An assessment of the HIV-risk factors and variations in HIV prevalence in rural Malawi

Francis Obare

Introduction

Estimates from the 2004 Malawi Demographic and Health Survey (MDHS) show that the national HIV prevalence among adults aged 15-49 years in the country was 12% (National Statistics Office [NSO] and ORC Macro 2005). Whereas this is an indication that Malawi is one of the countries in sub-Saharan Africa with generalized HIV/AIDS epidemic (prevalence of 10% or higher), this estimate masks wide variations in HIV prevalence between regions. As would be expected, prevalence was significantly higher in the urban than in the rural areas (18% versus 11%). Marked variations in prevalence also existed between the country's three major regions (North, Central and South). Prevalence was, for instance, slightly more than twice as high in the Southern region (18%) as in the Northern (8%) or the Central (7%) regions. These patterns are also reflected in prevalence among women and men (20%, 10%, and 7% in the Southern, Northern, and Central regions respectively for women with the corresponding figures for men being 15%, 6%, and 5%) (NSO and ORC Macro 2005).

What might explain these wide variations in HIV prevalence especially between the Southern region on the one hand and the Northern and Central regions on the other? Perhaps, the answer might lie in the fact that the three regions are characterized by different socio-economic and socio-cultural patterns which might have different implications for sexual partnerships and exposure to the risk of HIV infection. The Northern region, for instance, is wealthier and is characterized by a higher level of education than the Central or Southern regions (NSO and ORC Macro 2005). But the

patterns from the 2004 MDHS also show that HIV prevalence was higher among those with secondary and above education (16%) than among those with no education (12%). Prevalence was also twice as high among those in the richest wealth quintile (16%) as among those in the poorest quintile (8%) (NSO and ORC Macro 2005). Thus, on the basis of regional differences in socio-economic indicators alone, we should expect HIV prevalence to be highest in the Northern region, which is not the case.

The three regions are also different with respect to marriage patterns. The Southern region is mainly characterized by matrilineal and matrilocal marriage patterns, the Northern region by patrilineal and patrilocal patterns, and the Central region by mixed marriage patterns (Mtika and Doctor 2002; Zulu and Chepng'eno 2003; Chimbiri 2007). There are several implications of these patterns that might be relevant for exposure to the risk of HIV infection. First, polygyny is more common in the patrilineal and patrilocal North than in the matrilineal and matrilocal South (Reniers 2003). This implies exposure to multiple sexual partnerships for men from the North and increased risk of HIV infection not only for them but also their spouses. But the risk appears to be greater for women in polygynous unions than for men in such unions.[1] Second, divorce accompanied by faster re-marriages is more common in the South than in the other regions (Reniers 2003) and could, perhaps, be one of the factors explaining the high HIV

[1] Evidence from the 2004 MDHS, for example, indicates that women in polygynous unions were significantly more likely to be HIV positive than their counterparts in monogamous unions (16% versus 12%; $p<0.05$), which is not surprising. For men, however, those in monogamous unions had slightly higher HIV prevalence than those in polygynous unions (15% versus 10%) though the difference was not statistically significant ($p=0.16$) (NSO and ORC Macro 2005). The risk for women in polygynous unions could stem from the ripple effect of infection if the husband or one of the co-wives is already infected with HIV. The pattern for men could, perhaps, be an indication that those in monogamous unions may be more likely to engage in extra marital relationships than those in polygynous unions.

prevalence in the South compared to the other regions.[2] Third, different residency patterns following union formation or dissolution exist between the regions. In the North, it is the wife who moves into or out of the man's household following union formation or dissolution while in the South, residency can be either matrilocal or patrilocal (Chimbiri 2007). This might have implications for partner mobility-- mobility is one of the risk factors associated with HIV infection in the region (see for instance, Crampin et al. 2003).[3]

This paper uses two rounds of HIV survey data collected from three study sites in rural Malawi to explore the risk factors associated with HIV infection in the three sites and which might be relevant for explaining the variations in HIV prevalence between the three major regions of the country. It focuses on *partner mobility*, *marital experience*, and *sexual partnerships*-- factors which might be modified differently by the different socio-economic and socio-cultural patterns of the three regions (see 'Data and methods' section for the definition of these factors). But why Malawi? First, as already noted, it is one of the countries in sub-Saharan Africa with generalized HIV/AIDS epidemics, yet wide variations in HIV prevalence exist between the major regions of the country. Second, the distinct socio-cultural patterns that characterize the three regions provide an interesting case study to understand whether the regional variations in HIV prevalence reflect different risk factors operating in each region. Third, the availability of longitudinal data from rural Malawi permit us to conduct analyses that overcome the weaknesses of cross-

[2] Based on estimates from the 2004 MDHS, for example, HIV prevalence among women who were divorced or separated was twice as high as that among those who were currently married (26% versus 13%). The corresponding figures for men were 16% and 14% (NSO and ORC Macro 2005).

[3] The possible explanation for increased risk of HIV infection among mobile individuals is the potential for separation from spouses for long periods of time which might lead to involvement with extra marital partners.

sectional analyses e.g. the potential for reverse causality that may arise when "risky" sexual behaviours lead to HIV infection or the realization that one is HIV positive further fuels "risky" sexual behaviours.

Data and methods

Data

The Malawi Diffusion and Ideational Change Project (MDICP) provides the data for this paper. MDICP is a longitudinal household survey conducted in three rural sites in Malawi. Its general aim is to examine the role of social networks in changing attitudes and behaviour regarding family size, family planning, and HIV/ AIDS. The study sites include Balaka in the Southern region, Mchinji in the Central region, and Rumphi in the Northern region (hereafter referred to as the South, Centre, and North respectively). Initiated in 1998, there have been four waves of data collection to date (1998, 2001, 2004 and 2006). The survey initially targeted 1,500 ever-married women of reproductive age (15-49 years) and their husbands (Watkins et al. 2003) but over the years, new spouses of those already in the sample have been added to the sample. A new sample of about 1,000 adolescents aged 15-24 years was also included in the study during the third wave of the project while their spouses (for those who were married) were included in the fourth wave.

In addition to the main survey data collection, a biomarker component involving HIV testing was added during the last two waves (2004 and 2006). This paper uses data from these two waves. HIV testing in 2004 involved the collection of saliva specimens (using Ora-Sure™ Oral swab) by a team of trained nurses from outside the study areas (Bignami-Van Assche et al. 2004). Analysis of the specimens was done at the laboratory

using enzyme-linked immunosorbent assay (ELISA) and confirmatory Western blot tests (a detailed description of the 2004 protocol can be found in Bignami-Van Assche et al. 2004). To preserve confidentiality, specimens were labelled with a special biomarker ID number, and each respondent was given a Polaroid picture with this ID number to present when returning for the test results (the 2004 fieldwork procedures are described in detail in Anglewicz et al. 2005). Once the test results were available, team nurses provided post-test counselling and the test results in small tents that served as private and mobile quarters for post-test counselling and delivery of the results. To allay concerns about the confidentiality of results, the nurses were chosen from outside the area. Ninety one percent of the 3,282 individuals who were successfully contacted for HIV test in 2004 consented to be tested. Nonetheless, only 67% of those whose test results were available obtained them.

In 2006, HIV testing was done by certified voluntary counselling and testing (VCT) counsellors, again from outside the area but using finger-prick rapid testing (parallel Determine™ and UniGold HIV tests). Respondents were given the option to receive their test results either in their homes or at mobile clinics but virtually all of them chose to obtain the results in their homes. In order to preserve confidentiality, the respondent and VCT counsellor together disposed of the test kit in a pit latrine after the VCT counsellor showed the respondent the test results and offered post-test counselling (see MDICP Team 2007 for details about the 2006 protocol). Ninety two percent of the 2,987 individuals who were successfully contacted for the HIV test consented to be tested. This proportion is virtually identical to that of 2004 suggesting that changes in the protocol did not affect the likelihood of acceptance. But unlike in 2004, 98% of those

who were tested in 2006 obtained their test results. Also, 68% of those who were tested in 2004 were also tested in 2006 with mobility being one of the major reasons for non-retest (Obare 2007).

How do the MIDCP testing coverage and HIV prevalence estimates compare to those of the nationally representative 2004 MDHS and other studies? Figure 1a compares the percentage of individuals that were tested, refused or were temporarily away for HIV test in the two MDICP surveys (2004 and 2006) to those of the 2004 MDHS for rural areas. It shows that the percentage of rural respondents who were tested for HIV was higher in the MDICP than in the MDHS while the percentage that refused the test was higher in the MDHS than in the MDICP. But the MDICP HIV prevalence estimates were lower than the MDHS estimates for rural areas (Figure 1b). This could partly be due to the fact that the MDICP sites do not include major trading centres in the rural areas which have been found to have higher HIV prevalence and incidence than the rural villages (see for instance Boerma et al. 2002). However, prevalence among formerly married (separated, divorced or widowed) MDICP respondents closely resembled the estimates from the 2003 antenatal clinic (ANC) and the 2004 MDHS data (Figure 1b). Also, as in the MDHS rural areas, prevalence among men and women was highest in the South and lowest in the North (Figures 2a-b). Moreover, the percentage of the MDICP respondents that obtained their test results in 2004 is also comparable to that of similar studies in sub-Saharan Africa (e.g. Matovu et al. 2005) that offered clinic-based VCT for HIV.

<Figures 1a-b and 2a-b about here>

Methods

Given the longitudinal nature of the data used in this paper, we specify a model that takes into account the time-dependence of observations as well as the observed and unobserved characteristics that might be associated with an individual's risk of being infected with HIV. We posit that each individual has an underlying risk of being infected with HIV, denoted by Y^*_{it}. We also posit that there is some threshold θ such that at any time *t*, an individual is observed to be HIV positive if the underlying risk exceeds this threshold and to be HIV negative if the underlying risk is at or below the threshold, i.e.:

$$Y_{it} = \begin{cases} 1 & if\ Y^*_t > \theta \\ 0 & if\ Y^*_t \leq \theta \end{cases} \qquad [1]$$

where Y_{it} is the observed HIV status for individual *i* at time *t* which is a function of measured individual and household characteristics at time *t* (X_{it}) and a residual term (ε_{it}) that accounts for the unmeasured characteristics. The model formulation is thus:

$$Y_{it} = \beta_0 + \beta X_{it} + \varepsilon_{it} \qquad [2]$$

with β_0 being the intercept. We estimate equation [2] by means of a (random-effects) probit model since it is appropriate for modelling latent responses (Allison 1999). Separate models are estimated for men and women and for each study site.

The three central HIV-risk behaviours considered in the analysis include *partner mobility*, *marital experience*, and *sexual partnerships*. *Partner mobility* is defined as whether the spouses (of married individuals) usually resided in the village and is coded 1 if that is the case and 0 otherwise or if the individual was not married. *Marital experience*, on the other hand, refers to whether the individual had married multiple times

or otherwise (never married or married once). The number of life-time sexual partners (*sexual partnerships*) is coded 1 if the individual reported two or more life-time sexual partners and 0 otherwise. The models also control for the respondent's *age* (15-24 years versus 25 years and older), *education level* (secondary and above versus primary or no education), a dummy for ownership of both a tin-roofed house and a bicycle as an *indicator of household economic conditions, respondent mobility* (whether the respondent stayed outside the village for more than one month in the past 12 months prior to the survey wave), and *time* (coded 0 for 2004 and 1 for 2006).

One potential threat to the analysis is the fact that not everyone consents to be tested for HIV. This could lead to (non-response) bias not only in the estimated HIV prevalence estimates but also in the estimates of the predictors of HIV status. Previous analysis of non-response in the MDICP has shown that it significantly biased the prevalence estimates for the longitudinal participants but not the cross-sectional prevalence estimates (Obare 2007). The possible explanation for this is that whereas a significant proportion of those who were HIV positive in the first survey were likely to be non-respondents in the second survey, the addition of new sample members with different probabilities of HIV infection might have dampened the depressing effect of non-response on the cross-sectional prevalence estimates (Obare 2007). To explore the potential for bias due to non-response in the estimates obtained from the present analysis, additional models are estimated under two extreme assumptions: (i) that all non-respondents (refusals and temporary absentees) would have been HIV negative, and (ii) that all of them would have been HIV positive had they taken the tests such that we knew their HIV status. These results are in turn compared with those that ignore non-response.

Results

Background characteristics and HIV-risk behaviours

Table 1 presents the percent distribution of study participants by selected background characteristics (*age*, *education*, and *household ownership of tin-roofed house together with a bicycle*) and HIV-risk behaviours (*partner mobility*, *marital experience*, and *life-time sexual partnerships*). As would be expected, the North had a significantly higher percentage of respondents with at least secondary education than the South and Centre. It also had the highest proportion of households with a tin-roofed house and a bicycle. The Centre, too, had a significantly higher percentage of individuals with at least secondary education than the South but the two study sites did not significantly differ in terms of household ownership of tin-roofed house and a bicycle. These patterns are consistent with the general differences in the socio-economic conditions between the three major regions of Malawi.

<Table 1 about here>

With respect to HIV-risk behaviours, there was no significant difference between study sites in the proportion of men reporting that their spouses usually resided outside the village in either survey wave. Moreover, the proportion of men reporting mobile wives was substantially lower than that of women reporting mobile husbands. The possible explanation for this might be the gendered division of labour within households in which men are likely to be engaged in tasks that require temporary absence from the household while women tend to be engaged in household chores. The patterns show that in both waves, the lowest percentage of women reporting mobile husbands was from the North. The same applies to the percentage of women reporting multiple marital unions,

which could be a reflection of lower divorce and re-marriage rates in the North than in the other study sites (see for instance Reniers 2003).

Another interesting pattern from Table 1 is the difference between study sites in the percentage of men or women who reported at least two life-time sexual partners. Studies of sexual behaviour in sub-Saharan Africa (e.g. Buvé et al. 2001; Mensch et al. 2003) show that men tend over-report while women under-report sexual partners. Still a significantly higher percentage of men and women from the South reported multiple life-time sexual partners compared to their counterparts from the North. This raises a number of questions. For example, could it be that men from the South exaggerated the number of sexual partners more than their counterparts from the North? Alternatively, could it be that men and women from the South were more forthright in their reports than those from the North given the fluidity of marriages in this study site than in the North? Answers to these questions are beyond the scope of the present study. Nonetheless, we can speculate that where inheritance is along the matrilineal system as in the South, it can be expected that women may be empowered such that they may not be afraid to report that they have had multiple sexual partners compared to instances where inheritance is through the husband as in the North.

HIV-risk behaviours and the risk of infection

Tables 2a and 2b present the coefficient estimates from the random-effects probit models predicting HIV status among men and women in each of the three MDICP sites. *Partner mobility* and *marital experience* were significant predictors of the likelihood of being HIV positive for men from the South (Table 2a, Panel A). The predicted HIV prevalence

among men whose partners were mobile is over five times that of those whose partners usually lived in the village or those who were not married (Table 3, Panel A). Similarly, the predicted prevalence among men from the region who had married more than once is more than twice that of those who had been married once or those who had never married (Table 3, Panel A). None of the indicators of HIV-risk behaviours was significantly associated with HIV status among men from the North and Centre (Table 2a, Panel A).

Among women from the South, *partner mobility* and *multiple life-time sexual partnerships* were significantly associated with the likelihood of being HIV positive (Table 2b, Panel A). In particular, the predicted prevalence among women from the region whose partners were mobile is more than twice that of those whose partners usually resided in the village or those who were not married (Table 3, Panel A). The same applies to women who reported at least two life-time sexual partners compared to those who reported one or no sexual partner (Table 3, Panel A). Among women from the North, only *partner mobility* was significantly associated with the likelihood of HIV infection (Table 2b, Panel A). The predicted prevalence among women from the North whose partners were mobile is about 11 percentage points higher than that of those who partners usually lived in the village or those who were not married (Table 3, Panel A). Again, none of the HIV-risk behaviours was significantly associated with HIV status among women from the Centre.

<Tables 2a, 2b and 3 about here>

The second and third panels of Tables 2a, 2b and 3 ((Panels B and C) show the results we obtain by making two extreme assumptions about the HIV status of non-respondents (refusals and temporary absentees) for HIV test. The results based on the

assumption that all non-respondents would have been HIV negative had the project tested them and determined their HIV status (Panel B of Tables 2a, 2b and 3) are fairly consistent with those that ignore non-response. The other assumption that all of them would have been HIV positive, on the other hand, yields considerably different estimates (Panel C of Tables 2a, 2b and 3) from those of the first assumption and from the estimates that ignore non-response. These patterns suggest that the second assumption might be implausible given the low HIV prevalence in the study settings. Its implausibility is also evident in the higher predicted prevalence among some low-risk than among high-risk groups in some of the study sites (Table 3, Panel C).

Variations in the impact of HIV-risk behaviours

The results in the previous section indicate that the most obvious variations in the impact of HIV-risk behaviours on the likelihood of HIV infection between the study sites is the within-site differences between high-risk and low-risk groups. For instance, *partner mobility* and *marital experience* were significantly associated with increased risk of HIV infection among men from the South but not among those from the other study sites. Similarly, *partner mobility* significantly increased the chances of HIV infection among women from the South and the North but *multiple life-time sexual partnerships* significantly increased such risk for women from the South only. The Centre also differs from the rest of the study sites in that none of the HIV-risk behaviours was significantly associated with the likelihood of being HIV positive among men and women from the region.

In addition to the variations in the within-site differences between high-risk and low-risk groups, there are significant differences in the predicted HIV prevalence between study sites among some high-risk groups (Table 3, Panel A). In particular, the predicted prevalence among men whose partners were mobile is between five and seven percentage points higher in the South than in the North or Centre. It is also interesting to note that while the lowest percentage of women reporting mobile husbands was from the North, the predicted prevalence among these women is just as high as that of those from the South. Furthermore, the predicted prevalence among women reporting two or more life-time sexual partners was about twice as high among those from the South as among those from the North or Centre. At the same time, the predicted prevalence among women who reported being married more than once was significantly lower in the North than in the South (Table 3, Panel A).

There is also a gender dimension to the between-site variations in the impact of HIV-risk behaviours on the likelihood of HIV infection. Specifically, *partner mobility* accounts for some of the regional variations in HIV prevalence among men from the three study sites while for women, it is a combination of the three key indicators of HIV-risk behaviours i.e. *partner mobility*, *marital experience*, and *multiple life-time sexual partnerships* (Table 3, Panel A). Similarly, the predicted HIV prevalence among those in the high-risk groups (i.e. those whose partners were mobile, had married more than once, or who reported more than one life-time sexual partner) is significantly higher for women than for men. The exception is the predicted prevalence among those whose partners were mobile in the South and Centre.

What might account for some of these variations? To begin with, our data show that the three study sites differ in terms of reported condom use not only with any partner but also within marriage. In particular, the percentage of men and women who were sexually active in the past one year prior to the survey round and who reported using a condom with at least one sexual partner was lowest in the South and highest in the North in both survey waves (Obare and Poulin 2007). Thus, the differential impact of HIV-risk behaviours on the likelihood of infection between the South on the one hand and the North and Centre on the other could partly be attributed to low levels of condom use in the South despite the fact that some of the high-risk behaviours are more prevalent in this than in the other study sites (Table 1). But the differences in condom use between the study sites could also be a function of the prevailing socio-economic conditions that potentially determine the ability to purchase condoms. We should, for instance, expect individuals from the South to have diminished ability to purchase condoms because of the poorer socio-economic conditions there compared to their counterparts from the North.

As would be expected, there are also gender differences in reported condom use. Our data show that within each site, the proportion of women reporting condom use within the past twelve months preceding the survey round was lower than that of men in both years (Obare and Poulin 2007). Whereas this might explain why the impact of HIV-risk behaviours on the risk of infection seems to be greater for women than for men, it could also be a reflection of wider socio-economic and socio-cultural issues. First, it could be due to gender differences in access to condoms-- male condoms are the cheaper and more popularized form of protection than female condoms. This implies that even if

women have access to the male condoms, they still have to convince their spouses to use them. Second, economic power differentials between men and women might be at play to determine not only the ability to purchase condoms but also to negotiate safe sex. We should expect such power differentials to be greatest in the North with the patrilineal system but women still do not control inherited property even in the South with the matrilineal system of inheritance; rather, it is the maternal uncle who controls such property (Mtika and Doctor 2002; Chimbiri 2007). Third, the greater condom use among men compared to women could also be a reflection of use with extra-marital partners. This is because of the general perception that men are more likely than women to engage in extra-marital relationships and the fact that the use of condoms is viewed as acceptable within such relationships rather than with a spouse (Bauni and Jarabi 2003; Smith 2004; Watkins 2004; Chimbiri 2007).

Finally, circumcision or lack of it is the other factor that might explain the differential impact of HIV-risk behaviours on the likelihood of infection (Auvert et al. 2001a; 2001b). Two clinical trials of adult male circumcision in Kenya and Uganda, for instance, showed that medically performed circumcision significantly reduces a man's risk of acquiring HIV through heterosexual intercourse (National Institute of Allergy and Infectious Diseases [NIAID] 2006; Bailey et al. 2007; Gray et al. 2007). But it is unlikely that circumcision might be a factor in the differential impact of HIV-risk behaviours observed in the present study, at least in the context of the results from the two clinical trials. This is largely because evidence from the 2004 MDHS shows that HIV prevalence was highest in the region with the highest percentage of men reporting having been circumcised-- the South. In particular, men from the South were over six times more

likely to report having been circumcised compared to those from the North and about three times as likely as those from the Centre to report the same (NSO and ORC Macro 2005). This could be an indication of two things: one, it could be reflecting the fact that much of circumcision is not medically performed which might increase the risk of infection, and two, it might underscore the importance for circumcision to be accompanied with safe sex practices.

Discussion and implications

Malawi is one of the countries in sub-Saharan Africa with generalized HIV epidemic (prevalence of 10% or higher). But as elsewhere in the region, variations in prevalence do exist between urban and rural areas, between the major regions, and between men and women. It, however, provides an interesting case study for understanding the HIV-risk factors and the differential impact of these factors on the risk of HIV infection because of the regional variations in socio-economic and socio-cultural patterns that might modify differently these risk factors. Using two waves of HIV survey data collected from three rural sites in the country (North, South, and Centre), this paper examined the risk factors associated with HIV infection in the three sites with emphasis on *partner mobility*, *marital experience*, and *sexual partnerships* and the variations in their impact on such risk across the study sites.

The results show significant within-site differences between high-risk and low-risk individuals especially from the South and the North. *Partner mobility* is, for instance, significantly associated with the likelihood of being HIV positive among men from the South and among women from the South and the North. *Marital experience*, on the other

hand, is significantly associated with the likelihood of being HIV positive among men from the South only while *multiple life-time sexual partnerships* is significant for women from the South only. There are also significant differences across study sites in the predicted HIV prevalence among high-risk groups (i.e. those whose partners were mobile, who reported having been married more than once, or who reported at least two life-time sexual partners). But this is observed in relation to partner mobility for men and to all the three indicators of HIV-risk behaviours considered for women. Furthermore, consistent with the observed patterns of HIV prevalence, the predicted prevalence among high-risk groups is significantly higher among women than among men. The exception is those whose partners were mobile in the South and Centre where the differences are insignificant. These results are robust to the assumption that all non-respondents for the HIV test (refusals and temporary absentees) would have been HIV negative had they taken the tests such that we knew their HIV status.

The potential explanation for the differential impact of the HIV-risk behaviours especially between the South on the one hand and the North and Centre on the other could be the higher prevalence of high-risk behaviours coupled with lower levels of condom use in the South compared to the other study sites. Low levels of condom use could in turn be due to the poorer socio-economic conditions in the South compared to the North which may negatively impact on an individual's ability to purchase condoms. Another possible explanation for low levels of condom use could be the unacceptability of use especially within marriage (Watkins 2004; Chimbiri 2007). But analysis of attitude toward condom use within marriage shows that in both survey waves, the proportion of men and women reporting that such use is acceptable is higher in the South than in the

North or Centre (Obare and Poulin 2007). In contrast, the proportion of men and women reporting that condom use within marriage is acceptable only if the individual suspects the spouse to be infected with HIV is higher in the North than in the South. These patterns therefore suggest that attitude toward condom use might not explain the lower levels of use in the South compared to the other study sites.

The difference in the impact of HIV-risk behaviours between men and women could also be partly attributed low levels of condom use among women compared to men. But this might be a smokescreen for larger socio-economic and socio-cultural issues that include gender differences in access to condoms as well as economic power differentials that could determine not only women's ability to purchase condoms but also to make decisions regarding their sexual and reproductive health (UNAIDS 2006). It could also reflect the perception that men are more likely than women to have extra-marital partners and are therefore more likely to use condoms with such partners than with their spouses. A follow-up survey after the 2004 MDICP HIV testing and counselling (Thornton 2005), for instance, found that men were not only more likely than women to purchase condoms from the follow-up survey interviewers but also purchased more when they did. This could be an indication of any of the three circumstances i.e. gender differences in access to condoms, differences in purchasing power, or the need for use with pre- or extra-marital partners given the disapproval of condom use with a marital or stable partner.

These results have a number of implications for HIV prevention efforts. The first implication is the need for socio-economic empowerment which, in addition to improving life-styles in the rural areas, can also enable individuals to purchase and consistently use

condoms. The second implication is the need for prevention methods that women can control (UNAIDS 2006) e.g. the female condom which is not as widely popularized in the region as the male condom. A recently concluded international women's conference on HIV/AIDS held in Nairobi (Kenya), for example, noted this lack of awareness about the female condom in the region and therefore called for the need for it to be popularized (Nation Media Group 2007). The third implication is the need to initiate policies aimed at promoting gender equality (UNAIDS 2006) to ensure that women are in a position to negotiate safe sex. The results further suggest that these efforts are necessary even among matrilineal societies as in the South where one would expect that women should be more empowered than in the patrilineal societies because of the matrilineal system of property inheritance.

Acknowledgements

The data for this paper were collected through support from NIH/NICHD grants RO1-HD372-276, RO1-HD41713, and RO1-HD044228-01, as well as from the University of Pennsylvania's University Research Foundation. Both studies were approved by the institutional review boards at the College of Medicine in Malawi and the University of Pennsylvania in the United States. The views expressed in the paper are, however, those of the author.

References

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

Anglewicz, Philip, Simona Bignami-Van Assche, Li-Wei Chao, David Chilongozi, Irving Hoffman, Hans-Peter Kohler, Francis Martinson, Francis Onyango, Georges Reniers, and Kirsten Smith. 2005. *The Collection of Biomarkers in Rural Malawi: What Did We Learn*? Paper presented at the Meeting of the International Union for the Scientific Study of Population (IUSSP), July 18-24, Tours, France.

Auvert, B, A. Buvé, B. Ferry, M. Caraël, et al. 2001a. "Ecological and individual level analysis of risk factors for HIV infection in four urban populations in sub-Saharan Africa with different levels of HIV infection." *AIDS* 15(suppl 4): S15-S30.

Auvert, B, A. Buvé, E. Lagarde, M. Kahindo, et al. 2001b. "Male circumcision and HIV infection in four cities in sub-Saharan Africa." *AIDS* 15(suppl 4): S31-S40.

Bailey, R.C., S. Moses, C. B. Parker, K. Agot, I. Maclean, J. N. Krieger, C. F. Williams, R. T. Campbell, J. D. Ndinya-Achola. (2007). "Male circumcision for HIV prevention in Kisumu, Kenya: a randomised controlled trial." *Lancet* 369: 643-656.

Bauni, Evasius K. and Ben Obonyo Jarabi. 2003. "The low acceptability and use of condoms within marriage: Evidence from Nakuru District, Kenya." *African Population Studies* 18(1): 51-65.

Bignami-Van Assche, S., L.W. Chao, I. Hoffman, H-P. Kohler, G. Reniers, K. Smith, S. Watkins, and A. Weinreb. 2004. *Protocol for biomarker testing in the 2004 Malawi Diffusion and Ideational Change Project*. SNP Working Paper No.7, Philadelphia: University of Pennsylvania.

Boerma, J.T., M. Urassa, S. Nnko, J. Ng'weshemi, R. Isingo, B. Zaba, and G. Mwaluko.

2002. “Sociodemographic context of the AIDS epidemic in a rural area in Tanzania with a focus on people’s mobility and marriage.” *Sexually Transmitted Infections* 78(Suppl 1): i97-i105.

Buvé, A. E. Lagarde, M. Caraël, N. Rutenberg, et al. 2001. “Interpreting sexual behaviour data: Validity issues in the multicentre study on factors determining the differential spread of HIV in four African cities.” *AIDS* 15(suppl 4): S117-S126.

Chimbiri, Agnes M. 2007. “The condom as an ‘intruder’ in marriage: Evidence from rural Malawi.” *Social Science & Medicine* 64: 1102-1115.

Crampin, Amelia C., Judith R. Glynn, Bagrey M.M. Ngwira, Frank D. Mwaungulu, Jörg M. Pönnighaus, David K. Warndorff and Paul E.M. Fine. 2003. “Trends and measurement of HIV prevalence in northern Malawi.” *AIDS* 17: 1817-1825.

Gray, R.H., G. Kigozi, D. Serrwada, F. Makumbi, et al. 2007. “Male circumcision for HIV prevention in men in Rakai, Uganda: A randomized trial.” *Lancet* 369: 657-666.

Helleringer, Stéphane and Hans-Peter Kohler. 2005. “Social networks, perceptions of risk, and changing attitudes towards HIV/AIDS: New evidence from a longitudinal study using fixed-effects analysis.” *Population Studies* 59(3): 265-282.

Matovu, JKB, Gray RH, Makumbi F, Wawer MJ, Serwadda D, Kigozi G, Sewankambo NK, Nalugoda F. 2005. “Voluntary HIV counseling and testing acceptance, sexual risk behavior and HIV incidence in Rakai, Uganda.” *AIDS* 19:503-511.

MDICP Team. 2007. *2006 Malawi Diffusion and Ideational Change Project (MDICP): Door-to-Door HIV testing and Counseling Protocol*. University of Pennsylvania.

Mensch, Barbara S., Paul C. Hewett, and Annabel S. Erulkar. 2003. "The reporting of sensitive behavior by adolescents: A methodological experiment in Kenya." *Demography* 40(2): 247-268.

Mtika, Mike Mathambo and Henry V. Doctor. 2002. "Matriliny, Patriliny, and Wealth Flows in Rural Malawi." *African Sociological Review* 6(2):71-97.

Nation Media Group. 2007. *Leadership pledge in war on AIDS*. Daily Nation, Nairobi, July 9.

National Institute of Allergy and Infectious Diseases (NIAID). 2006. *Adult male circumcision significantly reduces the risk of acquiring HIV*. Press release. December 13. http://www.niaid.nih.gov.

National Statistics Office (NSO) [Malawi] and ORC Macro. 2005. *Malawi Demographic and Health Survey 2004*. Calverton, Maryland: NSO and ORC Macro.

Obare, Francis. 2007. *Response to population-based voluntary counselling and testing for HIV in rural Malawi*. Unpublished Doctoral Dissertation, Population Studies Center, University of Pennsylvania.

Obare, Francis and Michelle Poulin. 2007. *The changing sexual behaviour and attitudes regarding condom use in the era of HIV/AIDS in rural Malawi: A longitudinal assessment*. Unpublished working paper. Population Studies Center, University of Pennsylvania.

Reniers, Georges. 2003. "Divorce and remarriage in rural Malawi." *Demographic Research* S1(6): 176-205.

Republic of Malawi [Ministry of Health and Population]. 2003. *HIV Sentinel Surveillance Report 2003*. National AIDS Commission.

Smith, Daniel J. 2004. “Premarital sex, procreation and HIV risk in Nigeria.” *Studies in Family Planning* 35(4): 223-235.

Thornton, R. 2005. *The demand for learning HIV status and the impact on sexual behavior: Evidence from a field experiment*. Unpublished working paper, Harvard University, Center for International Development, Kennedy School of Government.

UNAIDS. 2006. *2006 Report on the Global HIV/AIDS Epidemic*. Joint United Nations Programme on HIV/AIDS (UNAIDS).

Watkins, Susan Cotts. 2004. “Navigating the AIDS Epidemic in Rural Malawi.” *Population and Development Review* 30(4): 673-705.

Watkins, Susan C., Eliya M. Zulu, Hans-Peter Kohler and Jere R. Behrman. 2003. “Introduction to Social Interactions and HIV/AIDS in Rural Africa.” *Demographic Research* S1(1): 2-29.

Zulu, Eliya Msiyaphazi and Gloria Chepng’eno. 2003. “Spousal Communication about the risk of contracting HIV/AIDS in rural Malawi.” *Demographic Research* S1(8): 248-277.

Table 1: Percent distribution of respondents by various characteristics and by the study site, MDICP 2004-06

	MDICP 2004			MDICP 2006		
Characteristics by sex	South	Centre	North	South	Centre	North
Age (25 years and above)						
Men	65.6	70.9	65.6	71.9	76.5	71.1‡
Women	66.3	64.0	65.1	73.7	70.4	73.3
Education level (secondary and above)						
Men	6.0	13.4*	39.1*‡	4.9	14.0*	39.7*‡
Women	2.1	4.7*	21.3*‡	2.9	5.3*	21.0*‡
HH owns tin-roofed house + bicycle[a]	7.8	7.8	17.5*‡	7.6	10.0	15.8*‡
Respondent mobility[b]						
Men	20.0	14.4*	12.0*	20.6	11.8*	11.9*
Women	10.2	5.7*	13.8‡	10.4	7.6	13.4‡
Partner mobility[c]						
Men	1.6	1.4	1.3	0.8	1.2	1.9
Women	16.2	13.5	10.7*	8.8	9.7	6.0‡
Married more than once						
Men	34.0	32.0	34.1	45.8	38.1*	33.7*
Women	37.5	25.9*	19.0*‡	42.3	29.8*	20.9*‡
Multiple life-time sexual partners						
Men	80.0	75.2	60.3*‡	87.2	81.8*	66.4*‡
Women	61.3	46.7*	28.8*‡	69.5	56.8*	35.1*‡
Number of respondents						
Men	586	575	555	531	538	534
Women	661	669	606	634	640	643

Notes: [a]Percentages are based on responses by women only; [b]Refers to whether the respondent had stayed outside the district for more than one month in the past one year before the survey; [c]Refers to whether the partner (if married) usually resides outside the village; *The difference between the study site and the South is statistically significant at $p<0.05$; ‡The difference between the North and the Centre is statistically significant at $p<0.05$; MDICP- Malawi Diffusion and Ideational Change Project; HH- household.

Table 2a: Coefficient estimates from the random-effects probit models predicting HIV status among men by the study site, MDICP 2004-06

Characteristics	South	Centre	North
	Panel A: Estimates ignoring non-response		
Age (25 years and older = 1)	1.76* [0.63]	0.72§ [0.43]	0.91§ [0.51]
Education level (secondary+ = 1)	-0.10 [0.72]	0.55 [0.35]	0.08 [0.29]
HH owns tin-roofed house + bicycle	0.62§ [0.35]	-0.21 [0.48]	0.41 [0.31]
Respondent mobility (mobile = 1)[a]	0.17 [0.29]	-0.54 [0.44]	-0.18 [0.43]
Partner mobility (partner mobile = 1)[b]	1.15§ [0.62]	0.80 [0.86]	1.01 [0.87]
Married more than once	0.53§ [0.28]	0.40 [0.28]	0.39 [0.31]
Multiple life-time sexual partners	-0.11 [0.39]	0.30 [0.39]	0.67 [0.43]
Survey year (2006 = 1)	-0.40§ [0.22]	-0.44§ [0.23]	0.02 [0.23]
	Panel B: Estimates based on assumption (i)[c]		
Age (25 years and older = 1)	1.73* [0.63]	0.70 [0.42]	0.89§ [0.51]
Education level (secondary+ = 1)	-0.07 [0.73]	0.55 [0.34]	0.06 [0.28]
HH owns tin-roofed house + bicycle	0.48 [0.34]	-0.20 [0.47]	0.37 [0.31]
Respondent mobility (mobile = 1) [a]	0.12 [0.28]	-0.54 [0.43]	-0.18 [0.42]
Partner mobility (partner mobile = 1)[b]	1.27‡ [0.60]	0.86 [0.86]	0.78 [0.80]
Married more than once	0.49§ [0.27]	0.38 [0.28]	0.37 [0.30]
Multiple life-time sexual partners	-0.07 [0.38]	0.36 [0.38]	0.66 [0.42]
Survey year (2006 = 1)	-0.41§ [0.22]	-0.43§ [0.23]	0.08 [0.22]
	Panel C: Estimates based on assumption (ii)[c]		
Age (25 years and older = 1)	0.28 [0.22]	0.24 [0.21]	0.71* [0.26]
Education level (secondary+ = 1)	-0.18 [0.40]	0.27 [0.23]	0.02 [0.19]
HH owns tin-roofed house + bicycle	0.42 [0.26]	-0.11 [0.30]	0.53‡ [0.22]
Respondent mobility (mobile = 1) [a]	0.41‡ [0.19]	-0.21 [0.21]	0.23 [0.25]
Partner mobility (partner mobile = 1)[b]	0.41 [0.66]	0.05 [0.81]	0.99§ [0.60]
Married more than once	0.41§ [0.21]	0.19 [0.20]	0.29 [0.22]
Multiple life-time sexual partners	-0.35 [0.23]	-0.33§ [0.20]	0.17 [0.24]
Survey year (2006 = 1)	0.11 [0.14]	-0.34‡ [0.14]	-0.52* [0.16]
Number of observations			
Ignoring non-response	737	687	806
Assumptions (i) and (ii)	827	757	858

Notes: [a]Refers to whether the respondent had stayed outside the district for more than one month in the past one year before the survey; [b]Refers to whether the partner (if married) usually resides outside the village; [c]Assumptions (i)- all non-respondents (refusals and temporary absentees) would have been HIV negative, and (ii)- all of them would have been HIV positive had they taken the tests such that we knew their HIV status; Standard errors are in brackets; MDICP- Malawi Diffusion and Ideational Change Project; HH- household; §p<0.10; ‡p<0.05; *p<0.01.

Table 2b: Coefficient estimates from the random-effects probit models predicting HIV status among women by the study site, MDICP 2004-06

Characteristics	South	Centre	North
	Panel A: Estimates ignoring non-response		
Age (25 years and older = 1)	0.63‡ [0.27]	0.84* [0.30]	0.13 [0.25]
Education level (secondary+ = 1)	0.64 [0.62]	0.53 [0.49]	0.31 [0.26]
HH owns tin-roofed house + bicycle	0.34 [0.33]	-0.17 [0.39]	0.29 [0.26]
Respondent mobility (mobile = 1)[a]	0.44 [0.27]	0.37 [0.38]	-0.03 [0.28]
Partner mobility (partner mobile = 1)[b]	0.63* [0.23]	0.05 [0.32]	0.89* [0.28]
Married more than once	0.26 [0.23]	0.41 [0.28]	0.50 [0.32]
Multiple life-time sexual partners	0.66‡ [0.26]	0.10 [0.28]	0.37 [0.29]
Survey year (2006 = 1)	-0.05 [0.16]	-0.16 [0.19]	-0.16 [0.18]
	Panel B: Estimates based on assumption (i)[c]		
Age (25 years and older = 1)	0.68‡ [0.26]	0.76* [0.26]	0.13 [0.25]
Education level (secondary+ = 1)	0.59 [0.60]	0.44 [0.42]	0.31 [0.26]
HH owns tin-roofed house + bicycle	0.35 [0.32]	-0.14 [0.34]	0.25 [0.25]
Respondent mobility (mobile = 1)[a]	0.43 [0.26]	0.09 [0.21]	-0.04 [0.28]
Partner mobility (partner mobile = 1)[b]	0.57‡ [0.23]	0.07 [0.27]	0.89* [0.27]
Married more than once	0.23 [0.22]	0.35 [0.25]	0.52 [0.32]
Multiple life-time sexual partners	0.67* [0.25]	0.13 [0.24]	0.36 [0.28]
Survey year (2006 = 1)	-0.04 [0.16]	-0.11 [0.17]	-0.11 [0.18]
	Panel C: Estimates based on assumption (ii)[c]		
Age (25 years and older = 1)	-0.13 [0.19]	0.34§ [0.18]	-0.01 [0.22]
Education level (secondary+ = 1)	0.23 [0.52]	0.68‡ [0.33]	0.37 [0.23]
HH owns tin-roofed house + bicycle	-0.01 [0.30]	0.08 [0.26]	0.22 [0.24]
Respondent mobility (mobile = 1)[a]	0.18 [0.23]	0.35§ [0.20]	-0.13 [0.26]
Partner mobility (partner mobile = 1)[b]	0.54* [0.20]	0.21 [0.23]	0.60‡ [0.28]
Married more than once	0.18 [0.19]	0.28 [0.22]	0.21 [0.30]
Multiple life-time sexual partners	0.27 [0.19]	-0.37‡ [0.19]	0.36 [0.26]
Survey year (2006 = 1)	0.08 [0.12]	-0.34* [0.13]	-0.56* [0.16]
Number of observations			
Ignoring non-response	985	908	991
Assumptions (i) and (ii)	1,098	1,003	1,035

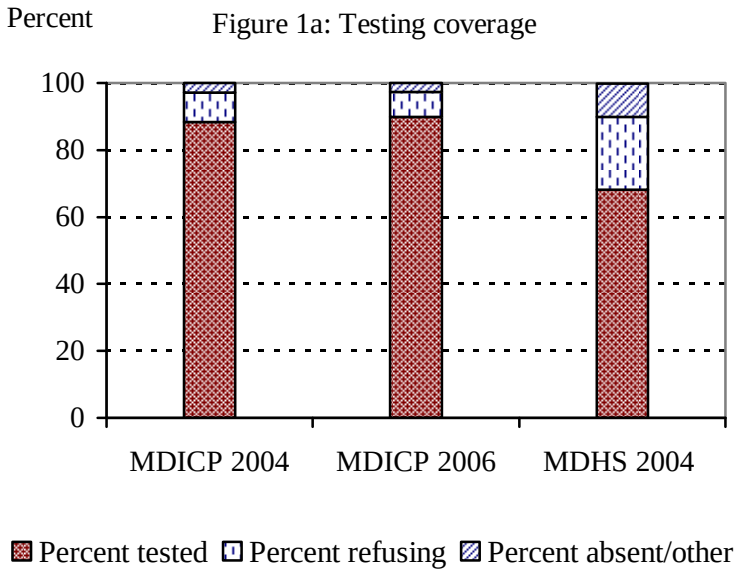
Notes: [a]Refers to whether the respondent had stayed outside the district for more than one month in the past one year before the survey; [b]Refers to whether the partner (if married) usually resides outside the village; [c]Assumptions (i)- all non-respondents (refusals and temporary absentees) would have been HIV negative, and (ii)- all of them would have been HIV positive had they taken the tests such that we knew their HIV status; Standard errors are in brackets; MDICP- Malawi Diffusion and Ideational Change Project; HH- household; §p<0.10; ‡p<0.05; *p<0.01.

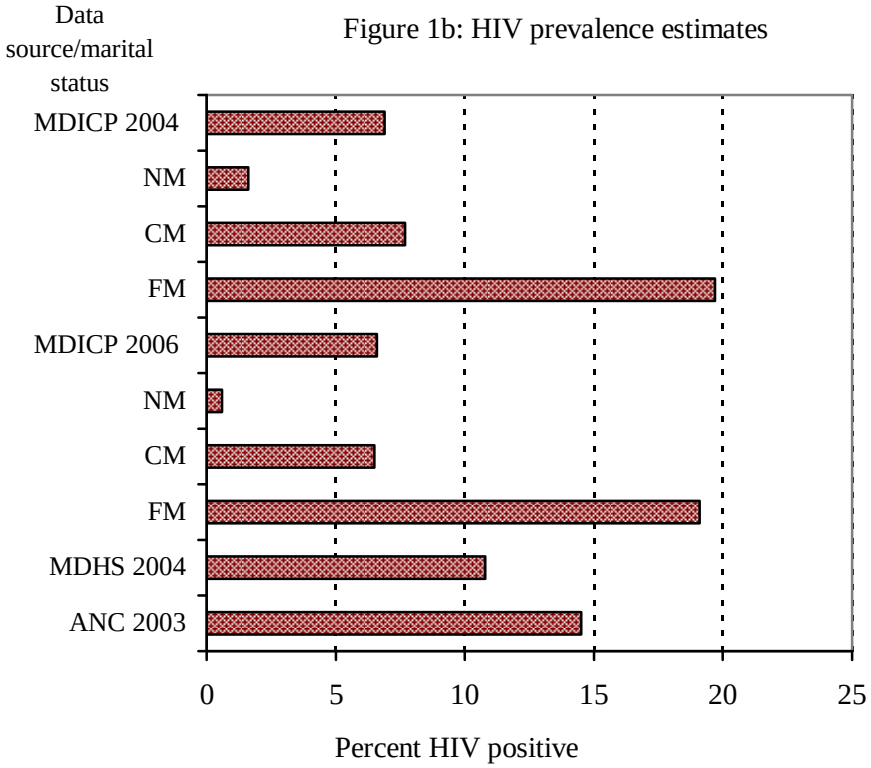
Table 3: Predicted HIV prevalence by partner mobility, marital experience, and sexual partnerships and by the study site, MDICP 2004-06

	Panel A: Predicted prevalence ignoring non-response					
	Men (%)			Women (%)		
Characteristics	South	Centre	North	South	Centre	North
Partner mobility[a]						
No/not married	2.8	3.4	2.3	7.9[§]	6.1[§]	3.9[*‡]
Partner mobile	16.0	9.4[*]	10.5[*]	17.4	7.0[*]	15.3[‡§]
Married multiple times						
No/ never married	1.9	2.8	1.8	7.8[§]	5.0[*§]	3.7[*§]
Married more than once	4.8	5.0	3.8	10.3[§]	9.7[§]	7.7[*§]
Multiple life-time sexual partners						
No/never had sex	3.3	2.2	1.0[*]	4.5	6.1[§]	3.5[‡§]
Two or more partners	2.8	3.9	3.7	12.0[§]	6.2[*§]	6.6[*§]
	Panel B: Predicted prevalence based on assumption (i)[b]					
Partner mobility[a]						
No/not married	2.4	3.1	2.2	7.0[§]	5.5[§]	3.7[*]
Partner mobile	17.1	9.4[*]	7.2[*]	14.9	6.5[*§]	14.7[‡§]
Married multiple times						
No/ never married	1.7	2.5	1.7	7.0[§]	4.6[*§]	3.5[*§]
Married more than once	4.2	4.4	3.5	9.0[§]	8.6[§]	7.6[§]
Multiple life-time sexual partners						
No/never had sex	2.8	1.8	0.9[*]	4.0	5.3[§]	3.4[‡§]
Two or more partners	2.5	3.6	3.5	10.7[§]	5.9[*§]	6.3[*§]
	Panel C: Predicted prevalence based on assumption (ii)[b]					
Partner mobility[a]						
No/not married	15.3	13.1	8.1[*‡]	18.1	15.0	8.0[*‡]
Partner mobile	23.4	12.3[*]	28.5[*‡]	28.0[§]	19.8[*§]	18.3[*§]
Married multiple times						
No/ never married	12.8	12.3	7.0[*‡]	17.5[§]	13.8[*§]	8.2[*‡]
Married more than once	19.6	14.7[*]	10.6[*‡]	21.8	20.0[§]	10.3[*‡]
Multiple life-time sexual partners						
No/never had sex	20.7	17.4	6.6[*‡]	15.4[§]	18.8[*]	7.3[*‡]
Two or more partners	14.4	12.0	9.2[*]	21.5[§]	12.8[*]	11.8[*]
Number of observations						
Ignoring non-response	737	687	806	985	908	991
Assumptions (i) and (ii)	827	757	858	1,098	1,003	1,035

Notes: [a]Refers to whether the partner (if married) usually resides outside the village; [b]Assumptions (i)- all non-respondents (refusals and temporary absentees) would have been HIV negative, and (ii)- all of them would have been HIV positive had they taken the tests such that we knew their HIV status; [*]The difference between the study site and the South is statistically significant at $p<0.05$; [‡]The difference between the North and the Centre is statistically significant at $p<0.05$; [§]The difference between women and men is statistically significant at $p<0.05$; MDICP- Malawi Diffusion and Ideational Change Project.

Figures 1a-b: Comparison of testing coverage and HIV prevalence estimates in the MDICP and the MDHS rural areas, Malawi 2004-06

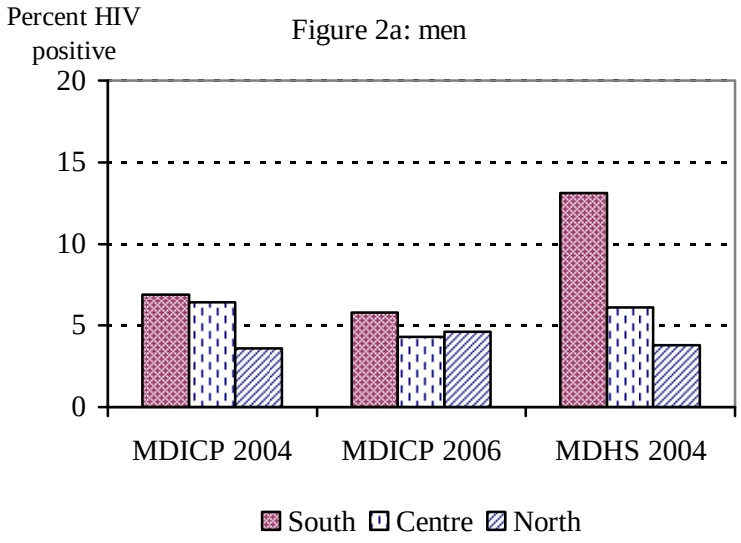


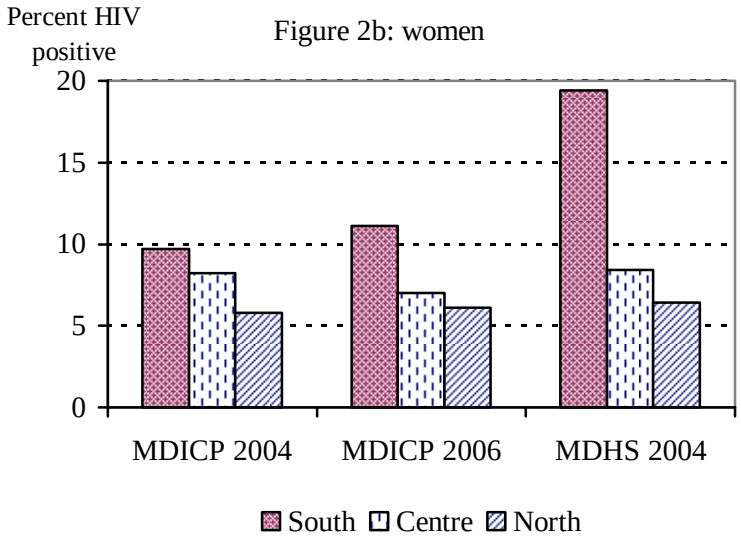


Notes: MDICP- Malawi Diffusion and Ideational Change Project; MDHS- Malawi Demographic and Health Survey (rural areas); ANC- antenatal clinic (rural); NM- never married; CM- currently married; FM- formerly married (divorced/separated/widowed).

Sources: Republic of Malawi 2003; NSO & ORC Macro 2005; 2004-06 MDICP data.

Figures 2a-b: Percent distribution of HIV positive individuals by study site and by sex, MDICP 2004-06 and MDHS 2004





Notes: MDICP- Malawi Diffusion and Ideational Change Project; MDHS- Malawi Demographic and Health Survey (rural areas); MDHS figures are unweighted.
Sources: NSO & ORC Macro 2005; 2004-06 MDICP data.