP-2 and MDICP-3) re-interviewed the same respondents and interviewed all their new spouses, if they had remarried between the two survey waves (more detailed information about fieldwork and sampling procedures can be found at http://malawi.pop.upenn.edu). MDICP-3 also collected biomarkers for HIV/AIDS and sexually transmitted infections for all respondents who agreed to be tested (the testing protocol is described in Bignami-Van Assche et al., 2004).

To identify the factors influencing self-assessed likelihood of HIV infection I use a variety of measures of risk perception from the MDICP-3. I then analyze the predictive power of these measures by comparing self-assessed likelihood of infection in the MDICP-3 with actual HIV infection as measured in the MDICP-3 for the same respondents[2]. The resulting sample size is 1126 women and 799 men.

Background characteristics for men and women in the sample are displayed in table 1. MDICP follows ever-married women, so almost all the men in our sample are married to women in the sample (a small number of men were followed after their marriage to a sampled wife ended). Because variables related to marriage are an important focus of the analysis, only married men and women are included in the sample. For both men and women, most respondents attended school, but left prior to secondary school. For measures of economic status, approximately 12% of both men and women lived in a house with an iron sheet roof, a sign of economic prosperity in rural Malawi, and more than half of the households both owned a bicycle and a radio. The HIV/AIDS prevalence in 2004 for these MDICP respondents is 7.8% for women and 7.4% for men, as shown in table 1.

Methods

Below I describe my methods for addressing the three topics of this paper: 1) the heuristics of subjective likelihood of current HIV infection, 2) the accuracy of self assessed likelihood of HIV infection, and 3) biases in the heuristics identified in the first section.

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[2] A small number of respondents (three men, five women) with indeterminate HIV test results were also discarded from this analysis.

Heuristics of Subjective Likelihood of Current HIV Infection

Here I isolate the components of the heuristics used by rural Malawians to assess their probability of current infection by describing the association between their reported HIV status and their characteristics, including those of their spouses. The dependent variable is "In your opinion, what is the likelihood (chance) that you are infected with HIV/AIDS by now?" Responses for these question are "No Likelihood," "Low," "Medium," "High," and "Don't know." Those responding "Don't know" are deleted from this analysis (see note 1).

I run ordered logistic regressions to identify the determinants of self-assessed probability of infection for respondents in 2004, in order to preserve as much information as possible from the original ordering of the response categories for subjective likelihood of HIV infection (see note 2). Under the proportional odds assumption, the effects of the explanatory variables are always the same regardless of how the dependent variable is dichotomized; any differences between coefficients in different dichotomizations are included in random error. Ordered logistic regression then estimates weighted averages from different dichotomizations as coefficients. In using ordered logistic regression, the dependent variable consists of J ordered categories, represented by 1, 2…J. When the categories are ordered, probabilities are cumulative: modeled as the probability that an individual gives a response in category J or higher. The Jth cumulative odds is then the probability of giving a response in the category J +1 or higher (Allison, 1999).

To examine the respondents' characteristics that associated with his or her report of current HIV status, I consider four categories of independent variables (shown in table 1). First are demographic variables: age, region of residence, level of education, marital status (men are assumed to be married), if the respondent is a polygamist husband or one of several wives, and measures of economic status (presence of a bicycle or radio in the household, and the material of the respondent's roof).

A respondent's own reported behavior is the second category of independent variables, and reported infidelity is included for this purpose. More than 20% of men report having been unfaithful to their current wife, and only 4% of women report being unfaithful. The literature shows that men are the primary source of HIV infection within marriage (Heise and Elias, 1995; King et al, 1993; Serwadda et al, 1995), in that their infidelity leads to their infection, and then to infection of their wife.

The next set of variables measures spouse's or cohabiting partner's perceived sexual activity. As mentioned above, reported infidelity is important in the spread of HIV in sub-Saharan Africa, as it is frequently husband's infidelity that leads to his infection, which is then passed to his wife. This is consistent with our survey reports of married women, who in 2004 considered their spouse to be their primary source of risk. Men also shared the view that they are the primary source of infection in their marriage: they reported "other partners" as their primary source of risk (Clark, 2005; Smith and Watkins, 2005). Variables measuring spouse's behavior include "During your time together, did you suspect or know that your current wife/husband had sexual relations with other men/women apart from you?" The responses for this variable are dichotomized into 1) know or suspect infidelity 2) can't, don't know, and 3) probably not. More than 35% of women in MDICP suspect or know that their husband is unfaithful, and only 12% of men say the same about their wife. The greatest source of concern for HIV infection is included, with response categories of 1) wife/husband, 2) other partners, and 3) other (transfusions, needle/injections). The respondent's opinion of the acceptability of condom use in marriage is also included. As shown in table 1, more than one quarter of both men and women report that they believe condom use within marriage to be acceptable.

The MDICP asked respondents with whom they had talked about AIDS. These social network partners people with whom have been shown to influence the extent to which respondents are worried about contracting AIDS (Helleringer and Kohler, 2005; Smith, 2001; Watkins, Kohler and Behrman, 2000). Thus, a characteristic of social networks is included in the regression: the number of people spoken to about AIDS. It is likely that subjective risk assessments may be influenced not only by network partners, but by perceptions of the prevalence of AIDS in the respondent's community: presumably, the more a person perceives that others are infected, the more he or she will feel at risk. We thus include the respondent's of the number of people known to have died of AIDS in the past 12 months are also included. Although the absence of testing means that respondents do not know for sure whether someone has died of AIDS, the MDICP qualitative data show that people in the communities diagnose cause of death using much the same heuristics that we hypothesize influence their own subjective risk assessment, indicators of physical illness and local knowledge of the sexual behavior of their past partners (Watkins and Swidler 2005).

The accuracy of self-assessed likelihood of current HIV infection

Once the heuristics used by rural Malawian men and women to assess their likelihood of current HIV/AIDS infection have been identified, I proceed to an examination of the accuracy of these subjective assessments by comparing the subjective assessment with the results of the MDICP HIV testing. I am interested first in the accuracy of the assessment, and then in whether respondents over-or under-estimate their risk.

To assess the accuracy of current and future self-assessed likelihood of HIV infection, I first create tables of the percent HIV infected by self-assessed probability of infection, dichotomized into 1) respondents reporting no or low likelihood, and 2) those answering medium or high. Then, these tables are repeated with the "don't know" response included. In addition to self-assessed probability of current infection, we also test the accuracy of responses to "In your opinion, what is the likelihood (chance) that you will become infected with AIDS in the future?" and "How worried are you that you might catch AIDS?"

Biases in heuristics

Finally, I use the heuristics identified in section one to identify factors that influence the accuracy of self-assessed HIV infection likelihood. By identifying characteristics that differ by the accuracy of subjective assessment, I address the question: why are some respondents incorrect in their subjective assessment?

According to Tversky and Kahneman (1992), heuristics used to assess probabilities are subject to biases that frequently lead to inaccurate estimation. For example, using the "availability" heuristic, people assess probability of an event by the ease with which instances or occurrences can be recalled. Tversky and Kahneman discover biases in availability due to the fact that the ability for an event to be imagined does not always represent its frequency or probability. AIDS deaths may be events that are easy to recall in rural Malawi, which can lead to an inaccurate assessment of AIDS prevalence and biased subjective infection likelihood.

Also, the "adjustments and anchoring" heuristic refers to the initial point of an estimation that is adjusted for a final prediction. A starting point is often estimated in the process of evaluating the risk or problem, and is then adjusted in the calculation of one's risk likelihood. Incorrect starting points can bias this heuristic. For example, the assessment of HIV infection risk for an individual may first depend on their estimate of the prevalence of HIV in the community. If one overestimates the likelihood of HIV transmission in one act of sexual intercourse with an infected person, their subjective likelihood of HIV infection will be biased upward.

To identify factors that influence the accuracy of subjective HIV infection likelihood, I analyze the determinants of overestimation of current HIV infection. I consider only HIV uninfected respondents, and then run the same ordered logistic regressions in step 1 to identify the differences in reporting characteristics for these two groups, in order to find out why some respondents found themselves at high risk of HIV infection in 2001 but were found uninfected in 2004. Because all respondents in this analysis are HIV negative, the results of this ordered logistic regression will reveal reasons for overestimating likelihood of current HIV infection.

Results

Heuristics of Subjective Probability of HIV Infection- Results

Table 2 shows that, as expected, rural Malawians combine their knowledge of the main sources of infection in a heterosexually transmitted infection with their knowledge of their own past behavior and that of their spouse. Because male and female sexual behavior is perceived to differ, the components of the heuristics used to estimate subjective probabilities of infection are gendered.

Even a cursory glance at Table 2 shows gendered patterns of the components of heuristics used to assess the likelihood of infection. For men, their own reported infidelity is highly significant in the model, with unfaithful men 2.3 times more likely to be in a higher category of perceived likelihood than male respondents reporting fidelity to current wife or partner. It is interesting to note that men are also concerned about the behavior of their spouse. Men who believe their spouse was unfaithful are 2.6 times more likely to be in a higher category of self-perceived infection likelihood. However, the spouse is not the primary source of HIV infection worry for men. As shown in table 2, there is not a significant difference between spouse and other partners in determining self-assessed likelihood of infection. Men whose primary source of worry is from other sources (e.g. needle, razor) are less likely to be in a higher category of current HIV infection likelihood, however. Men are also influenced by their perception of the prevalence of AIDS in their community. It is likely that if the respondent perceives a higher prevalence, he concludes that his outside partners are more likely to be infected as well, and thus he himself is more likely to be infected. Men who speak with more people from the community are less likely to think they're infected, perhaps indicating that infected men keep their fears of current infection to themselves.

In contrast, the heuristics that women use to assess their likelihood of infection feature the behavior of their husband rather than their own behavior (although this is probably under-reported). Women who reported that they knew or suspected their husband of infidelity are 2.6 times more likely to be in a higher category of self-assessment, a highly significant variable in the model. Other measures of the husband's perceived behavior—her perception that her husband is the greatest potential source of her infection, and his polygamy—are also components of women's risk assessment. It is interesting that women who are willing to use a condom in marriage to avoid AIDS are more likely to be in a higher category of self-assessed probability of current infection: here, the direction is undoubtedly from the wife's fear of infection by her spouse to her willingness to use condoms in marriage, suggesting the possibility of an oncoming change in the acceptability of condom use in marriage. Perceived HIV prevalence is also important for women- women who report 1-4 people to have died of HIV in the past year are significantly more likely to think they're infected than women who report no HIV deaths. However, these results are not consistent for women, as those who report 5 or more deaths are more likely to think they're infected, but not significantly so.

The components of the heuristics used by men and women to assess their risk are consistent with research findings that show that indeed men's greatest risk is from extramarital partners, and women's greatest risk is from their husbands, suggesting that both men and women would be accurate in assessing their current HIV status.

Accuracy of Subjective Probability of HIV Infection- Results

Table 3 shows the percentages of respondents who are HIV-positive in 2004 by their subjective probability of current infection. Again, we see differences by gender. All respondents in this table are infected, but men are more likely to correctly believe they are infected than are women. 6% of female respondents who report a low likelihood of current HIV infection are, in fact, HIV positive in 2004, but 9% who report a high likelihood of current infection in 2001 are infected in 2004. In comparison, 6% of men who report they are not infected also are, but 14% of respondents who report a high likelihood of HIV infection are correct. The differences in HIV prevalence by self-assessment category are significant for men, but not for women, which reinforces that men are more accurate than women in assessing their HIV status. Only small percentages of infected men and women accurately report their likelihood of current HIV infection. When they are wrong, it is often because they think they are infected when they are not.

Table 4 includes the "don't know" responses with the categories in table 3. From this, it is revealed that the HIV prevalence among men who don't know their status is not very different from all men (7.4 to 5.4), there is a significant difference between women who claim they don't know their status and women who report a level of subjective infection likelihood. There is a HIV prevalence of almost 15% among women who report that they don't know their status, compared with an overall prevalence of less than 8% for women in the sample. This perhaps indicates reluctance on the part of rural women in Malawi to report a higher likelihood of current infection.

Table 5 reports similar results for the subjective likelihood of HIV infection in the future. Neither men or women are very accurate in assessing their future HIV status, using current HIV infection. 93% of women who report a low likelihood of HIV infection in the future are uninfected in 2004, and 9% of women who subjectively assess a high likelihood of infection in the future are infected in 2004. These figures show no improvement in accuracy in assessing HIV status for both women and men; again, however, the uninfected are more likely to be wrong than the infected.

As seen in table 6, another measure of risk perception, the level of worry of contracting HIV, is also not a reliable indicator of HIV infection for men: far more were worried that they would be infected than were. However, this measure is more accurate for women than subjective assessment of current status. About 10% of women who are "worried a lot" about contracting HIV are HIV positive in 2004, compared with 6% of women who are not worried about contracting HIV and 6% who were worried a little. For men, all three categories of worry have approximately the same HIV prevalence: 7-8%. While it has been demonstrated that social networks influence worry (Helleringer and Kohler, 2005; Smith, 2001), and that worry can also be used to measure behavior change (Smith and Watkins, 2005); it is important to note that worry does not accurately measure HIV infection among respondents, particularly for men in MDICP.

Overall, these results reveal that for men, there is a difference in HIV status prediction accuracy between respondents who self-assess a low and high likelihood of HIV infection. In general, respondents overestimate their risk, but the heuristics used by respondents work better for the infected than the uninfected. Again, we see a difference by gender. Women are less accurate than men. They also overestimate, but compared to the men, larger percentages of both uninfected infected are inaccurately assessing their current HIV status.

Biases in Heuristics- Results

We've seen from the above than man men and women in rural Malawi think they are infected but 2004 MDICP testing revealed that they were HIV negative. Because most men and women in rural Malawi know how HIV is transmitted and have a good understanding of the sources of their greatest risk—other partners for men, husbands for women, it is surprising that relatively large numbers believed they were already infected in 2001 but were not infected three years later. What are the reasons for this discrepancy between subjective probability of infection and actual infection status? My next question is why the uninfected overestimate their risk. To examine this, the analysis is of the uninfected: what leads them to think they are infected when they are not? The results are shown in table 7 (seen note 3).

To a considerable degree, the same heuristics that individuals use to estimate their subjective probabilities of infection also lead them to overestimate their infection status. Uninfected men reporting infidelity were more than five times more likely to think they were infected when they were not than were men who do not report infidelity.

And women who report that their husband is the greatest potential source of infection are particularly prone to overestimate their vulnerability. Similar to the results of the determinants of perceived risk presented earlier, men overestimate their risk when they perceive a higher HIV prevalence, and these results are significant but not consistent for women. There are interesting difference between these estimates and the previous analysis of the determinants of subjective risk. Here the significance of discussion about HIV is not significant in determining a higher level of likelihood for men. For women, there is some indication of an economic and schooling effect on correct assessment: women of higher education were more likely to be incorrect in their assessment than women without education. Also, women with an iron sheet roof and a radio were less likely to overestimate their current infection likelihood.

Region of residence is also associated with overestimating the likelihood of infection for women. Possible explanations for this are beyond the scope of this paper, but

Helleringer and Kohler (2005) describe important demographic and cultural differences between regions in Malawi, and some of these may contribute to the lesser likelihood of overestimation among women in Balaka.

The results in this section reinforce the hypothesized biases in heuristics used by rural Malawians to assess their likelihood of HIV infection. As seen from the above, men are more likely to overestimate their probability of HIV infection if they report infidelity and perceive a higher prevalence of HIV in the community. Women who are report infidelity or concern about the behavior of their spouse are more likely to overestimate their likelihood of HIV infection. This reinforces other research findings that women do not have accurate knowledge of their husband's possible infidelity, and social networks do not necessarily improve the accuracy of this knowledge for women (Clark, 2005).

Discussion and Conclusion

The results above indicate that, in the absence of VCT, men and women are nonetheless assessing the likelihood that they are infected or not. To do this, they heuristics that are consistent with what we know are the primary ways through which AIDS is transmitted in sub-Saharan Africa: the husband becomes infected from an extramarital partner and then passes the infection on to his wife. Our analyses of the determinants of these heuristics show that these are important for rural men and women in Malawi, and important for understanding the discrepancies between subjective and actual HIV status.

The discrepancies are gendered and systematic: women and men use different heuristics, and they both are more likely to overestimate than to underestimate risk. Men may be correct than an extramarital partner is infected, and women may be correct that their husband is, or soon will be, infected. What they do not assess correctly, however, is the transmission probabilities of HIV. As shown in table 1, more than 95% of both men and women believe AIDS is certain to be transmitted from one act of unprotected intercourse with an infected person. It is likely that this overestimate of transmission probabilities underlies the overestimation of infection.

There are potentially dangerous implications of these inaccurate estimates on the spread of HIV. Just as previous behavior influences the assessed likelihood of contracting HIV, some evidence indicates that these assessments are used to decide future sexual behavior. For example, Kaler (2003) describes sexually active men in rural Malawi, who believe they are already infected with HIV and use this unverified assumption to justify risky sexual activity. In contrast, some adolescents reportedly feel invulnerable to HIV infection and engage in risky activity as a result (Gage, 1998). Particular to HIV/AIDS, economic models of decision-making regarding sexual behavior include a component of self-assessed probability of infection that influences the decision to engage in risky sexual activity (Philippson and Posner, 1993).

Recent research also describes increasing efforts by individuals to lower their likelihood of HIV infection by assessing the probability of infection of potential sexual partners. For example, Smith and Watkins (2005) and Reniers (2005) describe divorce as a method of protection for women who fear HIV infection from their promiscuous husbands. Similarly, partner selection in sexual activity or marriage (Messersmith et al, 2000; Reniers, 2005; Watkins, 2004) also involves an assessment of the potential partner's likelihood of infection. These phenomenons implicitly involve a self-assessed likelihood of infection; if one is infected already, there is no reason for this caution.

This research reinforces the importance of HIV testing in high prevalence areas of sub-Saharan Africa. If people indeed act based on their perceived likelihood of infection, and these assessments can be inaccurate, rational action regarding the decision to engage in unprotected sex can potentially spread HIV. Access to testing prevents individuals from these discrepancies between actual and subjective HIV status.

Table 1: Background Characteristics of Married and HIV Tested Respondents from MDICP 2004

	Men N=799	Women N=1126
	Percentages	
HIV Prevalence	7.4	7.8
Self-Assessed Likelihood of Current HIV Infection		
No Likelihood	61	51
Low	18	18
Medium	4	7
High	5	9
Don't Know	12	15
1. Demographic Characteristics		
Age (average)	41	34
Marriage		
Polygamous Husband or Wife	15	12
Schooling		
None	14	27
Attended Primary School	70	67
Attended Secondary School or More	16	6
Region of Residence		
Balaka	37	38
Rumphi	33	34
Mchinji	30	28
Economic Variables		
Iron Sheet Roof	12	13
Bicycle	59	54
Radio	79	73
2. Own Behaviors		
Unfaithful to current spouse	20	3
3. Spouse's Behavior		
Believes spouse was unfaithful	12	37
Condom use with spouse is acceptable	29	38
Most worried about infection from:		
Spouse	18	40
Other partners	31	15
Any other source	51	45
4. Community/Social Characteristics		
Knows:		
No people who have died of AIDS in last 12 months	23	27
Between 1 and 4 died of AIDS in last 12 months	56	60
Five or more died of AIDS in last 12 months	18	8
Doesn't t know number died from AIDS in last 12 months	3	5
Average Number of people chatted with about AIDS (SD)	7.3 (15.6)	4.1 (4.4)

Table 2: Determinants of Subjective HIV Infection for Married Men and Women From 2004 MDICP		
	Men	**Women**
	N=639	**N=946**
	Odds Ratios	
1. Demographic Characteristics		
Age	1.01	1.00
Marriage		
Polygamous Husband or Wife	0.77	1.88**
Schooling		
None (reference)		
Attended Primary School	0.69	1.37
Attended Secondary School or More	0.92	1.67
Region of Residence		
Balaka	0.82	0.59**
Rumphi (reference)		
Mchinji	0.96	1.08
Economic Variables		
Iron Sheet Roof	1.08	0.77
Bicycle	1.40*	1.15
Radio	1.78	0.78
2. Own Behaviors		
Unfaithful to current spouse	2.26***	0.56
3. Spouse's Behavior		
Believes spouse was unfaithful	2.59***	2.58***
Condom use with spouse is acceptable	1.19	1.53***
Most worried about infection from:		
Spouse (reference)		
Other partners	0.72	0.53***
Any other source	0.36***	0.21***
4. Community/Social Characteristics		
No people who have died of AIDS in last 12 months (reference)		
Between 1 and 4 died of AIDS in last 12 months	1.43	1.49**
Five or more died of AIDS in last 12 months	2.31***	1.45
Doesn't t know number died from AIDS in last 12 months	1.12	2.01*
Spoke to No People About HIV/AIDS (reference)		
Spoke to 1-4 People About HIV/AIDS	0.55*	1.10
Spoke to 5 or More People About HIV/AIDS	0.53*	1.19
*Significant <.10 **significant < .05 *** significant < .01		

Table 3: Percentages HIV Infected by Self Assessment of Current Infection Likelihood and Gender		
Gender	Percentage HIV Positive (Number) Self Assessment	
	Low	High
Women	6.1% (47)	8.8% (16)
Pearson chi2(1) = 1.85 Pr=0.17		
Men	6.6% (42)	14.3% (10)
Pearson chi2(1) = 5.4 Pr = 0.02		

Table 4: Percentages HIV Infected by Self Assessment of Current Infection Likelihood and Gender (Including 'Don't Know' Responses)			
Gender	Percentage HIV Positive (Number) Self Assessment		
	Low	High	Don't Know
Women	6.1% (47)	8.8% (16)	14.8 (24)
Pearson chi2(2) = 14.6785 Pr = 0.001			
Men	6.6% (42)	14.3% (10)	5.4 (7)
Pearson chi2(2) = 6.04 Pr = 0.050			

Table 5: Percentages HIV Infected by Self Assessment of Future Infection Likelihood and Gender

Gender	Percentage HIV Positive (Number) Self Assessment: Low	High
Women	6.9% (43)	8.9% (26)
	Pearson chi2(1) = 1.2330 Pr = 0.267	
Men	7.5% (42)	9.5% (13)
	Pearson chi2(1) = 0.6082 Pr = 0.435	

Table 6: Percentages HIV Infected by Level of HIV Worry and Gender

Gender	Percentages HIV Positive (Number) Level of Worry: Not Worried	Worried A Little	Worried a Lot
Women	5.9% (20)	5.6% (14)	9.6% (49)
	Pearson chi2(2) = 5.8609 Pr = 0.053		
Men	7.2% (20)	8.1% (17)	7.3% (22)
	Pearson chi2(2) = 0.1567 Pr = 0.925		

Table 7: Determinants of Incorrect Prediction of HIV Status Among HIV Uninfected Respondents		
	Men N=596	Women N=863
	Odds Ratios	
1. Demographic Characteristics		
Age	1.00	1.00
Marriage		
Polygamous Husband or Wife	0.84	1.78**
Schooling		
None (reference)		
Attended Primary School	0.75	1.33
Attended Secondary School or More	1.09	1.84*
Region of Residence		
Balaka	0.87	0.61**
Rumphi (reference)		
Mchinji	1.08	0.99
Economic Variables		
Iron Sheet Roof	0.97	0.67*
Bicycle	1.41*	1.19
Radio	1.07	0.71*
2. Own Behaviors		
Unfaithful to current spouse	2.17***	0.71
3. Spouse's Behavior		
Believes spouse was unfaithful	2.64***	2.71***
Condom use with spouse is acceptable	1.21	1.49***
Most worried about infection from:		
Spouse (reference)		
Other partners	0.84	0.53***
Any other source	0.38***	0.21***
4. Community/Social Characteristics		
No people who have died of AIDS in last 12 months (reference)		
Between 1 and 4 died of AIDS in last 12 months	1.46	1.57**
Five or more died of AIDS in last 12 months	2.44***	1.54
Doesn't t know number died from AIDS in last 12 months	1.30	2.25**
Spoke to No People About HIV/AIDS (reference)		
Spoke to 1-4 People About HIV/AIDS	0.62	1.09
Spoke to 5 or More People About HIV/AIDS	0.50*	1.17
*Significant <.10 **significant < .05 *** significant < .01		

Notes

1. We omit the respondents who "don't know" their likelihood of current HIV infection after running the regressions in step 1 and step 3 with the "don't know" category included. When including the "don't know" category, we merge with those reporting a high likelihood of current infection, since a relatively high percentage of respondents reporting "don't know" are HIV positive (as seen in table 4). When running regressions in tables 2 and 7 with the "don't know" responses included, I found that the inclusion does not change the significance (or dramatically change the coefficients) of other categories of current infection assessment, for men or women.

2. For this assessment, we chose to use ordered logistic regression instead of binary logistic regression, ordinary least squares regression, or multinomial logit. As mentioned above, we prefer ordered logistic regression to binary logistic regression to retain as much information as possible from the ordering of responses in the variable. We do not use OLS regression because, although the scale between "no likelihood" and "high" likelihood of infection could be assumed to be continuous, the nature of the dependent variable is categorized. Therefore, we find the interpretation of odds ratios in ordered logistic regression to be more suitable. However, we later claim that the distance between all response categories is not the same, which violates the proportional odds assumption of ordered logistic regression. In other words, the difference between "low" and "medium" likelihood of current infection may not be the same as between "no likelihood" and "low." Therefore, multinomial logistic regression should be the best option for this regression. After running a multinomial regression, we find that the values (and level of significance) of odds ratios for independent variables are very close between ordered and multinomial regressions. Because the interpretation of multinomial regression results is unnecessarily complex, for easier interpretation I use ordered logistic regression.

Bibliography

Allison, Paul D. 1999. Logistic Regression Using the SAS System: Theory and Application. SAS Institute Inc, Cary, N.C.

Becker, Marshall H., Lois A. Maiman, John P. Kirscht, Don P. Haefner, Robert H. Drachman. 1977. "The Health Belief Model and Prediction of Dietary Compliance: A Field Experiment." *Journal of Health and Social Behavior* 18 (4): 348-366.

Behrman, Jere, Hans-Peter Kohler and Susan Watkins. Forthcoming. "Social Networks, HIV/AIDS and Risk Perceptions."

Bignami-Van Assche et al., 2004. "Research Protocol for Collecting STI and Biomarker Samples in Malawi, 2004" Forthcoming.

Bracher, M., Santow, G., & Watkins, S. C. (2003). *A microsimulation study of the effects of divorce and remarriage on lifetime risk of HIV/AIDS in rural Malawi*. Paper presented at the Annual Meeting of the Population Association of America, Minneapolis, MN.

Caldwell, John C. 2000. "Rethinking the African AIDS Epidemic." *Population and Development Review* 26 (1): 117-135.

Clark, Shelley. Forthcoming. "Understanding Perceptions of HIV Risks Among Married Couples: Why do Wives Worry More?"

de Zoysa, I., Sweat, M.D. and Denison, J.A., 1996. "Faithful but fearful: Reducing HIV transmission in stable relationships". *AIDS,* 10 Suppl. A, pp. S197–S203.

Gregson, Simona, Tom Zhuwau, Roy M. Anderson and Stephen K. Chandiwana 1998. "Is there evidence for behaviour change in response to AIDS in rural Zimbabwe?" *Social Science and Medicine*, Vol. 46, Issue 3.

Gray et al. 2001. "Probability of HIV-1 Transmission Per Coital Act in Monogamous, Heterosexual, HIV-1 Discordant Couples in Rakai, Uganda," *The Lancet* 357.

Heimer, Carol A. 1988. "Social Structure, Psychology, and the Estimation of Risk." *Annual Review of Sociology* 14: 491-519.

Heise, L.L. and Elias, C., 1995. "Transforming AIDS prevention to meet women's needs. A focus on developing countries". *Social Science and Medicine* 40 7, pp. 931–943.

Helleringer, Stephane, and Hans-Peter Kohler. Forthcoming. "Social Networks, Risk Perceptions and Changing Attitudes Towards HIV/AIDS: New Evidence from Rural Malawi."

Holbrooke, Richard, 2004. Council on Foreign Relations.

http://www.usembassy.it/file2004_04/alia/a4042802.htm

Kahneman, Daniel, Paul Slovic, Amos Tversky. Judgment Under Uncertainty: Heuristics and Biases. Cambridge University Press, 1982.

Kaler, Amy. "'My Girlfriends Could Fill a Yanu-Yanu Bus': Rural Malawian Men's Claims About Their Own Serostatus." *Demographic Research* Special Collection 1: Article 11.

Kengeya-Kayondo, Jane F.; Carpenter, Lucy M.; Kintu, Peter M.; Nabaitu, Januario; Pool, Robert; Whitworth, James A. G. 1999. "Risk Perception and HIV-1 Prevalence in 15,000 Adults in Rural South-West Uganda." *AIDS*. 13(16): 2295-2302.

King, R., Allen, S., Serufilira, A., Karita, E. and Van de Perre, P., 1993. "Voluntary confidential HIV testing for couples in Kigali, Rwanda". *AIDS* **7** 10, pp. 1393–1394.

Kohler, Hans-Peter. 1997. "Learning in Social Networks and Contraceptive Choice." *Demography*, 34(3):369-383.

Lurie, Mark N a,b; Williams, Brian G c; Zuma, Khangelani a,d; Mkaya-Mwamburi, David a; Garnett, Geoff P e; Sweat, Michael D f; Gittelsohn, Joel f; Karim, Salim SAbdool g. 2003. "Who infects whom? HIV-1 concordance and discordance among migrant and non-migrant couples in South Africa". *AIDS*. 17(15):2245-2252.

McKenna, S.L., Muyinda, G.K., Roth, D., Mwali, M., Ng'andu, N., Myrick, A., Luo, C., Priddy, F.H., Hall, V.M., von Lieven, A.A., Sabatino, J.R., Mark, K. and Allen, S.A., 1997. "Rapid HIV testing and counseling for voluntary testing centers in Africa". *AIDS* 11 Suppl. 1, pp. S103–S110.

Messersmith, Lisa J., Thomas T. Kane, Adetanwa I. Odebiyi, Alfred A. Adewuyi. 2000. "Who's at Risk? Men's STD Experience and Condom Use in Southwest Nigeria." *Studies in Family Planning* 31 (3): 203-216.

Montgomery, Mark R. 2000. "Perceiving Mortality Decline." *Population and Development Review*, 26 (4): 795-819.

Mwaluko, Gabriel; Urassa, Mark; Isingo, Raphael; Zaba, Basia; Boerma, J Ties. 2003. **"**Trends in HIV and Sexual Behaviour in a Longitudinal Study in a Rural Population in Tanzania 1994-2000." *AIDS*. 17(18): 2645-2651.

Rabin, Matthew. 1998. "Psychology and Economics." *Journal of Economic Literature*,

Serwadda D, Gray RH, Wawer MJ, Stallinger RY, Sewankambo NK, Kunde-Lule JK. "The social dynamics of HIV transmission as reflected through discordant couples in rural Uganda". *AIDS* 1995; 9:745-750**.**

Simon, H.A. Models of bounded rationality, volume 2. MIT Press, 1982.

Smith, Kirsten P. 2003. "Why Are They Worried? Concern About HIV/AIDS in Rural Malawi." *Demographic Research* Special Collection 1: Article 9.

W.I. Thomas and D.S. Thomas (1928). The Child in America: Behavior Problems and Programs. New York: Alfred A. Knopf

UNAIDS, UNICEF, WHO. 2004. "Malawi: Epidemiological Fact Sheet on HIV/AIDS and Sexually Transmitted Infections".

UNAIDS, 1999. "Sexual Behavior Change for HIV: Where Have Theories Taken Us?" Pp. 3-55. Geneva, Switzerland: WHO.

UNAIDS, "Consultative Meeting on HIV Testing and Counseling in the African Region: A Report" UNAIDS, 2005
http://www.unaids.org/NetTools/Misc/DocInfo/CounsellingAfricaReport.bpdf

UNAIDS/WHO. 2004. "UNAIDS/WHO Policy on HIV Testing".
http://www.unaids.org/html/pub/una-docs/hivtestingpolicy_en_pdf.pdf

United Nations. (2002). HIV/AIDS awareness and behavior [WWW document]. URL **http://www.un.org/esa/population/publications/AIDS_awareness/AIDS_English.pdf.**

Watkins, Susan. 2004. "Navigating AIDS in Rural Malawi". *Population and Development Review* 30(4): 673-705.

White, Richard; Cleland, John; Caraël, Michel "Links between premarital sexual behaviour and extramarital intercourse: a multi-site analysis." *AIDS*: Volume 14(15) 20 October 2000 pp 2323-2331.

WHO. 2003. "New Approaches to Counseling and Testing"
http://www.who.int/hiv/pub/vct/pub34/en/