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*Research Article*

# Overestimating HIV infection:
# The construction and accuracy of subjective
# probabilities of HIV infection in rural Malawi

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## Abstract

In the absence of HIV testing, how do rural Malawians assess their HIV status? In this paper, we use a unique dataset that includes respondents' HIV status as well as their subjective likelihood of HIV infection. These data show that many rural Malawians overestimate their likelihood of current HIV infection. The discrepancy between actual and perceived status raises an important question: Why are so many wrong? We begin by identifying determinants of self-assessed HIV status, and then compare these assessments with HIV biomarker results. Finally, we ask what characteristics of individuals are associated with errors in self-assessments.

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## 1. Introduction

The rise of HIV infection during the early years of the AIDS epidemic resulted in a rapid increase in mortality – particularly during adulthood – in eastern and southern Africa, with further increases in AIDS-related mortality projected for the next decade (Timaeus and Jasseh 2004). For individuals, such changes in mortality levels often result in considerable *uncertainty* about the magnitude of risk (Montgomery 2000). This uncertainty is heightened due to information constraints in sub-Saharan Africa (SSA), as accurate up-to-date information about changing mortality conditions is often not available for many, particularly those residing in rural areas.  Moreover, this uncertainty is likely to be particularly severe in the context of HIV, where the long latency period between infection and death makes it difficult to connect the source of infection with deaths a decade or so later.

In the low- and middle-income countries of sub-Saharan Africa, people facing the tide of the AIDS epidemic have little alternative but to rely on subjective assessments of their HIV status. Virtually all living in highly AIDS-affected areas of SSA 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 think that they have already been infected.  However, 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) that provides the possibility for individuals to confirm their HIV status.  The few existing VCT centers are concentrated in urban areas, making certainty particularly difficult for rural residents.[3]  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 maintain that in the absence of testing facilities, subjective assessments are likely to drive behavior.  As has been said, "If [people]

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[3] Whereas relatively few MDICP respondents had access to HIV testing facilities prior to 2004, the number of HIV testing centers has rapidly increased since 2004.  For example, the number of people tested for HIV in Malawi more than doubled between 2004 and 2005, to 440,000; and by December 2005 there were 239 approved VCT sites, compared to 11 in 2004 (Department for International Development 2005).  By 2005, VCT was available in all 23 of the district hospitals in Malawi (National AIDS Commission 2006). Furthermore, in 2005 the Government of Malawi developed a 5-year plan for expansion of VCT services throughout the country from which it is expected that nearly three million Malawians will access VCT by 2010 (Malawi Ministry of Health 2006).

define situations as real, they are real in their consequences." (Thomas and Thomas 1928: 572).

In this paper, we use a unique dataset from rural Malawi that includes respondents' HIV status as well as their subjective assessment of currently being infected with HIV. These data show that 12% of rural Malawian men and women estimate a medium or high likelihood of current infection. At 7%, actual prevalence was significantly lower. (Obare et al, 2008). The difference between the measures of self-assessed and objective HIV status raises important questions: How accurate are rural Malawians in assessing their HIV status, and why are these self-assessments incorrect?[4] Addressing this question is related to the important issue of subjective HIV risk assessment construction. In this paper, we therefore begin by identifying characteristics or beliefs that lead individuals to believe they are, or are not, already infected. We 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, we distinguish between those who overestimate their risk and those who underestimate it, and identify individual characteristics that are associated with this error.

We 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 wife's behavior and 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, and are also 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 the basis for their subjective estimates are also associated with their overestimation of risk.

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[4] Due to the stochastic element in HIV transmission, it is possible at the individual level for one to estimate a high likelihood of HIV infection but nonetheless be HIV negative (i.e. an individual may have engaged in repeated risk activity but nonetheless be HIV negative by chance). In this case, the individual is not 'incorrect' if they assess a high likelihood of current infection with HIV. However, for a population who understands basic transmission facts about HIV, we expect there to be correspondence between subjective risks and actual HIV infection at the population level. Thus, our description of subjective beliefs as "correct" and "incorrect" is a population-level statement and does not necessarily hold at the individual level.

## 2. Background

When many are at risk but few are tested, how do individuals assess risk and likelihood of HIV infection? In principle, individuals could engage in simple calculations to estimate their infection risk. For instance, they might 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. Or they could try to make inferences by observing the extent of deaths attributed to AIDS in their environment, and then make inferences about their own status from the mortality of individuals with similar characteristics. Some evidence suggests that both processes might be occurring: 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, are very worried about becoming infected, and know infection can be prevented by abstinence before marriage and fidelity after, or by consistent condom use (Kengeya-Kayondo et al 1999). Other studies have shown that heightened concerns about HIV infection are associated with conversations with others who are also concerned and with the number of persons that a respondent believes have died of AIDS (Kohler, Behrman and Watkins 2007).

Yet the accuracy of subjective estimates 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. Heuristics are typically defined as simple rules, either learned or inherent to evolutionary processes, which have been proposed to explain how people make decisions, come to judgments, and solve problems, typically when facing complex problems or incomplete information. However, heuristics often suffer from biases that can lead to inaccurate estimation of risk or evaluation of problems (Montgomery 2000; Rabin 1998; Kahneman et al. 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 (from 2004 Malawi Diffusion and Ideational Change Project survey data). 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 among residents of Malawi (Watkins 2004), 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 likelihood or even certainty of HIV infection from a single instance of unprotected sex with an infected person (from 2001 Malawi Diffusion and Ideational Change Project survey data).  The actual likelihood of infection, in the absence of an increased viral load or sexually transmitted infection, 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 aspects of their own past behaviors that were associated with increased HIV infection risks, but they have less knowledge about such behaviors of their spouses. In particular, their observation of their spouse's comings and goings is limited by gendered patterns of work and social interaction.  Although their social network partners may speculate and offer their own observations, this information may be imprecise and limited in detail, and therefore fails to improve knowledge of a spouse's behavior (Watkins 2004; Kohler 1997).  Finally, likely because many overestimate the likelihood of HIV transmission in one act of intercourse, many also overestimate the prevalence of HIV in their village (Anglewicz 2007).

In this paper, we investigate the construction and accuracy of subjective HIV/AIDS infection probabilities in rural Malawi.  First, we identify factors influencing self-assessed likelihood of HIV infection.   In assessing their likelihood of HIV infection, we hypothesize that rural Malawians use a set of heuristics.  In the context of this paper, we define heuristics as a set of rules that individuals use to assess their personal risk of HIV infection, under the uncertainty of not knowing their HIV status due to the absence of testing.  We expect that rural Malawians will use 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, we then compare these self-assessments with actual HIV infection.

Next, we investigate possible reasons for discrepancies between these measures by identifying possible biases in the heuristics identified above.  We expect to find that biases in these heuristics lead to inaccurate subjective estimates of HIV infection.  For men, reported infidelity and higher subjective estimates of HIV prevalence in the community will lead to biases in self-assessed probability of infection.  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 2001 and 2004 rounds of the Malawi Diffusion and Ideational Change Project (MDICP), a longitudinal survey of ever-married women and their spouses in rural Malawi.   These data are unusually appropriate because they include biomarkers and offer more than one measure 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 generally measured using only one variable that uses a likelihood-based scale (not likely, somewhat likely, very likely), a limitation that is seldom acknowledged (one exception is Delavande and Kohler 2007).


# 3. Setting and data

Malawi is among countries with the highest HIV prevalence, with an estimated national prevalence of 11.8% of adults aged 15-49 infected (Demographic and Health Surveys, 2004). The epidemic in Africa is predominantly heterosexual, and the majority of new HIV infections occur within discordant couples in long-term stable partnerships (Dunkle et al. 2008, Hudson 1996, Robinson et al. 1999). Early research on patterns of HIV infection in sub-Saharan Africa suggested that men are most likely to be infected by pre-marital and extramarital partners, and women most likely to be infected by their husbands (de Zoysa, Sweat and Denison 1996; Heise and Elias 1995; King et al 1993; McKenna et al. 1997). However, more recent evidence suggests that extramarital sexual activity among women is likely to be dramatically underreported, and spousal infidelity is also a substantial source of HIV infection risk for men – although the HIV risk faced by women from their husbands still appears to be greater in most sub-Saharan African countries (de Walque 2007).

The data for the analysis come from the second and third wave of the Malawi Diffusion and Ideational Change Project (MDICP), 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 1998, at which time MDICP interviewed 1541 ever-married women of childbearing age and 1065 husbands of the currently married women in three districts of Malawi: Balaka in the Southern region, Mchinji in the Central region, 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 along with new spouses for respondents who remarried between the two survey waves (more detailed information about fieldwork and sampling procedures can be found at http://www.malawi.pop.upenn.edu/; see also Watkins et al. 2003 and Anglewicz et al. 2007). MDICP-3 also added a sample of approximately 1,000 adolescents between the ages of 15-25, and 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).

Low HIV prevalence for never-married adolescents in the MDICP sample (1.7% for boys and 1.4% for girls aged 15-25) confirms micro-simulation estimates that most rural Malawians marry at ages when few are HIV positive (Bracher, Santow and Watkins 2003). Because, as noted above, married men and women are the population most at risk of contracting HIV, and many of the variables most relevant to HIV risk perception are related to marital behaviors and beliefs, we limit this analysis to currently married men and women in the MDICP sample. The resulting sample size is 1100 women and 833 men.[5]

Background characteristics for men and women in the selected sample are displayed in Table 1. Most men and women have some education but did not attend secondary school. Approximately 13% 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 owned a bicycle and a radio. The HIV prevalence in 2004 for these MDICP respondents is 6.6% for women and 7.1% for men.

Gender differences in HIV risk perception and behavior are apparent in Table 1. Not surprisingly, men report being unfaithful to their spouse more frequently than women; as a corollary more women suspect infidelity from their spouse, are more willing to use condoms within marriage to protect themselves from HIV infection, and are more worried of becoming infected from their spouse than from other sexual partners.

# 4. Results

## 4.1 Heuristics of subjective probability of HIV infection

First, we estimate factors in respondent's heuristics contributing to the formation of subjective risk assessments used by rural Malawians to assess their probability of current infection. To do so, we describe the association between their reported HIV status and characteristics, perceptions, and reported behavior for individuals and 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 this question are "No Likelihood," "Low," "Medium," "High," and "Don't know." Those responding "Don't know" are removed from this analysis.[6]

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

[6] We omit the respondents who "don't know" their likelihood of current HIV infection from the regressions presented in Tables 2 and 8. Assuming that the "don't know" response could be the result of social

**Table 1:** **2004 MDICP background characteristics of married and HIV tested men and women**

|  | Men N=833 | Women N=1100 |
|---|---|---|
|  | **Percentages** (unless otherwise indicated ) | |
| **HIV prevalence** | 7.1 | 6.6 |
| **Self-Assessed Likelihood of Current HIV Infection** | | |
| No likelihood | 60 | 51 |
| Low | 20 | 18 |
| Medium | 4 | 7 |
| High | 4 | 10 |
| Don't know | 12 | 14 |
| **Demographic Characteristics** | | |
| Age (average) | 41 | 34 |
| **Marriage** | | |
| Polygamous husband or wife | 11 | 14 |
| **Schooling** | | |
| None | 18 | 27 |
| Attended primary school | 67 | 67 |
| Attended secondary school or higher | 15 | 6 |
| **Region of Residence** | | |
| South | 38 | 38 |
| North | 34 | 34 |
| Central | 29 | 28 |
| **Economic Variables** | | |
| Iron sheet roof | 13 | 13 |
| Bicycle | 58 | 54 |
| Radio | 79 | 72 |
| **Own Behaviors** | | |
| Unfaithful to current spouse | 20 | 3 |
| **Spouse's Behavior** | | |
| Respondent knows or suspects spouse was unfaithful | 10 | 35 |
| Condom use with spouse is acceptable | 30 | 39 |
| Most worried about infection from: | | |
| Spouse | 17 | 40 |
| Other partners | 32 | 15 |
| Any other source | 51 | 45 |
| **Community/Social Characteristics** | | |
| Perceived number of people who died of AIDS in last 12 months | | |
| Nobody died of AIDS in last 12 months | 24 | 27 |
| From one to four | 56 | 55 |
| Five or more | 17 | 14 |
| Doesn't know | 3 | 4 |
| Average number of people chatted with about AIDS (SD) | 7.3 (15.6) | 4.1 (4.4) |

desirability bias and respondents who report "don't know" in fact think there's a high chance of their infection, we included this response with the "high" likelihood of infection in these regressions, and found no significant differences in regression results.

Because the dependent variable (likelihood of infection) consists of four ranked categories, we use ordered logistic regressions to identify the determinants of self-assessed probability of infection.[7]  Under the proportional odds assumption in an ordered logistic regression model, the effects of the explanatory variables are always the same regardless of how the dependent variable is dichotomized.  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 and can be modeled as the probability that an individual gives a response in category *J* or higher.  The *J*th cumulative odds is then the probability of giving a response in the category *J* +1 or higher as opposed to *J* or lower.  The log of these odds can be modeled as a linear regression (Allison 1999).

To examine how respondents' characteristics, perceptions, and behaviors are associated with his or her estimated current HIV status, we consider four categories of independent variables (shown in Table 1).  First are the demographic variables: age, region of residence, level of education, 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 particularly relevant for this analysis.  Approximately 20% of men report having been unfaithful to their current wife, and less than 3% of women report being unfaithful.  This reporting pattern is compatible with literature, which suggests that individuals frequently become infected with HIV through their spouse, who has become infected through extramarital sexual relations (de Walque 2007, Dunkle et al. 2008, Hudson 1996, Robinson et al. 1999).

The next set of variables measures individuals' reported sexual activity of their spouse or cohabiting partner.  As mentioned above, extramarital sexual activity is an important factor in the spread of HIV in sub-Saharan Africa.  This is consistent with MDICP survey reports of married women, who in 2004 considered their spouse to be a primary source of HIV infection risk. Men appear to share the view that they are the primary source of infection in their marriage: they reported extramarital partners as

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[7] For this assessment, we chose to use ordered logistic regression instead of binary logistic regression, ordinary least squares regression, or multinomial logit.  First, we prefer ordered logistic regression to binary logistic regression to retain as much information as possible from the ordering of responses in the variable. Second, 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.  Finally, for ease of interpretation we again prefer ordered logistic regression over multinomial regression for these analyses.

their primary source of risk (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 divided into 1) know or suspect infidelity, 2) can't or don't know, and 3) probably not. More than one third of all women in MDICP suspect or know that their husband is unfaithful. Fewer men suspect their wife was unfaithful (10%), but the percentage of men who suspect infidelity is much larger than the percentage of women reporting infidelity (3%). 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.

Finally, we include a set of variables that measure community and social characteristics. It is likely that subjective risk assessments are influenced 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 reported number of people known or believed to have died of AIDS in the past 12 months. 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 2006). We also include a variable measuring the number of people spoken to about AIDS to control for social interactions that may be associated with perceptions about HIV/AIDS infection.

It is important to note that the multivariate analysis we use in this and subsequent sections of this paper does not allow us to make any causal claims about the relationship between HIV risk perception and behavior, for at least two reasons. First of all, it is possible that the direction of causality between risk perception and behavior goes in both directions: people who have engaged in risk behavior in the past are more likely to perceive a higher risk of HIV infection; and conversely, people with a higher perceived risk are more likely to reduce risk behavior. In addition, there are likely to be several variables that may influence both risk perception and behavior that are missing from our regressions, such as measures of knowledge of HIV transmission. As a result of these methodological concerns, we emphasize that only the association between risk perception and behavior can be found in our regression results, and not a causal relationship between risk and behavior. Because of the general lack of empirical analyses on the determinants of HIV risk perceptions in sub-Saharan Africa, even the descriptive analyses presented in this paper are of considerable importance for improving our understanding of these relationships.

The evidence in Table 2 suggests that, as expected, rural Malawians combine their knowledge of the main sources of HIV infection in SSA 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. However, both men and women agree that spousal infidelity is an important determinant of HIV infection risk.

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; unfaithful men have approximately two times greater odds of being in a higher category of perceived likelihood than male respondents reporting fidelity to their 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 have 2.7 times higher odds of being in a higher category of self-perceived infection likelihood. 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 believe that they are currently infected, 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. Women who reported that they knew or suspected their husband of infidelity are 2.3 times more likely to be in a higher category of self-assessment, a highly significant variable in the model. Another measure of the husband's perceived behavior — her perception that her husband is the greatest potential source of her infection — is also an important component 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 likely from the wife's fear of infection by her spouse, which suggests the possibility of an oncoming change in the acceptability of condom use in marriage among Malawians. 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 are infected than women who report no HIV deaths. Unlike for men, women's reported infidelity is not

**Table 2:** **Ordered logistic regression results for the determinants of subjective HIV infection for 2004 MDICP married men and women**

| | Men N=725 | Women N=924 |
|---|---|---|
| | Odds Ratios | |
| **Demographic Characteristics** | | |
| Age | 0.99 | 1.00 |
| **Marriage** | | |
| Polygamous husband or wife | 0.75 | 1.06 |
| **Schooling** | | |
| None | (ref) | (ref) |
| Attended primary school | 0.86 | 1.37 |
| Attended secondary school or more | 0.95 | 1.56 |
| **Region of Residence** | | |
| South | 0.74 | 0.70* |
| North | (ref) | (ref) |
| Central | 0.85 | 1.10 |
| **Economic Variables** | | |
| Iron sheet roof | 0.93 | 1.35 |
| Bicycle | 1.47** | 1.06 |
| Radio | 0.81 | 0.75* |
| **Own Behaviors** | | |
| Unfaithful to current spouse | 1.98*** | 0.61 |
| **Spouse's Behavior** | | |
| Respondent knows or suspects that spouse was unfaithful | 2.67*** | 2.31*** |
| Condom use with spouse is acceptable | 1.25 | 1.45*** |
| Most worried about infection from: | | |
| Spouse | (ref) | (ref) |
| Other partners | 0.77 | 0.53*** |
| Any other source | 0.34*** | 0.21*** |
| **Community/Social Characteristics** | | |
| Perceived number of people who died of AIDS in last 12 months | | |
| Nobody died of AIDS in last 12 months | (ref) | (ref) |
| From one to four | 1.29 | 1.46** |
| Five or more | 1.99** | 1.08 |
| Doesn't know | 1.01 | 2.13** |
| Number people spoken to about HIV/AIDS | | |
| Spoke to no one | (ref) | (ref) |
| Spoke to one to four people | 0.54** | 0.95 |
| Spoke to five or more people | 0.53** | 1.06 |

*Significant <.10  **significant < .05   *** significant < .01
Note: Regressions drop 11 male and 18 female respondents with missing values for various variables.

associated with greater perceived risk of HIV infection. However, it is likely that marital infidelity is underreported by female MDICP respondents – a trend that has been suggested in several other countries in sub-Saharan Africa (de Walque 2007).

Components of the heuristics used by men and women to assess their risk are consistent with research findings that show that indeed marital infidelity (either one's own, or a spouse's extramarital sexual relations) are a primary source of HIV infection risk (de Walque 2007, Dunkle et al. 2008, Hudson 1996, Robinson et al. 1999). This suggests that both men and women should be accurate in assessing their current HIV status.

## 4.2 Accuracy of subjective probability of HIV infection

Next we examine accuracy of these subjective assessments by comparing the subjective assessment with the results of the MDICP HIV testing. We are interested first in the accuracy of the assessment, and then in whether respondents over- or under-estimate their risk. Accuracy of risk perceptions about HIV infection in this context needs to be evaluated at the group or population level. In particular, due to the stochastic element in HIV – or any other disease – transmission, high past infection risks do not necessarily imply an HIV-positive status for a specific individual, and low prior infection risks are not always associated on the individual level with being HIV-negative. It is thus possible at the individual level for a person to correctly perceive a high likelihood of having been infected with HIV, but nonetheless being HIV-negative because the person "was lucky" and did not get infected despite the high HIV infection risks in the past. In this case, the individual is not "incorrect" if he/she assesses a high likelihood of current infection with HIV. On the group and population level, however, the stochastic elements in determining HIV infection during a single intercourse or other risk behaviors cancel out, and differences in past infection risks do translate into differential HIV prevalence. Hence, if individuals correctly understood how prior HIV infection risks translated into probabilities for being currently infected by HIV, for a population who understands basic transmission facts about HIV, we would expect a correspondence between subjective perceptions about being HIV-positive and actual HIV infection at the population or group level. In our subsequent discussions, therefore, if we characterize risk perceptions as being "correct" or "incorrect", we refer to this population/group level relation, acknowledging that on the individual level HIV infection risk and actual HIV status can diverge.

To evaluate accuracy of individual's subjective perceptions about HIV infection, we use two measures of risk perception from the MDICP-3: worry of AIDS infection ("How worried are you that you might catch AIDS?") and self-assessed likelihood of

infection.  We then analyze, as shown in Table 3, the predictive power of these measures by dichotomizing the risk perception variables into 1) respondents reporting no or low likelihood, and 2) those answering medium or high.[8]  Then, Table 4 shows the repeat of these analyses with the "don't know" response included.  Similar Tables are created for worry of HIV infection, where the response categories are "not worried," "worried a little," and "worried a lot"[9] (Tables 5 and 6).  We then compare these measures of perceived risk in the MDICP-3 with actual HIV infection as measured in the MDICP-3 for the same respondents.

The comparison between self-assessed likelihood of HIV infection and actual HIV infection, however, is complicated by the difficulty of interpreting likelihood-based scales in terms of numeric probabilities (Manski 2004). In this paper we assume that respondent's perception of a high likelihood of being HIV-positive corresponds to a fairly high probability – say, above 50% – of being infected with HIV; similarly, we assume that a no or low likelihood corresponds to a fairly low probability of HIV infection – say, below 5%. No directions were given to respondents about the interpretation of the likelihood-based scales in questions about subjective risk assessments, and only probabilistic subjective expectations, which have the disadvantage of being difficult to collect in sub-Saharan Africa due to low levels of literacy and numeracy, can provide direct evidence on how respondents interpret these scales (Delavande and Kohler 2007).  The above interpretation of the likelihood-based scales in terms of numeric infection probabilities is consistent with evidence collected in 2006 that allow the combination of likelihood-based risk assessments and numeric subjective probabilities (Devalande et al 2007).

Table 3 shows the percentages of respondents who are HIV-positive in 2004 by their subjective probability of current infection.  There are two important findings related to the accuracy of estimating HIV infection that can be seen in Table 3.

First, we see differences in accuracy of estimating HIV status by gender.  Both men and women who assess a low likelihood of infection are incorrect in assessing their HIV status at about the same frequency: 5-6% of male and female respondents who

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[8] We acknowledge that the responses for estimated likelihood of HIV infection in MDICP 2004 (no likelihood, low, medium and high) are qualitative categories, and we therefore assume that respondents do not interpret a "medium" or "high" likelihood of current HIV infection to represent a 5-10% likelihood, but a much higher likelihood.  The validity of this assumption is supported through analysis that compares the categorical likelihood of HIV infection used in this paper with a numeric probability.  Preliminary analyses of the 2006 data, for instance, indicate the following numeric infection probabilities which are very similar for men and women (Delavande, Kohler and Anglewicz, 2007): no likelihood: less than 2% subjective infection probability; low likelihood: around 10%; medium likelihood: around 25%; and high likelihood: above 50%.

[9] The "Don't know" category is not relevant for worry of HIV infection as it is for current and future likelihood of HIV infection: less than 2% and 1% of 2004 MDICP men and women, respectively, reported "don't know" to their worry of HIV infection.

report a low likelihood of current HIV infection are, in fact, HIV-positive in 2004. However, men are much more accurate in assessing a positive HIV status: 14% of male respondents who report a high likelihood of HIV infection are correct, compared with about 8% of women. In addition, 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.

**Table 3:    HIV status by self-assessed likelihood of HIV infection: 2004 MDICP**

| | Self-Assessment | | |
| --- | --- | --- | --- |
| | Low | High | N |
| **Men** | | | |
| **HIV-** | 93.7% | 86.5% | 684 |
| **HIV+** | 6.3% | 13.5% | 52 |
| **N** | 662 | 74 | 736 |
| Pearson chi2(1) =  5.21  Pr = 0.02 | | | |
| **Women** | | | |
| **HIV-** | 95.2% | 92.2% | 891 |
| **HIV+** | 4.9% | 7.8% | 51 |
| **N** | 763 | 179 | 942 |
| Pearson chi2(1) =  2.50  Pr = 0.11 | | | |

A striking finding, as seen in Table 3, is the tendency among many respondents to overestimate their likelihood of HIV infection. While the majority of MDICP respondents estimates a low likelihood of HIV infection and is correct in this assessment, among men and women who think there is a high likelihood of HIV infection, 92% of women and 87% of men are incorrect in their assessment and are in fact HIV-negative.[10] A previous study also found a relatively high percentage of overestimating individuals for all MDICP respondents, aged 15 or older (Bignami et al 2007). While the inaccuracy among MDICP respondents who think they are HIV-positive may reflect a tendency to overestimate risk in general, the proportion of rural Malawians who are inaccurate is much higher than risk assessments from other studies. For example, a study in the Netherlands found that, of women who reported having an STI, 60% were in fact currently infected (Fennema et al 1995). Another study using

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[10] Among MDICP respondents, reporting a "medium" or "high" likelihood of HIV infection is not necessarily the same as thinking that one is currently infected with HIV. As a result, we acknowledge that, for example, a respondent who reports a medium likelihood of infection but is HIV negative is not necessarily "incorrect" in their assessment.

data from the United States, Puerto Rico and Brazil found that 89% of individuals who self-reported being infected with HIV were indeed HIV-positive (Strauss et al 2001).

**Table 4:    HIV status by self-assessed likelihood of HIV infection (including "don't know" responses): 2004 MDICP**

| | Self-Assessment | | | |
|---|---|---|---|---|
| | Low | High | Don't know | N |
| **Men** | | | | |
| **HIV-** | 93.7% | 86.5% | 91.8% | 773 |
| **HIV+** | 6.3% | 13.5% | 8.3% | 60 |
| **N** | 662 | 74 | 97 | 833 |
| Pearson chi2(2) = 5.29  Pr = 0.07 | | | | |
| **Women** | | | | |
| **HIV-** | 95.2% | 92.2% | 86.1% | 1027 |
| **HIV+** | 4.9% | 7.8% | 13.9% | 73 |
| **N** | 763 | 179 | 158 | 1100 |
| Pearson chi2(2) = 17.88  Pr = 0.00 | | | | |

In addition to the results shown in Table 3, respondents who don't know their HIV status are an important group to examine.  Table 4 thus adds the "don't know" responses to the same categories as Table 3.  From this, it can be seen that the HIV prevalence among men who don't know their status is not very different from other response categories, but there is a significant difference in HIV prevalence between women who claim they don't know their status and women who report a level of subjective infection likelihood.  HIV prevalence is almost 14% among women who report that they don't know their status, compared with an overall prevalence of less than 7% for women in the sample.  Reasons for why women report not knowing their likelihood of infection are examined in the next section.

As seen in Table 5, another measure of risk perception, the level of worry of contracting HIV, is also not a reliable indicator of current HIV infection for men: there are no significant differences in HIV prevalence for the three levels of worry of HIV infection.  However, this measure is more accurate for women than subjective assessment of current status, although differences in HIV prevalence between levels of worry are not highly significant for women.  About 9% of women who are "worried a lot" about contracting HIV are HIV-positive in 2004, compared with 5% of women who are not worried about contracting HIV and 5% who were worried a little.

Differences by sex in the association between risk perception and HIV status are seen in the three measures in this section.  Whereas men are more accurate in assessing their likelihood of infection and display less uncertainty in assessing their HIV status,

women who are worried about AIDS infection are significantly more likely to be infected than women who worry less. This same relationship is not found for men. This difference implies that, despite the fact that worry is influenced by social network partners (Kohler et al 2007; Helleringer and Kohler 2006), and that worry is associated with behavior change (Smith and Watkins 2005), worry of AIDS infection is differentially associated with current HIV status for men and women. Further analyses would be necessary to untangle the relationship between HIV status and worry.

**Table 5:** **Percentages HIV-infected by worry level of HIV for 2004 MDICP men and women**

| | Not worried | Worried a little | Worried a lot | N |
|---|---|---|---|---|
| | | Worry of HIV Infection | | |
| **Men** | | | | |
| **HIV-** | 93.1% | 92.2% | 92.3% | 768 |
| **HIV+** | 6.9% | 7.8% | 7.7% | 62 |
| **N** | 290 | 230 | 310 | 830 |
| Pearson chi2(2) = 0.21 Pr = 0.90 | | | | |
| **Women** | | | | |
| **HIV-** | 95.5% | 95.2% | 91.2% | 1014 |
| **HIV+** | 4.5% | 4.8% | 8.8% | 71 |
| **N** | 333 | 252 | 500 | 1085 |
| Pearson chi2(2) = 7.73Pr = 0.02 | | | | |

Note: the above table excludes 3 men and 15 women who respond "Don't know" to worry of HIV infection

Overall, these results reveal that there is a general tendency among both male and female MDICP respondents to overestimate their risk – only relatively small percentages of those who think they are infected were in fact HIV positive. We also see a difference by gender; women are less accurate in assessing their HIV status than are men.

## 4.3 The "don't know" response

As shown in Table 4, women who didn't know their HIV status were significantly more likely to be infected than women who reported either a high or low likelihood of being infected. This highlights the importance of the "don't know" response category for

women.[11]  Furthermore, this response composed a relatively large response category for women in 2004: 15% of women reported that they didn't know their likelihood of HIV infection.  Finally, respondents who claim to not know their HIV status represent the most obvious example of HIV-related uncertainty and are therefore relevant for further investigation.  As a result, next we investigate why women report not knowing their HIV status.

To address this issue, we test several possible reasons for the "don't know" response among women.  One possible reason for this response is *genuine uncertainty*. In this case, the woman doesn't know her HIV status because she correctly realizes that this estimation is not based just on her own actions, but on her spouse's.  A woman may suspect that her spouse has been unfaithful but is unlikely to know if her spouse is HIV-positive, how frequently the partner was unfaithful, or whether her husband used a condom with an extramarital partner.  In missing these critical pieces of information, some women may understand that they are constrained when estimating their own likelihood of infection.

A second possible explanation for not knowing one's HIV status is *ignorance* of how HIV is transmitted.  This is unlikely in countries with a mature epidemic, and indeed, surveys consistently show that the vast majority of respondents know that HIV is sexually transmitted and that it can be prevented by abstinence and faithfulness, with many also reporting that it can be prevented by condoms (e.g. Malawi Demographic and Health Surveys, 2004).  What our respondents do not know is how likely a single act of unprotected intercourse with an infected person is to transmit HIV.

Alternatively, respondents may have a strong subjective sense that they are infected, but may not wish to report it due to fear of social *stigma*.  As HIV infection is a sensitive issue, respondents may be afraid that their response would be overheard or passed on, which could result in divorce, expelled from church or mosque, or avoided by friends and others in the community.  Other studies have found evidence for social desirability bias in reporting self-estimated risk of HIV infection (Bignami-Van Assche et al 2007).

No questions measuring knowledge of HIV transmission were included in the 2004 MDICP survey.  However, several were included in MDICP 2 (2001).  Using 2001 data, we test for differences in HIV knowledge between women who don't know their HIV status and women who report another response to their likelihood of HIV

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[11] For men, there was no significant difference in HIV prevalence between respondents reporting "don't know" and respondents who report a likelihood of infection. We also compared background characteristics and other variables from Table 1, and found there were no significant differences between male respondents who don't know their current HIV status and male respondents who report an HIV status. As a result, we conclude that the "don't know" response is not associated with HIV-related characteristics or behaviors for MDICP men.

infection. If women who don't know their HIV status are less likely to respond correctly to the HIV transmission questions, we can conclude that women are unable to estimate their HIV status due to a lack of understanding of HIV transmission. In addition, such differences in HIV knowledge by self-assessment could also explain why women who don't know their status are more likely to be HIV-positive: if one does not adequately understand HIV transmission basics, there would then be a higher likelihood of not knowing how to protect oneself from infection.

As in 2004, a similar percentage of women in 2001 claimed to not know their current HIV status (12%). To check whether this is related to knowledge of HIV transmission, we check the correlation with three HIV transmission knowledge questions: "Can you get AIDS if you have sex with someone who looks perfectly healthy?", "Does having an STD increase, decrease or not affect a person's chance of getting AIDS?", and "Does being circumcised increase, decrease or not affect a man's chance of getting AIDS?" Cross-tabulations of the above questions with the percentage responding "don't know" to the self-assessment in 2001 reveal no significant differences, as shown in Table 6. As no significant differences in levels of HIV knowledge are found for respondents who don't know their HIV status, it appears that ignorance of HIV transmission can be eliminated as a reason for why women claim to not know their current HIV status.

**Table 6:** **Differences in AIDS transmission knowledge between 2001 MDICP women who report and don't know their likelihood of HIV infection**

|  | Reports Likelihood | Don't Know | N |
|---|---|---|---|
| **1. AIDS Infected Individuals Can Look Healthy** | | | |
| No | 6.7% | 4.6% | 92 |
| Yes | 93.3% | 95.4% | 1398 |
| N | 1316 | 174 | 1490 |
| Pearson chi2(1) = 1.16  Pr = 0.28 | | | |
| **2. Effect of STIs on Likelihood of AIDS Transmission** | | | |
| Increases | 89.8% | 92.0% | 1297 |
| Decreases | 2.6% | 3.1% | 38 |
| No Affect | 7.6% | 4.9% | 105 |
| N | 1277 | 163 | 1440 |
| Pearson chi2(2) = 1.64  Pr = 0.44 | | | |
| **3. Effect of Circumcision On Likelihood of AIDS Transmission** | | | |
| Increases | 34.6% | 31.3% | 432 |
| Decreases | 8.7% | 6.1% | 106 |
| No Affect | 56.7% | 62.6% | 723 |
| N | 1130 | 131 | 1261 |
| Pearson chi2(2) = 2.00  Pr = 0.37 | | | |

Note: Analysis above excludes respondents reporting "Don't know" for the AIDS transmission questions, including 30 respondents for 1, 80 for 2, and 269 for 3.

To test whether uncertainty, stigma or guilt each contribute to the "don't know" response, we run a logistic regression with the "don't know" response as the dependent variable, and the same independent variables as in Table 2. To these variables, we add measures of perceived stigma in the community: "Most people in your village are comfortable around someone with AIDS", "People who are infected with AIDS are expelled from my church/mosque", and "Do you think that you would stop socializing with some people because of their reactions to your having AIDS?" To evaluate whether uncertainty is the reason for the "don't know" responses among women, we focus on the spouse-related variables listed in Table 1: perceived infidelity, greatest source of worry of AIDS infection, and acceptability of condom use in marriage. Finally, to investigate whether the respondent was unfaithful but is reluctant to admit infidelity, we add a series of indirect questions related to infidelity, including: "Do you agree or disagree that a woman can be sexually satisfied with one husband and no other sexual partners?", "Usually people do not plan to have sex, it just happens", and "Do you think that some people would act as though it is your fault that you have AIDS?".

Results in Table 7 reveal that uncertainty of spouse's actions is the primary reason for women reporting to not know their HIV status. Women who believe their spouse was unfaithful have 1.65 higher odds to not know their HIV status than women who don't believe their spouse was unfaithful. Women who are worried about infection from other partners are significantly less likely to not know their status than women who are concerned about HIV infection from their spouse. None of the stigma or social desirability bias variables are significant in this model.

It is interesting to note from Table 7 that women who don't know their status also speak with fewer others about HIV/AIDS, compared with women who report a likelihood of their infection. This could be for two possible reasons: women who speak with few others know less about HIV transmission or their husband's activities and are therefore unable to calculate their HIV status; or women who claim to not know their status actually do not want to admit that they are highly likely to be infected, and also do not want to discuss the sensitive topic with other women.

**Table 7:     Logistic regression results for determinants of reporting "don't know" HIV status among 2004 MDICP women**

|  | Women N=922 Odds Ratios |
|---|---|
| **Demographic Characteristics** |  |
| Age | 0.99 |
| **Marriage** |  |
| Polygamous husband or wife | 1.92** |
| **Schooling** |  |
| None | (ref) |
| Attended primary school | 0.71 |
| Attended secondary school or more | 0.88 |
| **Region of Residence** |  |
| South | 2.70*** |
| North | (ref) |
| Central | 2.25** |
| **Economic Variables** |  |
| Iron sheet roof | 1.01 |
| Bicycle | 0.93 |
| Radio | 1.33 |
| **Own Behaviors** |  |
| Unfaithful to current spouse | 0.60 |
| **Spouse's Behavior** |  |
| Knows or suspects that spouse was unfaithful | 1.65** |
| Condom use with spouse is acceptable | 1.22 |
| Most worried about infection from: |  |
| Spouse | (ref) |
| Other partners | 0.63** |
| Any other source | 1.25 |
| **Community/Social Characteristics** |  |
| Perceived number of people who died of AIDS in last 12 months |  |
| Nobody died of AIDS in last 12 months |  |
| From one to four | 0.99 |
| Five or more | 0.80 |
| Doesn't know | 0.87 |
| Number people spoken to about HIV/AIDS |  |
| Spoke to no one | (ref) |
| Spoke to 1-4 people | 0.53** |
| Spoke to 5 or more people | 0.52** |
| **Stigma** |  |
| Thinks most in village are comfortable around someone with AIDS | 0.97 |
| Thinks religious leaders feel that HIV-infected deserve to be infected | 0.65 |
| Would stop socializing with some due to their reactions to being HIV-infected | 0.83 |
| **Infidelity** |  |
| Thinks a woman can be satisfied with only husband and no other sexual partners | 0.90 |
| Thinks people do not plan for sex, it happens spontaneously | 0.91 |

*Significant <.10  **significant < .05    *** significant < .01

Note: Regression drops 178 respondents with missing values for variables above, or "don't know" response for stigma or infidelity variables.

### 4.4 Biases in heuristics

Finally, we use the heuristics identified in Section 4.1 to identify factors that influence the accuracy of self-assessed HIV infection likelihood. By identifying the characteristics that are associated with the accuracy of subjective assessment of being infected with HIV, we can then address the question: Why are some respondents incorrect in their subjective perceptions about being HIV-positive?

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. Incorrect starting points may 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, we analyze the determinants of overestimation of current HIV infection. We consider only HIV uninfected respondents, and then run ordered logistic regressions using the same variables as in Table 2 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, but tested HIV-negative during the 2004 wave of the MDICP. Because all respondents in this analysis are HIV-negative, the results of this ordered logistic regression will reveal the correlates of overestimating likelihood of current HIV infection. One potential weakness in this section is that, for reasons described above, the HIV risk perception variable used in these regressions is actually a noisy indicator of the true measure of HIV risk perception. This measurement error in HIV risk perceptions, for which we cannot control at this moment using instrumental variable or related techniques (Greene 2007), could be systematically related to some of the explanatory variables in these regressions. This could hence lead to biases in the estimates of the regressions.

The preceding analysis demonstrates that it is common for men and women in rural Malawi to think they are infected, while 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, this is surprising. What are the reasons for this discrepancy between subjective probability of infection and actual infection status? Our 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 8.

To a considerable degree, there is evidence that the same heuristics that individuals use to estimate their subjective probabilities of infection also lead them to overestimate their likelihood of HIV infection. Uninfected men reporting infidelity were twice as likely to (inaccurately) think they were infected, as were men who do not report infidelity.

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 differences between these estimates and the previous analysis of the determinants of subjective risk. Here discussion about HIV drops in significance from the models in Table 2 in determining a higher level of likelihood for men. For women, there is some indication of a relationship between schooling and correct assessment: women of higher education were more likely to be incorrect in their assessment than women without education. Also, there is some evidence of a relationship between economic status and overestimating HIV infection, but this result is not consistent across the measures of economic status.

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, suspect infidelity, and perceive a higher prevalence of HIV in the community. Women who suspect spousal infidelity and are concerned about their husband's behavior are more likely to overestimate their likelihood of HIV infection.

**Table 8:** **Ordered logistic regression results for the determinants of incorrect prediction of HIV status among 2004 MDICP HIV uninfected respondents**

| | Men N=674 | Women N=873 |
|---|---|---|
| | Odds Ratios | |
| **Demographic Characteristics** | | |
| Age | 0.99 | 1.00 |
| **Marriage** | | |
| Polygamous husband or wife | 0.81 | 1.19 |
| **Schooling** | | |
| None | (ref) | (ref) |
| Attended primary school | 0.74 | 1.41 |
| Attended secondary school or more | 0.87 | 1.82* |
| **Region of Residence** | | |
| South | 0.72 | 0.75 |
| North | (ref) | (ref) |
| Central | 0.94 | 1.05 |
| **Economic Variables** | | |
| Iron sheet roof | 1.03 | 1.50* |
| Bicycle | 1.48** | 1.09 |
| Radio | 0.90 | 0.67** |
| **Own Behaviors** | | |
| Unfaithful to current spouse | 1.91*** | 0.74 |
| **Spouse's Behaviors** | | |
| Respondent knows or suspects that spouse was unfaithful | 2.44*** | 2.38*** |
| Condom use with spouse is acceptable | 1.25 | 1.43** |
| Most worried about infection from: | | |
| Spouse | (ref) | (ref) |
| Other partners | 0.90 | 0.51*** |
| Any other source | 0.36*** | 0.21*** |
| **Community/Social Characteristics** | | |
| Perceived number of people who died of AIDS in last 12 months | | |
| Nobody died of AIDS in last 12 months | (ref) | (ref) |
| From one to four | 1.28 | 1.52** |
| Five or more | 1.95** | 1.08 |
| Doesn't know | 1.04 | 2.38** |
| Number people spoken to about HIV/AIDS | | |
| Spoke to no one | (ref) | (ref) |
| Spoke to 1-4 people | 0.59* | 0.95 |
| Spoke to 5 or more people | 0.54* | 1.07 |

*Significant <.10  **significant < .05   *** significant < .01

# 5. Discussion and conclusion

The results above indicate that, in the absence of VCT, men and women assess their HIV status using heuristics that are consistent with what many studies indicate 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 or partner. 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 in that an extramarital partner is infected, and women may be correct in that their husband is, or soon will be, infected. What they do not assess correctly, however, is the transmission probabilities of HIV. More than 95% of both men and women believe AIDS is highly likely or 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.

The implications of inaccurate HIV status estimates vary across theories on the relationship between risk perception and behavior. Several influential AIDS behavior change theories in public health suggest that individuals with a greater perceived vulnerability to HIV infection are more likely to adopt behaviors that reduce their likelihood of infection (UNIADS 1999). This implies that overestimating HIV infection can be beneficial, in that it is better for an HIV-negative person to overestimate their HIV infection than an HIV-positive individual to underestimate their likelihood of infection. In contrast, research in economic theory on decision-making posits that, barring altruism, HIV-negative individuals who overestimate their likelihood of HIV infection have less incentive to avoid high-risk sexual situations, or protect themselves in such circumstances (Philippson and Posner 1993). However, neither economic nor public health theory on the relationship between risk perception and behavior has been consistently supported by research in AIDS-affected regions. For example, some research in sub-Saharan Africa indicates that high perceived risk can lead to an increase in risky behavior: 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. On the other hand, research on the effect of HIV testing on behavior has shown that HIV-positive individuals who know their sero-status are more likely to adopt protective behaviors than are HIV-negative individuals (Allen 1992; Coates et al 2000, Thornton 2005). The discrepancies in results, as well as the wide array of analytical methods and research structures, make it difficult to resolve the differences in these theories.

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 popular strategy 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 phenomena implicitly involve a self-assessed likelihood of infection; if one is infected already, there is no reason for this caution.

HIV/AIDS testing and counseling potentially play an important role in the construction of these subjective assessments of HIV status, as well as recalibration of these self-assessments. If individuals act on these assessments, and individuals who incorrectly think they're infected are less likely to protect themselves in risk situations, then HIV testing can reveal such overestimations and thus prevent the spread of the epidemic. On the other hand, if overestimating risk will result in more people protecting themselves, receiving an unexpected HIV-negative test result could lead to lowering perceived risk and a disregard for protective behavior. Evaluating the effect of HIV testing on shaping estimates of HIV infection and the subsequent affect on risk behavior is an important future task for AIDS research.

## 6. Acknowledgements

# References

Allen, S., Serufilira, A., Bogaerts, J., Van de Perre, P., Nsengumuremyi, F., Lindan, C., Carael, M., Wolf, W., Coates T., and Hulley S. (1992). Confidential HIV testing and condom promotion in Africa: Impact on HIV and gonorrhea rates. *Journal of the American Medical Association* 268(23): 3338-43. doi:10.1001/jama.268.23.3338.

Allison, P.D. (1999). *Logistic Regression Using the SAS System: Theory and Application*. Cary, NC: SAS Institute Inc.

Anglewicz, P. (2007). Migration, risk perception and HIV infection in rural Malawi. Ph.D. Dissertation. Philadelphia: Graduate Group in Demography, Population Studies Center, University of Pennsylvania.

Anglewicz, P., Adams, J., Obare, F., Kohler, H.-P., and Watkins, S. (2007). The Malawi Diffusion and Ideational Change Project 2004–06: Data collection, data quality and analyses of attrition. Philadelphia: Population Studies Center, University of Pennsylvania (SNP working paper no. 12).

Bignami-Van Assche, S., Anglewicz P., Chao L.W., Reniers G., Smith K., Thornton R., Watkins S., Weinreb A. (2004). Research Protocol for Collecting STI and Biomarker Samples in Malawi. Philadelphia: Population Studies Center, University of Pennsylvania (SNP working paper no.7).

Bignami-Van Assche, S., Chao, L.W., Anglewicz, P., Bula, A., Chilongozi, D. (2007). The Validity of Self-Reported Likelihood of HIV Infection Among the General Population of Rural Malawi. *Sexually Transmitted Infections* 83(1): 35-40. doi:10.1136/sti.2006.020545.

Bracher, M.D., Santow, G., and Watkins, S. (2003). Moving and Marrying; Modeling HIV Infection Among Newlyweds in Malawi. *Demographic Research* S1(7): 207-246. doi:10.4054/DemRes.2003.S1.7.

Coates, T.J., Grinstead, O.A., Gregorich, S.E., Sweat, M.D., Kamenga, M.C., Sangiwa, G., Balmer, D., and Furlonge, C. (2000). Efficacy of voluntary HIV-1 counselling and testing in individuals and couples in Kenya, Tanzania, and Trinidad: A randomised trial. *Lancet* 356(9224): 103–112. doi:10.1016/S0140-6736(00)02446-6.

Delavande, A. and Kohler, H.-P. (2007). An Interactive Approach for Eliciting Probabilistic Expectations in a Developing Country Context with High HIV

prevalence. Philadelphia: Population Aging Center, University of Pennsylvania (PARC WPS 2007-06).

Delavande, A., Kohler H.-P. and Anglewicz, P. (2007). Subjective risk perceptions about HIV infection: An interactive approach. Philadelphia: Population Aging Center, University of Pennsylvania (PARC WPS 2007-06).

Demographic and Health Surveys (2004). Malawi Demographic and Health Survey, 2004. Zomba, Malawi and Calverton, MD USA: National Statistics Office and ORC Macro.

Department for International Development (2005). About HIV/AIDS in Malawi [electronic resource]. London: Department for International Development. http://www.dfid.gov.uk/pubs/files/malawi-hiv-aids.pdf.

de Walque, D. (2007). Sero-discordant couples in five African countries: Implications for prevention strategies. *Population and Development Review* 33(3): 501-523. doi:10.1111/j.1728-4457.2007.00182.x.

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

Dunkle, K., Stephenson, R., Karita, E., Chomba, E., Kayitenkore, K., Vwalika, C., Greenberg, L., and Allen, S. (2008). New heterosexually transmitted HIV infections in married or cohabiting couples in urban Zambia and Rwanda: an analysis of survey and clinical data. *The Lancet* 371(9631): 2183 – 2191. doi:10.1016/S0140-6736(08)60953-8.

Fennema, J.S., van Ameijden, E.J., Coutinho, R.A., and van den Hoek, J.A.R. (1995). Validity of self-reported sexually transmitted diseases in a cohort of drug-using prostitutes in Amsterdam: trends from 1986 to 1992. *International Journal of Epidemiology* 24(5): 1034-41. doi:10.1093/ije/24.5.1034.

Gray, R., Wawer, M., Brookmeyer, R., Sewankambo, N., Serwadda, D., Wabwire-Mangen, F., Lutalo, T., Li, X., vanCott, T., and Quinn, T. (2001). Probability of HIV-1 Transmission Per Coital Act in Monogamous, Heterosexual, HIV-1 Discordant Couples in Rakai, Uganda. *The Lancet* 357(9263):1149-53. doi:10.1016/S0140-6736(00)04331-2.

Greene, W.H. (2007). *Econometric Analysis*. London: Prentice Hall.

Heimer, C.A. (1988). Social Structure, Psychology, and the Estimation of Risk. *Annual Review of Sociology* 14:491-519. doi:10.1146/annurev.so.14.080188.002423.

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):931–943. doi:10.1016/0277-9536(94)00165-P.

Helleringer, S. and Kohler, H.-P. (2006). Social Networks, Risk Perceptions and Changing Attitudes Towards HIV/AIDS: New Evidence from a Longitudinal Study Using Fixed-Effects Analysis. *Population Studies* 59(3):265-282. doi:10.1080/00324720500212230.

Holbrooke, R. (2004). Fighting AIDS is Good Business [electronic resource]. Washington D.C. Council on Foreign Relations. http://www.usembassy.it/file2004_04/alia/a4042802.htm

Hudson, C.P. (1996). The importance of transmission of HIV-1 in discordant couples in the population dynamics of HIV-1 infection in rural Africa. *International Journal of STD and AIDS* 7(4): 302 304. doi:10.1258/0956462961917906.

Kahneman, D., Slovic, P., and Tversky, A. (1982). *Judgment Under Uncertainty: Heuristics and Biases*. Cambridge: Cambridge University Press.

Kaler, A. (2003). "My Girlfriends Could Fill a Yanu-Yanu Bus": Rural Malawian Men's Claims About Their Own Serostatus. *Demographic Research* S1(7): 349-72. doi:10.4054/DemRes.2003.S1.11.

Kengeya-Kayondo, J.F., Carpenter, L.M., Kintu, P.M., Nabaitu, J., Pool, R. and Whitworth, J.A.G. (1999). Risk Perception and HIV-1 Prevalence in 15,000 Adults in Rural South-West Uganda. *AIDS* 13(16): 2295-2302. doi:10.1097/00002030-199911120-00012.

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): 1393–1394. doi:10.1097/00002030-199310000-00018.

Kohler, H.-P. (1997). Learning in social networks and contraceptive choice. *Demography* 34(3): 369-383. doi:10.2307/3038290.

Kohler, H.P., Behrman, J.R. and Watkins, S. C. (2007). Social Networks and {HIV/AIDS} Risk Perceptions. *Demography* 44(1): 1-33. doi:10.1353/dem.2007.0006.

McKenna, S.L., Muyinda, G.K., Roth, D., Mwali, M., N'gandu, N., and Myrick, A. (1997). Rapid HIV testing and counseling for voluntary testing centers in Africa. *AIDS* 11(S1): S103–S110.

Manski, C. F. (2004). Measuring expectations. *Econometrica* 72(5):1329–1376. doi:10.1111/j.1468-0262.2004.00537.x.

Messersmith, L.J., Kane, T.T., Odebiyi, A.I., and Adewuyi, A.A. (2000). Who's at Risk? Men's STD Experience and Condom Use in Southwest Nigeria. *Studies in Family Planning* 31(3):203-216. doi:10.1111/j.1728-4465.2000.00203.x.

Ministry of Health (Malawi) (2006). Report on ARV Therapy in Malawi – up to September 2005. Malawi: Ministry of Health.

Montgomery, M.R. (2000). Perceiving Mortality Decline. *Population and Development Review* 26(4): 795-819. doi:10.1111/j.1728-4457.2000.00795.x.

National AIDS Commission (Malawi) (2006). Malawi HIV and AIDS Monitoring and Evaluation Report. Malawi: Office of the President and Cabinet.

Obare, F., Fleming, P., Anglewicz, P., Thornton, R., Martinson, F, Kapatuka, A., Poulin, M., Watkins, S., and Kohler, H.-P. (2008). HIV Incidence and Learning One's HIV Status: Evidence From Repeat Population-based Voluntary Counseling and Testing in Rural Malawi. *Sexually Transmitted Infections* online 16 Oct 2008.

Philipson, T. and Posner, R. (1993). *Private Choices and Public Health*. Boston, MA: Harvard University Press.

Rabin, M. (1998). Psychology and Economics. *Journal of Economic Literature*, *American Economic Association* 36(1): 11-46.

Reniers, G. (2005). *Nuptual Strategies for Managing the Risk of HIV Infection in Rural Malawi*. Paper presented at the Annual Meeting of the Population Association of America, Philadelphia, April 1-3 2005.

Robinson, N.J., Mulder, V., Auvert, B., Whiworth, A.G., and Hayes, R.J. (1999). Type of partnership and heterosexual spread of HIV infection in rural Uganda: results from simulation modelling. *International Journal of STD and AIDS* 10: 718-725. doi:10.1258/0956462991913394.

Smith, K.P. and Watkins, S.C. (2005). Perceptions of Risk and Strategies for Prevention: Responses to HIV/AIDS in Rural Malawi. *Social Science and Medicine* 60(3): 649-60. doi:10.1016/j.socscimed.2004.06.009.

Strauss, S.M., Rindskopf, D.M., Deren, S., and Falkin, G.P. (2001). Concurrence of drug users' self-report of current HIV status and serotest results. *Journal of the Acquired Immune Deficiency Syndrome* 27(3): 301-7.

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

Thornton, R. (2005). *Is it Good to Know? The Demand for and Impact of Learning HIV Results*. Paper presented at the Northeastern University Development Conference, Brown University, Providence, RI, September 3, 2005.

Timaeus, I.M. and Jasseh, M. (2004). Adult Mortality in Sub-Saharan Africa: Evidence from Demographic and Health Surveys. *Demography* 41(4): 757-772. doi:10.1353/dem.2004.0037.

Tversky, A. and Kahneman, D. (1992). Judgment and Uncertainty: Heuristics and Biases. *Science* 185(4157): 1124-1131. doi:10.1126/science.185.4157.1124.

UNAIDS (2004). Malawi: Epidemiological Fact Sheet on HIV/AIDS and Sexually Transmitted Infections [electronic resource] Geneva, UNAIDS. data.unaids.org/Publications/Fact-Sheets01/malawi_en.pdf

UNAIDS (1999). Sexual Behavior Change for HIV: Where Have Theories Taken Us? [electronic resource] Geneva: UNAIDS. www.who.int/hiv/strategic/surveillance/en/unaids_99_27.pdf

UNAIDS/World Health Organization (2004). UNAIDS/WHO Policy on HIV Testing [electronic resource]. Geneva: UNAIDS. http://data.unaids.org/una-docs/hivtestingpolicy_en.pdf

Watkins, S.C. (2004). Navigating AIDS in Rural Malawi. *Population and Development Review* 30(4): 673-705. doi:10.1111/j.1728-4457.2004.00037.x.

Watkins, S.C and Swidler, A. (2006). Hearsay Ethnography: Capturing Culture in Action. Los Angeles: California Center for Population Research (On-Line Working Paper Series Paper CCPR-007-06).

Watkins, S., Behrman, J.R., Kohler, H.-P., and Zulu, E.M. (2003). Introduction to "Research on demographic aspects of HIV/AIDS in rural Africa". *Demographic Research* S1(1): 1–30. doi:10.4054/DemRes.2003.S1.1.