SAGA

Strategies and Analysis for Growth and Access

SAGA Working Paper
June 2008

Determinants of HIV Knowledge and Condom Use among Women in Madagascar: An Analysis Using Matched Household and Community Data

Peter Glick
Cornell University

Josée Randriamamonjy
International Food Policy Research Institute

David E. Sahn
Cornell University

Strategies and Analysis for Growth and Access (SAGA) is a project of Cornell and Clark Atlanta Universities, funded by cooperative agreement #HFM-A-00-01-00132-00 with the United States Agency for International Development.

USAID
FROM THE AMERICAN PEOPLE

ISSN 1936-5071

Determinants of HIV Knowledge and Condom Use among Women in Madagascar: An Analysis Using Matched Household and Community Data

Peter Glick
Cornell University

Josée Randriamamonjy
International Food Policy Research Institute

David E. Sahn
Cornell University

June 2008

Determinants of HIV Knowledge and Condom Use among Women in Madagascar: An Analysis Using Matched Household and Community Data

ABSTRACT

We estimate the determinants of HIV/AIDS knowledge and related behavior (use of condoms) among women in Madagascar, a country where prevalence remains low but conditions are ripe for a rapid increase in infections. In both rural and urban areas, more educated and wealthier women are more likely to know about means of preventing infection, less likely to have misconceptions about transmission, and more likely to use condoms. Community factors such as availability of health centers and access to roads also are associated with greater HIV knowledge. However, most of the large rural-urban difference in mean knowledge is due not to location per se but to differences in schooling and wealth; rather than simply being geographically targeted, AIDS education efforts must be designed to target and be understood by uneducated and poor subpopulations.

INTRODUCTION

HIV prevalence in Madagascar remains very low compared with other countries in sub-Saharan Africa. UNAIDS estimates the adult HIV prevalence rate in the country at just 0.5% in 2007, compared with 5.0 % in sub-Saharan Africa overall and 15% or higher in the adjacent countries in the Southern African region. However, there are some important warning signs both that HIV prevalence may be higher than estimated, and that Madagascar is vulnerable to a rapid increase in HIV infections. Most important are the high prevalence of sexually transmitted infections (STI) that share modes of transmission and behavioral risk factors with HIV and the lack of knowledge on how to prevent infection. 82% of female sex workers had at least one sexually transmitted infection in a study by Kruse and Behets (2001), making Madagascar's STI prevalence rate in excess of that in most high HIV prevalence countries. STIs are not just an indicator of risk behavior; they also directly make people biologically more susceptible to HIV infection, and thus are associated with higher rates of incidence and prevalence (Cohen and Trussel 1996).

Another major risk factor in Africa and in Madagascar specifically is the high prevalence of simultaneous multiple partnerships and a variety of cultural practices that encourage promiscuity (Boerma et al. 2002), though in the Malagasy context sexual attitudes and the acceptability of multi-partnerships vary across ethnic groups. Further, widespread poverty, high illiteracy, limited access to health and social services, and the increasing mobility of the population, all add to the potential for future growth of HIV infections in Madagascar. The country is among the least developed in the world, with approximately three-quarters of the population living below the poverty line (Paternostro, Razafindrovanona, and Stifel 2001). Almost half of Malagasy adults have no formal education and only around one in ten have attended secondary school or beyond. Considerable internal migration, including temporary movements of male workers to find temporary or seasonal employment at Madagascar's multiple mining sites in the interior of the country, along with the regular arrival of cargo boats from high HIV risk countries (Medecin du Monde 2001; Direction Generale de la Jeunesse 1999), also represent important risk factors for the spread of HIV infection on the island.

Madagascar began implementing activities to combat HIV/AIDS as early as 1988, but these efforts are considered to have been generally ineffective (USAID 1999). However, the new government that emerged at the end of the political crisis in 2002 has made a greater commitment to tackle the HIV/AIDS problem. Among the key planks of this effort is the identification of groups vulnerable to HIV and the provision of appropriate services and education to them to reduce high-risk behaviors and increase rates of treatment for STIs. Another has been to increase the access to and utilization of condoms (Projet Multisectoriel de Prévention des IST/SIDA 2002).

Prevention policies such as these will be enhanced by greater understanding of the household and community level determinants of HIV-related knowledge and behaviors. Such an understanding will help both to identify vulnerable groups among the population and to devise appropriately targeted policies to improve HIV knowledge and reduce risk behaviors. In this study we address this need through an analysis of the Madagascar Demographic and Health Survey (DHS), collected in 1997. We estimate the determinants of several forms of HIV knowledge as well of condom use among women age 15-49. The DHS is the only nationally representative survey providing information on these topics for Madagascar. The DHS has been carried out in numerous other countries in Africa as well and been used to analyze HIV knowledge and/or behavior in a number of them (Glick and Sahn 2007, 2008; Blanc 2000; Gersovitz 2005). However, in the present case we have a unique opportunity to supplement these data with a matched data set--the 2001 Commune census--containing information on local health and other infrastructure in the communities where the DHS was carried out. Use of these additional data allows us both to investigate the potentially important effects of public health and communication infrastructure on knowledge and behavior, and to obtain more accurate estimates of the effects of individual and household factors such as schooling and wealth that may be correlated with community level characteristics (as well as to determine if standard estimates of these effects are likely to be biased through the exclusion of community characteristics).

A disadvantage of the data that we use, particularly when considering the HIV epidemic, is that they are approximately a decade old. Our initial intention was to measure both levels and changes over time in knowledge and (condom) behaviors using this data set together with the latest Madagascar DHS, carried out in 2003. However, potentially serious sample comparability problems arose, with concerns about the later DHS; these are described in Glick, Sahn, and Younger (2006).[1] In view of this we restrict our analysis to the earlier 1997 survey. Nevertheless, the analysis retains considerable value, for several reasons. First, the situation in Madagascar with respect to HIV prevalence has barely changed in the last several years; for example, prevalence was about 0.3% in 2001 and 0.5% in 2007. Therefore the picture we present is likely still valid for Madagascar today. More generally, the patterns and determinants of HIV knowledge reported here should be applicable to other low income countries that, like Madagascar, have not yet experienced generalized epidemics. Finally, as indicated, in the paper is unusual in its ability to provide insights into the effects of community level factors on this knowledge and on related behavior.

The remainder of the paper is organized as follows: Section 2 describes the data and sample in more detail. Section 3 presents our empirical approaches to estimating the determinants of HIV/AIDS prevention knowledge and condom use. Section 4 presents and

[1] That analysis was motivated by differences between the two surveys in reported infant and child mortality rates that suggested implausibly large drops over the six year interval between them. A series of statistical checks confirmed that the sampled populations differed along various dimensions and also found evidence of additional problems with the 2003 fertility and mortality data. While we could not definitively conclude that the later sample was not representative (or was less representative) of the population than the earlier one, the mortality rates derived from the 1997 DHS were consistent with those from other nationwide surveys carried out close to that time.

interprets the results, and Section 5 concludes with a discussion of policy implications of our findings.

DATA

The Madagascar DHS was conducted between September and December 1997 by *Institut National de la Statistique* (INSTAT) of Madagascar with the technical assistance of Macro International (1998); the DHS surveys are financed by USAID. The DHS is designed to be nationally representative and follows a two-stage cluster-sampling technique: the first stage at the commune level and the second stage at the household level. The DHS consists of two types of questionnaires: an individual questionnaire for women of reproductive age (15-49), and a household questionnaire. 7,060 women were interviewed for the former. In addition to standard 'DHS-type' information on topics such as reproductive behavior, contraception, vaccination history, and mother's and children's health, the individual questionnaire has a section designed to evaluate the respondent's knowledge, attitudes and behavior with regard to HIV/AIDS. Included are questions about the means of transmission, means of prevention, and perceptions of the risk of getting AIDS.

The household questionnaire provides a range of information about the socio-demographic characteristics of the household. Since the DHS does not contain information on incomes or expenditures, we use data on assets to represent the level of resources of the household. Specifically, following the methodology of Sahn and Stifel (2003), we use factor analysis to construct an asset index using information on ownership of a radio, TV, refrigerator, bicycle, motorcycle and car, and on the source of drinking water (piped, surface water, or well water), toilet facilities (flush, pit toilet or latrine), and flooring material of the domicile.

We merge the DHS with commune level information obtained from the Commune Census carried out over a three-month period in 2001 as part of collaborative efforts between the

Ilo Program of Cornell University[2], the Malagasy Rural Development Research Institute (known by the acronym of its Malagasy name, FOFIFA) and INSTAT. The country's 1392 communes are the lowest administrative level above the village or community[3]; in rural areas they typically encompass about 10 villages. Communes also correspond to the primary sampling unit of the DHS survey. The census focused on infrastructure and availability of services: presence of health centers and schools, presence of national and regional roads in the commune, availability of national and regional TV and radio reception—all factors that to some degree may be expected to impart information about HIV/AIDS to residents of the commune.

Although the commune census collected these data for both urban and rural areas, we only use this information in our estimations for the rural sample. There is no meaningful variation within the urban sample since the infrastructure in urban areas is relatively highly developed. Almost all urban communes, for example, have paved roads, national TV reception, and nearby health facilities.

Researchers have often noted concerns about the validity of survey responses to sensitive questions about sexual practices (Gersovitz et al. 1998; Gersovitz 2005; Glick and Sahn 2008). Comparison of descriptive results from the DHS with several separate small-scale surveys in Madagascar shows an overall consistency of responses across surveys.[4] This provides some assurance of the quality of the DHS, but of course there may be common biases in responses in all surveys. The potential for misreporting therefore must be kept in mind, but it should be noted

[2] Information about *Ilo* can be found at http://www.ilo.cornell.edu/ . For a description of the commune census, see http://www.ilo.cornell.edu/ilo/data.html
[3] We dropped 10 out of the 270 DHS clusters for which no correspondence between the two surveys was found. This adjustment leads to a sample reduction from 7060 to 6876 women.
[4] The same questions used in the DHS on knowledge of means of HIV transmission were asked in the survey conducted by the Programme National de Lutte contre les Maladies Sexuellement Transmisible et le SIDA (PNLS) on a sample of 396 young people of 10-29 years old living in Toamasina and Tulear provinces. The results in that study (Gonzales, Ranorolalao, and Ravalondrazana 1998) on beliefs that AIDS can be transmitted by kissing or mosquito bites, for example, are similar to those we discuss below for the DHS data. The results of another survey (Population Services International 2001) conducted among 2440 adolescents in Toamasina on the socioeconomic determinants of condom use are also consistent with those presented in this paper.

that the discussion about response reliability usually concern questions about the individual's own sexual behavior; there is likely to be less of a problem when it comes to questions like those we focus on here about HIV knowledge, which presumably are significantly less personal.

METHODOLOGY

In this study we are interested in specifying the relationship between binary dependent variables representing HIV/AIDS knowledge and sexual practice (use of condoms), on the one hand, and a set of individual, household and community characteristics on the other. The first outcome we model is whether the respondent can correctly identify one or both of the two means of HIV prevention that are the most relevant in the Malagasy context: using condoms and having just one sexual partner. The second outcome is whether the respondent correctly rejects both of two common misconceptions about the disease: that transmission can occur through mosquito bites and kissing, and that a healthy-looking person cannot be infected with HIV. The third, behavioral, outcome we model is whether a (sexually active) woman has ever used a condom.[5] Although the DHS asks separately whether the individual has used a condom for pregnancy prevention or to prevent disease transmission, we consider condom use for either purpose the more relevant outcome from a prevention standpoint; however, results for the alternative of considering use of condoms for disease prevention only will be discussed as well since it provides particular insight into whether women are motivated to use condoms to avoid infection. Since the outcomes are discrete binary indicators we estimate their determinants using probits.[6] Our specification of the index function equation underlying the probit model is similar for each outcome and can be represented as follows (for the *i*th observation):

---

[5] We also estimated this model on the sample of all women 15-49 whether sexually active or not, but the parameters are nearly identical. The only exception was the age coefficients, which capture the impact of maturity on initiation of sexual activity.

$$Y_i = \beta_0 + \sum_h \beta_{1h} AGE_{hi} + \beta_2 PRIMARY_i + \beta_3 SECNDRY_i + \beta_4 AGEEDUC_i + \sum_k \beta_{5k} REL_{ki} + \sum_l \beta_{6l} PROV_{li} + \sum_m \beta_{7m} RELH_{mi} + \beta_8 RADIO_i + \beta_9 ASI_i + \beta_{10} CLINIC + \beta_{11} NROAD + \beta_{12} PROAD + \varepsilon_i$$

AGE_{hi} is a vector of dummy variables representing age group. Years of primary schooling (up to five) and secondary schooling (up to seven) are entered separately to allow for differences in the effect of education by level. There is a fairly long list of reasons to expect those who are better schooled to have attained more awareness of HIV and how it can be prevented (Glick and Sahn 2007). Educated people are likely to have better access to many sources of health and HIV-related information: they are more likely, for example, to read the newspaper or to visit private or public health services where HIV-related information is dispensed. If information comes through channels they already use, the costs of obtaining HIV/AIDS information will be low for them. Having an education may also make it easier for someone to process and understand the information to which they have access. That is, education and health information inputs may be complements in the production function for health knowledge, though the opposite may also occur: if messages are designed to be understood by the uneducated, schooling and health information may be substitutes. Further, as Becker (1993) has pointed out, those who have devoted more time and resources to education have already made larger investments in the future. Since their future stream of earnings, hence consumption and utility, is higher, they have greater incentives to protect their health and insure their longevity by gathering or being attentive to information about HIV prevention. Greater investment in education may also be a reflection

[6] For the knowledge outcomes, an alternative to the simple binary probits we report would be to use ordered probits to estimate the probabilities of knowing none, one and both prevention methods (or having none, one, and two misconceptions). However, results were very similar to those for the simpler binary probits we present.

of a low discount rate, which again would incline those with an education to seek information and change behaviors to insure their longevity.

Finally, at least in younger cohorts, those who went to or stayed in school may have been exposed to school-based HIV/AIDS programs. It is not clear whether this would be important in our sample, since even the youngest observations (those age 15-20) were in school before the implementation of major school-based HIV/AIDS education programs were implemented in Madagascar. Nevertheless, to capture this possibility, we include an interaction term for age and education $AGEEDUC_i$; a negative sign would be consistent with the provision of HIV information in school, since only younger educated women would have been exposed to such school-based information.

With respect to the relation of schooling to condom use, a number of studies (Glick and Sahn 2008, Filmer 1998, Messersmith et al. 1994, Becker and Ashraf 1997) show that condom use is higher among the better-educated, in particular condom use with non-regular partners. The pathways from schooling to use of condoms are potentially complex, as they have to do not just with prevention knowledge but also the level of risk behavior. With regard to the latter, better educated people typically have more sexual partners. In part this reflects their higher incomes: many studies of developing countries show that the number of partners is increasing in income (Blanc 2000; Filmer 1998, Carael 1995, Glick and Sahn 2008). Our models control for income, (or more precisely, wealth) but education may have independent effects on preferences for and possibly (via say, occupation) on access to for multiple partners or frequency of intercourse with these partners (De Walque 2002). This may lead to greater use of condoms by the better educated (even controlling for income) via having a larger number of partners (on which the Madagascar DHS does not collect data), in addition to education effects through the information access and processing pathways just noted. In addition, among women especially, a higher level of schooling may enhance bargaining ability within partnership(s), making it easier for them to persuade a partner to use a condom (Blanc et al. 1996; WHO 2001). More generally, education is thought to impart a sense of efficacy, that is, belief in ones' ability to change behavior (Martin and Juarez 1994). For each of these reasons, we would predict that more schooling increases the probability of condom use in our sample, though as the discussion has made clear, this does not mean that other risk behaviors (number of partners, number of acts of intercourse) also decline.

Among other covariates, ASI_i is our index of household wealth, described in the previous section. Prior analyses of household data find that knowledge of HIV/AIDS prevention is higher among the better-off than among the disadvantaged (Gwatkin and Deveshwar-Bahl 2001; Glick and Sahn 2007). Correlations of wealth and HIV knowledge outcomes may occur through the association of wealth with education as well as with urban residence, but even controlling for these factors Glick and Sahn (2007) find positive wealth impacts in their African samples. These may reflect in part an association of wealth or income with access to HIV-related information, e.g., though ownership of a radio or television or the use of healthcare practitioners. Furthermore, the rate of time preference may be higher for poorer people (perhaps because their poverty lowers their life expectancy; see Lawrance 1991). If as a result the poor discount future consumption more heavily than the well-off, they would be expected to invest less time or money in gathering information that could prolong healthy life. For these reasons, we would predict the affluent to be more receptive to messages about HIV/AIDS, and to adjust their behavior accordingly.

$RADIO_i$ is a dummy variable which takes on the value of 1 if the respondent listens to the radio daily. It is intended to capture the individual's exposure to the mass media information about HIV/AIDS that has routinely been broadcast in Madagascar since the mid-1990's. Although inclusion of this type of variable is standard in studies of HIV (and more generally, health) knowledge, one should be aware of the potential for simultaneity bias. Individuals who listen to the radio may also be more willing or able than others to absorb the messages heard on it, as well as to seek out HIV information in other, unobserved, ways. Therefore radio listening is potentially endogenous to knowledge or behavior outcomes, and one must be careful is assigning a causal interpretation to the estimate on this variable.

REL_{ki} is a vector of dummy variables for religion. Religious belief and practices may be important influences on sexual attitudes and behavior, hence possibly HIV knowledge. As seen in Appendix Table 1, Christianity is dominant in Madagascar: Catholics represent 33% and 40% of the rural and urban population, respectively, while Protestants make up 38% and 47%. 'No religion' is next in importance, followed by Islam and traditional religion. Finally, $PROV_{li}$ is a series of *faritany* (province) dummies.

We turn now to a discussion of how community level factors are incorporated into the models. Most existing studies of the determinants of HIV knowledge analyze only individual or household level determinants such as those discussed above, e.g., education and wealth. There are two concerns with this standard methodology. First, from a policy perspective we are also interested in the impacts of factors such as the proximity of health services on HIV knowledge; provision of these services are potentially important policy levers for improving HIV/AIDS knowledge and changing behaviors. Second, these and a number of other community level factors--for example, the presence of NGO health workers, and social networks that influence the spread of information--are likely to be correlated with individual or household level covariates. This correlation would imply standard omitted variable biases in the estimates on the latter in models that do not include controls for community factors. For example, if communities in which individuals tend to be well educated also have better developed public health services for disseminating health information, the (presumed positive) estimate of the effect of schooling on HIV knowledge will be biased upward. In our estimations we address these concerns in two ways.

First, we add to the basic models several local level infrastructure variables, namely, the presence of or distance to roads and health clinics. As discussed in the previous section, we do this for the rural sample only. *CLINIC* is defined as the distance in kilometers from the commune's administrative center to nearest commune where a health facility is available (it equals zero for facilities located in the surveyed commune). This variable thus captures the access to and availability of health infrastructure. *NROAD* and *PROAD* are dummy variables for the presence of national and regional roads, respectively, in the commune. We would expect HIV/AIDS related information to disseminate more quickly to communities served by well-trafficked road networks, and proximity to means of travel should also affect behaviors.[7] Beyond simply controlling for community level characteristics, of course, these estimates of the impacts of policy-related factors are of significant interest themselves. It should be noted, however, that we are not able to deal with possible biases from non-randomness in either health program placement or infrastructure investment. For example, health clinics may be located in areas where knowledge would be higher even without them, in which case any positive impacts of proximity to health clinics on knowledge will be overstated. Other types of service placement rules could lead to the impacts being understated. Therefore the estimates of the effects of these community covariates need to be interpreted with caution.

Our second and more comprehensive approach to dealing with potential biases from the correlation of individual factors with community level characteristics is to estimate community fixed effects models by adding dummies for each community (survey sample cluster or commune) to the basic specification. The fixed effects specification eliminates bias in the estimates of the included regressors caused by unmeasured community level factors that enter

[7] Though not necessarily positively, as is well known: in Africa, the HIV virus spread early along truck routes.

linearly in the index function.[8] Since the model with community dummies in effect relies on within-cluster variation of the regressors and outcomes to estimate the parameters, the community infrastructure variables (which are fixed within the community) do not enter these models. The fixed effects model therefore cannot provide information on the effects of specific community variables, unlike the previous approach, but unlike the first model it controls for both observed and unobserved community level factors.

A potentially serious concern with fixed effects in the context of non-linear models such as probit is bias arising from the 'incidental parameters' problem: the inclusion of cluster dummies means that as total sample size increases, so do the number of parameters to be estimated (with a fixed group size or number of observations T per cluster, increasing sample size means increasing the number of cluster dummies). This renders the estimator inconsistent and biased away from zero when group sizes are small, but the bias diminishes as group size increases. Monte Carlo evidence provided by Greene (2002) for the probit model indicates that with a value of $T=20$ the small sample bias is not large (around 5%). In our data the mean number of women per cluster is 26, suggesting that the use of fixed effects will not lead to important biases in the probit estimates.

RESULTS

DESCRIPTIVE ANALYSIS

Basic statistics on knowledge and practices are reported in Table 1. First we note that the proportion of women who have ever heard of AIDS (not shown in table) is high in urban areas (87%) but much less so in rural areas (62%), where approximately four-fifths of the population resides. These percentages are quite low compared to the nearly universal awareness of the

---

[8] The results will not be unbiased if the unobservables enter non-linearly, that is, if they interact with included individual level covariates—for example, if the response to the presence of a local program to dispense HIV

disease for a sample of other countries in sub-Saharan Africa at roughly the same time (Glick and Sahn 2007), though in other African countries AIDS has had a longer history and more widespread impacts. As the table indicates, prevention knowledge is also much higher among urban women, but even for them it is not very high: 61% of all urban women can identify at least one of the two main means of HIV prevention, condom use and having one partner. Among those who have heard of AIDS, the share is still only 70%. Only 29% of rural women (and less than half of rural women who are aware of AIDS) can identify at least one of the two prevention methods. This pattern repeats for the misconceptions variable (middle columns of the table). Only 27% of rural women and 51% of urban women know that the disease does not pass among people by kissing and mosquito bites and that a healthy-looking person can transmit HIV/AIDS. The table also suggests an inverted U-shaped profile by age, with knowledge as measured by either outcome variable lower among 15 to 19 year-olds and among 40-49 year olds. Knowledge appears to increase very sharply with educational attainment and there are large differences by province (*faritany*).

The last two columns of Table 1 report the share of sexually active women reporting ever having used a condom. Condom use is very low among Malagasy women: only 10 % of urban sexually active women say they have ever used a condom—and this proportion is five times higher than for rural women. It is likely that the rural-urban gap reflects locational differences in both knowledge and availability of condoms. It may also reflect differences in the probability of having non-regular partners, which we cannot assess with our data. Since the proportion of women who have used condoms is so low in rural areas, the multivariate analysis will consider urban women only. Condom use in this sample increases with education, and is highest among those age 2024 (who among other factors are most likely to be single).

information depends on wealth or education. As the earlier discussion makes clear, this process cannot be ruled out.

MULTIVARIATE ANALYSIS

Determinants of HIV prevention knowledge

Table 2 presents parameter estimates and marginal effects from the probit models of knowledge of the main means of preventing infection for women in rural and urban areas. Note that the samples for estimation include all women, including those who have not heard of AIDS; these individuals are grouped with other women who cannot identify either of the two prevention methods.[9] The marginal effects indicate the change in probability of knowing at least one of the means of prevention resulting from a unit change in the explanatory variable, evaluated at the mean values of the explanatory variables. For the case of dummy variable regressors, the 'marginal effect' refers to the change in probability associated with a change from zero to one in the value of the dummy variable.

We focus first on the models without cluster fixed effects. For both rural and urban areas, the age dummies are generally highly significant, indicating that older women are more knowledgeable about HIV prevention than women age 15-20, the base category. There is some suggestion, consistent with the descriptive statistics, of an inverse U-shaped pattern, especially for the rural case. This pattern, though not very pronounced, is also evident in Figure 1a which calculates the predicted rural probabilities by age and education, setting other covariates to their mean values (and accounting for the interaction term of age and education). Glick and Sahn (2007) also find a tendency for quadratic age impacts on prevention knowledge in their sample of African countries. Filmer (1998) found a similar pattern in some cases in his multi-country study; for others he reports a flat knowledge-age profile. Note that the age-education interaction is negative in both the rural and urban samples, meaning that the impact of education on knowledge decreases with age. One explanation is that for younger women education has more

[9] The structure of the DHS is such that respondents who say they have never heard of AIDS are not asked about transmission or prevention.

impact because this group received some in-school instruction related to HIV/AIDS—though as noted above, even for this group such programs were probably not widely available at the time of their schooling.   Another possibility is that there is depreciation of the human capital acquired in school, so that older women are less able to absorb information than are younger women with the same schooling attainment.

Not unexpectedly, however, there is a strong positive direct effect of education on the probability of knowing HIV/AIDS prevention methods. This finding is consistent with Glick and Sahn’s (2007) findings for their sample of African countries.   Likelihood ratio tests rejects the equality of the coefficients on years of primary and post-primary education for both rural and urban areas (p=0.011 and p=0.014, respectively), indicating a significantly larger incremental impact of primary education on HIV prevention knowledge. With regard to differences across areas, the point estimates of the marginal effect of primary education and post-primary in rural areas are not significantly different from those for urban areas (p=0.57 for primary and 0.60 for post-primary education; again this calculation takes account of the age-schooling interaction terms). This equivalence may seem surprising. A priori it might seem that it is in rural environments that education would confer the greatest advantage in access to HIV information. This would occur if information in rural areas is relatively scarce and transmitted narrowly though channels used highly disproportionately by educated rural residents, such as newspapers and radio or the formal health care system. These conditions would lead, all things equal, to a larger gradient of knowledge with respect to schooling in the rural sample. On the other hand, if information and education inputs are complements in the production of health or HIV knowledge, the effect of schooling will be tend to be enhanced in urban areas, where there is a greater supply of such information. Therefore there are no real priors regarding differences in education effects between rural and urban areas.

Perhaps more significant to note is that in absolute terms the effect of schooling in all cases is quite large. In rural areas, for example, the impact of an additional year of primary education is 0.06,[10] implying that a woman with completed primary schooling (five years) has a nearly 30 percentage point higher probability of being aware of one of the two main prevention methods than a woman with no education. In proportional terms, a primary-educated woman is twice as likely as one with no schooling to be aware of at least one of the means of prevention. The effect of an additional year of secondary schooling is about 0.034, and a woman with four years of secondary education is about 2.5 times as likely as an uneducated woman to know about prevention methods. In urban areas the benefits of schooling are similar (see Figure 1b).

The asset index has a positive and significant effect on prevention knowledge, in keeping with expectations. Unlike for education, the marginal impacts are greater in rural areas than urban areas, at the 0.10 significance level (p=0.09). The rural-urban difference may be interpreted using similar reasoning as above with regard to education, that is to say, in terms of relative scarcity and differential access to information. As noted, information on HIV is probably harder to come by in rural areas. In the absence of significant public efforts to reach the general rural population, such information as is available will likely be transmitted through means accessed disproportionately by wealthier rural residents, such as health centers, newspapers, or radio. In urban areas information is probably more generally accessible: poor urban residents usually have greater access to health services than their rural counterparts, are probably more likely to know someone or someplace with a TV or radio, and may be exposed to more information simply because social networks are denser in cities and towns. This would tend to reduce the advantage to having more income in urban as compared with rural areas, leading to a larger knowledge/wealth gradient in the latter. Note that unlike the case of

[10] This calculation takes into account the negative age-education interaction (it assumes the sample median age) so is slightly less than the reported marginal effect for primary school years.

schooling, this effect would not be offset by any possible complementarities with information (which is more plentiful in urban areas) in the production of health knowledge.

Daily listening to the radio is strongly and significantly associated with HIV prevention knowledge, with similar effects in rural and urban areas (p= 0.32). This points to the potential effectiveness of HIV prevention information disseminated through this medium, but as discussed above, we need to be cautious in making such causal inferences because of the possibility that radio listening and HIV knowledge are jointly determined. Beyond this statistical issue, note that only about a third of women in rural areas actually have daily access to radio (see Appendix table 1), compared with twice that for urban women. This places significant limits on the medium's effectiveness in disseminated information among the rural population.

The base category for the religion dummies is 'Christianity" including both Catholics and Protestants; for HIV knowledge and the other dependent variables we could not reject equality of the effects of belonging to these two faiths. Women who report having no religion or are practicing traditional religion are significantly less likely than those who are Christian to know about HIV/AIDS prevention methods. This may be because institutions such as churches, or social networks that revolve around organized religion, are important in the spread and dissemination of AIDS/HIV knowledge. Being Muslim is strongly associated with having prevention knowledge. The Muslim community, which is very small in Madagascar, may be particularly cohesive, facilitating information exchange among its members.

With regard to the province of residence, our results are consistent with the descriptive data presented above. Women who live in Antsiranana or Toamasina have more knowledge than those in the excluded province of Antananarivo, while those who live in Fianarantsoa or Tulear (the poorest provinces) have less knowledge. It is intriguing that these significant regional differences remain even after controlling for differences in mean levels of schooling and wealth. With regard to the findings for urban Antsiranana and Taomasina, these are port cities in which regular international communication should lead to greater exposure to HIV knowledge (and unfortunately, to the virus as well) than even in capital city Antananarivo, which is inland. Antsiranana port, where foreign military naval traffic is concentrated, has had particularly intense HIV/AIDS awareness campaigns (Kruse and Behets, 2001). The fact that the rural probit shows the greatest prevention knowledge among women in this province suggest that the information diffuses to the surrounding rural zones

The second set of estimates for each sample in Table 2 adds cluster dummies to the models to control for community fixed effects. For both rural and urban areas the magnitudes of the estimates on key individual characteristics—such as those relating to age and education-- are generally quite robust to the inclusion of the community fixed effects controls. The interaction term between age and education, however, is no longer significant in the model for rural areas.

Next, for the rural sample, instead of cluster dummies, we add several community infrastructure variables (3rd set of estimates in Table 2). An increase in the distance to health clinics reduces the probability that a woman knows about HIV prevention methods. Presumably this reflects the role of health facilities in providing HIV prevention information[11], though it may also be the case that exposure to public health services makes individuals or communities generally more sensitive to the benefits of learning about health and illness prevention. It is important, as noted earlier, to consider any such causal inferences as tentative given the potential endogeneity of program placement to the outcomes. The coefficient on the presence of a national road in the commune is positive and significant, in keeping with the notion that transportation networks are a means by which outside influences and information spread. The inclusion of these community variables does not materially affect the estimates of individual variables and household assets. This is consistent with the results of the fixed effects model and

[11] Note that the services provided by local clinics in all or almost all cases probably do not include HIV testing and counseling services, which were, and remain, rare in rural areas of the country.

confirms again the robustness of the key individual and household level coefficients in the models to controls for community factors.

Determinants of not having common HIV/AIDS misconceptions

Table 3 presents results from probit models for not having misconceptions about HIV/AIDS transmission. The dependent variable equals one if the individual correctly answers the questions regarding possible infection status of healthy-looking people and the role of mosquito bites and kissing in HIV transmission. The results of the 'no misconception' models for the most part are qualitatively very similar to those for prevention knowledge presented above, so our discussion of these estimates can be brief. The large positive impact of education on the probability of not having misconceptions about AIDS is similar to its effects on prevention knowledge, and is consistent with other studies that have considered the determinants of AIDS misconceptions (Gregson et al. 1998; Ingham 1995; Vandermooretele and Delamonica 1999). An additional year of primary education raises the no-misconceptions probability in rural areas by 4.8 percentage points; for a year of post-primary schooling the effect is 4%. As with prevention knowledge, we find no significant rural-urban differences in the marginal effects either of primary education or post-primary education (p=0.75 and 0.74, respectively). Unlike with the previous outcome, the impacts of primary and post-primary education on the "no misconceptions" probabilities are not significantly different in either the rural (p=0.36) or urban (p=0.38) cases.

As with prevention knowledge, we find that: the level of the household's assets has a significant and positive effect on not having misconception about AIDS transmission, with larger marginal effects in rural areas than urban areas (p=0.062); daily listening to the radio is associated with greater knowledge, with statistically equivalent effects in rural and urban areas (p=0.18); commune characteristics--distance to clinics and the presence of a national road--have similar effects as before; and inclusion of the cluster fixed effects has little impact on most of the household and individual covariate estimates.

However, a few differences are seen. In rural areas, age has increasing effects on the probability of not having misconceptions, rather than showing an inverted U shape. In urban areas, interestingly, there is essentially no impact of age at all for this outcome. Also, for both areas, the interaction of age and education is not significant. Finally, while there was no statistical difference between Christian and Muslims for prevention knowledge, all non-Christian categories, including Muslims, are more likely than Christians to have misconceptions about the transmission of HIV/AIDS.

Determinants of condom use

Table 4 presents estimates of the determinants of having ever used a condom for sexually active women in urban areas. In the non fixed effects model, educational attainment, regular exposure to radio, and level of assets are significant positive influences on reported condom use. For schooling, a year of primary has the same effect as a year of secondary (p=.42). With regard to asset index result, previous research from developing countries has found that higher income individuals are more likely to use condoms (Blanc 2000; Filmer 1998, Carael, 1995). This may reflect a positive link between incomes and having multiple sex partners; an additional explanation would be that the cost of condoms discourages their use by poorer individuals. Note, however, that the coefficient on the asset index falls sharply and becomes completely insignificant in the fixed effects specification (in contrast to the robustness of the schooling and other estimates). Hence there may be unmeasured community level characteristics that affect the probability of condom use and are correlated with level of wealth. For example, local supply and access to condoms may be related to average levels of household income in the community.

While others have reported associations of condom use and the frequency of attending religious services (Gupta 2000), we do not find any significant effect of religious affiliation, even though as seen above being Christian has a large positive impact on knowledge. The discrepancy may reflect the teachings of the church on contraception, or perhaps that Christians tend to have fewer sexual partners, hence less need for condoms. As in the other models, statistically there was no difference in the effects of being Catholic and Protestant. Spouses of the head (the left out relation category) have the lowest probability of condom use, indicating, unsurprisingly, that currently married women are less likely to have used condoms than single women.

We also ran the condom use model after redefining the dependent variable equal to 1 only where the woman reported using a condom for ‘disease prevention’; i.e., not including contraceptive use. Only 4% of sexually active women in urban areas report having used a condom for this purpose. The results by and large are similar to the previous model, but post-primary schooling is no longer significant. While this may be due simply to the reduced variation in the dependent variable, it may also be an indication that the effect on overall use of condoms of being well educated comes primarily through the contraception motive.

Rural-urban gaps in knowledge controlling for education and wealth

The descriptive statistics presented at the start of this section reveal very large rural-urban disparities in knowledge of HIV prevention methods and in the prevalence of misconceptions about HIV/AIDS. To what extent do these gaps remain once we take into account differences by rural-urban location in schooling and other factors? To assess this, we calculated predicted rural and urban probabilities using the rural and urban parameter estimates and the pooled (rural and urban) sample mean values of all regressors.[12] Knowledge of HIV prevention methods remains statistically higher in urban and rural areas even controlling for differences in characteristics ($p<.001$). However, the gap in the predicted probabilities is only ten percentage points, or about one-third the difference in the mean values seen in Table 1. For the misconception case the observed mean difference in Table 1 is about 0.24. Controlling for difference in characteristics between rural and urban samples, the difference is reduced to just 0.04 and is not statistically significant ($p=.20$).

These comparisons suggest that women in rural areas lack appropriate knowledge of HIV/AIDS not because of (or only because of) where they live, but because of their characteristics, namely their low levels of schooling and income. This does not change the imperative of targeting rural populations for information campaigns. However, such programs need to be tailored to account for the lack of education and resources of the audience rather than simply transplanted from urban environments. To take one possible example, information dissemination efforts that operate through health or maternity clinics will be ineffective at reaching poor rural women who rarely visit such facilities.

CONCLUSIONS AND POLICY IMPLICATIONS

We have analyzed the determinants of knowledge regarding HIV/AIDS prevention and of common misconceptions about the disease among women in rural and urban areas of Madagascar, as well as the determinants of condom use among women in urban areas. Education plays a key role in shaping HIV knowledge and behavior, in keeping with findings from other studies. The magnitude of these effects are large, especially (in the case of prevention knowledge) for primary schooling. Our estimates imply that in both rural and urban areas a

[12] Variances of the predicted probabilities were derived using the delta method.

woman with a completed primary education is twice as likely as a woman with no schooling to know one or more means of HIV prevention.

This study has gone beyond most previous studies of the determinants of HIV-related knowledge and behavior using standard household data in that it assesses the role not just of individual and household factors, but also of several important community level characteristics. In rural areas, proximity to health facilities and to national and regional roads increases HIV/AIDS knowledge. This is useful information from a policy perspective, but we caution again that we are unable to control in these estimates for the non-randomness of facility and infrastructure placement. The estimates on key individual and household level factors (education, age, wealth) appear by and large not to suffer from biases due to the omission of community covariates. This would suggest, with appropriate allowance for differences in context, that estimates from the numerous analyses of HIV knowledge determinants that lack controls for these factors may not be seriously biased. This robustness was confirmed in alternative specifications using community fixed effects.

The results indicate that regardless of rural or urban residence, factors such as schooling and wealth matter for accessing and/or understanding information about HIV/AIDS. Therefore it is important for AIDS education and mobilization efforts to target the less educated and poorer portions of the population rather than simply focusing on urban or rural status. This implication was confirmed by comparisons of predicted rural and urban probabilities of having HIV prevention knowledge or having no common misconceptions that controlled for differences in individual and household characteristics.

The very large gap in HIV knowledge between those with and without an education presents several challenges for policymakers. Increasing investment in education will help, but this is a long-term solution. Illiteracy remains high in Madagascar (some 25% of women in our sample have had no formal instruction) so there is a clear need for public information campaigns to reach those with no schooling or very little schooling. Our estimates are consistent with the hypothesis that women with less education have less access to sources of HIV-related information and/or the ability to process or act on this information. If both factors are operative, the challenge is to devise mass media and other campaigns that both reach such individuals and contain messages that are easily understood by them; obviously the sources of HIV information available at the time of the DHS were failing on one or both counts.[13]

Further, the integration of sexual education and health programs into school curricula will be an important means of imparting HIV information to the young. The most likely place to do this would seem to be lower and upper secondary school, but in very poor countries like Madagascar secondary enrollments are often very low – less than a fifth of secondary-age Malagasy children attend secondary school (See Glick and Razakamanantsoa 2006). Secondary school-based programs thus seem bound to increase the HIV knowledge gaps that already separate the well educated and poorly educated (a divide that closely mirrors that between the non-poor and the poor). To have an impact in terms both of coverage and reducing disparities by education and income levels, school based programs would need to begin at the primary level. Even at this level, however, a non-trivial share of poor rural children would be missed through non-enrollment and the very high dropout rates prevailing in the country.

Conditional on caveats regarding simultaneity biases, our results suggest that spreading information via radio broadcast may be highly effecting at increasing HIV/AIDS knowledge, especially in rural areas where there are fewer alterative sources of information. It also is a means of reaching at least some among the illiterate or poorly educated (those with access to a radio) who could not be reached through print media or the formal health care system. Even this strategy will only reach some of the poor, however, given that many poor households do not

[13] To the extent that the less educated are also less likely to engage in high risk behavior (e.g., have multiple partners) and to live in areas where prevalence is very low, the urgency of targeting this group as opposed, say, to

have access to a radio. Finally, the descriptive and econometric results also indicate large disparities in knowledge by region (province). Hence there is a need to target AIDS education efforts geographically beyond the broad cut of rural versus urban location. Some of these regional discrepancies may reflect cultural or ethnic differences that public campaigns must incorporate.

---

more sexually active urban groups is somewhat reduced.

Table 1. Percentage of women who know about AIDS prevention, have no common misconceptions about transmission, and have ever used a condom.

	Knowledge of AIDS prevention [a]		No misconceptions about HIV/AIDS [b]		Ever used condom (sexually active women)		
	Rural	Urban	Rural	Urban	Rural	Urban	N
Total	29.2	61.2	27.0	51.2	1.5	9.6	7060
Age group							
15 to 19	21.6	52.9	24.0	50.4	1.0	9.1	1553
20 to 24	29.9	62.6	28.6	48.9	2.2	13.5	1325
25 to 29	31.9	62.6	25.6	50.4	1.2	11.2	1196
30 to 39	34.4	67.8	29.8	53.7	1.8	9.0	1856
40 to 49	26.9	58.6	26.0	51.9	1.1	5.4	1130
Education level							
No education	9.6	18.7	10.7	20.0	0.1	1.9	1499
Primary	27.6	45.1	25.2	36.7	1.0	5.9	3662
Post primary	64.0	81.1	57.6	67.7	5.9	14.1	1897
Religion							
Christian	36.2	66.2	32.5	55.4	1.9	10.5	5327
Islam	51.4	86.6	22.3	51.4	4.6	17.8	50
No religion	9.2	20.9	12.3	19.5	0.7	3.3	296
Traditional religion	20.2	26.0	18.7	18.9	0.2	0.0	1377
Province of residence							
Antananarivo	37.1	70.6	30.0	56.2	1.3	9.1	2387
Fianarantsoa	19.3	34.2	19.4	29.0	1.9	6.0	1432
Toamasina	37.5	68.1	32.2	53.1	2.6	9.1	1007
Majunga	19.8	61.8	24.9	55.0	0.5	10.2	852
Tulear	15.7	44.5	14.1	39.0	1.3	13.4	876
Antsiranana	50.8	66.2	53.6	75.5	1.3	12.1	506

[a] Knowledge that using condoms and/or having one sexual partner is a means of prevention. Sample includes all women, whether they have heard of AIDS or not.
[b] No common misconceptions about AIDS: correctly identifies as incorrect that a healthy-looking person cannot have the virus and that transmission can occur by mosquito bites and kissing. Sample includes all women, whether they have heard of AIDS or not.

Table 2. Women 15-49 - Determinants of knowledge of condom use and/or having one partner as means of avoiding HIV/AIDS: probit model results

	Rural						Urban			
	Without cluster fixed effects		With cluster fixed effects		With community covariates		Without cluster fixed effects		With cluster fixed effects	
	Marginal effect	Coefficient	Marginal effect	Coefficient	Marginal effect	Coefficient	Marginal effect	Coefficient	Marginal effect	Coefficient
Age (base=15-19)										
20 to 24	0.098	0.295***	0.116	0.345***	0.101	0.302***	0.067	0.183*	0.074	0.213*
		(4.05)		(4.17)		(4.10)		(1.71)		(1.76)
25 to 29	0.104	0.312***	0.119	0.351***	0.110	0.328***	0.078	0.214*	0.065	0.186
		(3.56)		(3.86)		(3.73)		(1.71)		(1.39)
30 to 39	0.170	0.508***	0.183	0.540***	0.172	0.512***	0.147	0.407***	0.131	0.384**
		(4.92)		(5.02)		(4.89)		(3.15)		(2.79)
40 to 49	0.142	0.417***	0.155	0.448***	0.145	0.425***	0.135	0.379***	0.110	0.324**
		(3.60)		(3.40)		(3.55)		(2.44)		(1.98)
Education										
Years of primary education	0.075	0.238***	0.069	0.217***	0.073	0.232***	0.089	0.236***	0.084	0.233***
		(7.96)		(6.14)		(7.49)		(7.90)		(6.51)
Years of post primary education	0.051	0.162***	0.051	0.162***	0.048	0.154***	0.059	0.156***	0.058	0.161***
		(4.61)		(4.03)		(4.32)		(4.59)		(4.18)
Education x Age	-0.001	-0.002*	0.000	-0.001	0.000	-0.001	-0.001	-0.002**	-0.001	-0.002**
		(-1.86)		(-1.03)		(-1.54)		(-2.13)		(-2.01)
Household asset index	0.106	0.337***	0.069	0.218***	0.097	0.310***	0.025	0.065**	0.020	0.057
		(3.42)		(2.78)		(3.04)		(2.05)		(1.44)
Listen to the radio	0.138	0.418***	0.133	0.403***	0.132	0.400***	0.134	0.352***	0.095	0.260
		(7.85)		(7.09)		(7.39)		(5.10)		(3.21)***
Religion (base=Chistianity)										
Islam	0.040	0.121	0.112	0.322	0.054	0.163	0.181	0.549	0.117	0.361
		(0.46)		(1.35)		(0.63)		(1.21)		(0.84)
No religion	-0.166	-0.601***	-0.152	-0.545***	-0.169	-0.617***	-0.180	-0.460***	-0.223	-0.580
		(-7.69)		(-5.95)		(-7.25)		(-3.18)		(-2.97)
Traditional religion	-0.054	-0.183*	-0.088	-0.309**	-0.056	-0.191*	-0.212	-0.540*	-0.336	-0.870***
		(-1.75)		(-2.26)		(-1.78)		(-1.79)		(-3.10)

continued

Table 2. Women 15-49 - Determinants of knowledge of condom use and/or having one partner as means of avoiding HIV/AIDS: probit model results *continued*

	Rural						Urban			
	Without cluster fixed effects		With cluster fixed effects		With community covariates		Without cluster fixed effects		With cluster fixed effects	
	Marginal effect	Coefficient	Marginal effect	Coefficient	Marginal effect	Coefficient	Marginal effect	Coefficient	Marginal effect	Coefficient
Province (base=Antananarivo)										
Fianarantsoa	-0.030	-0.097	--	--	-0.009	-0.030	-0.108	-0.279	--	--
		(-0.72)		--		(-0.21)		(-1.43)		--
Toamasina	0.111	0.330***	--	--	0.137	0.402***	0.141	0.397***	--	--
		(3.19)		--		(3.15)		(2.89)		--
Majunga	0.037	0.114	--	--	0.083	0.249*	0.050	0.135	--	--
		(0.99)		--		(1.81)		(1.21)		--
Tulear	0.049	0.151	--	--	0.063	0.192	-0.106	-0.273*	--	--
		(1.17)		--		(1.37)		(-1.74)		--
Antsiranana	0.342	0.925***	--	--	0.345	0.934***	0.087	0.240	--	--
		(9.64)		--		(9.59)		(1.50)		--
Relationship to household head (base=spouse)										
Self	-0.023	-0.076	-0.033	-0.107	-0.029	-0.094	-0.070	-0.181*	-0.091	-0.243**
		(-0.98)		(-1.30)		(-1.17)		(-1.65)		(-2.09)
Daughter of head	-0.012	-0.039	-0.010	-0.032	-0.007	-0.022	-0.072	-0.188**	-0.103	-0.279***
		(-0.58)		(-0.46)		(-0.33)		(-1.95)		(-2.70)
Other	-0.056	-0.190**	-0.054	-0.181*	-0.055	-0.185**	-0.099	-0.256**	-0.154	-0.408***
		(-2.13)		(-1.78)		(-1.98)		(-2.28)		(-3.25)
Commune Characteristics										
Distance to clinic	--	--	--	--	-0.026	-0.082**	--	--	--	--
		--		--		(-1.97)		--		--
Access to provincial road	--	--	--	--	0.024	0.075	--	--	--	--
		--		--		(0.79)		--		--
Access to national road	--	--	--	--	0.064	0.201	--	--	--	--
		--		--		(2.54)***		--		--
Constant		-1.494		-1.807		-1.657		-0.947		-0.601
		(-12.60)		(-17.90)		(-11.40)		(-6.03)		(-3.96)
Log-Likelihood		-2190.91		-1993.93		-2091.07		-1207.62		-1119.70
Number of Observations		4669		4373		4472		2370		2317

Notes: T-statistics in parentheses. Standard errors are adjusted to account for within-cluster correlations.

*Significant at *10%; **significant at 5%; ***significant at 1%

Table 3. Women 15-49 - Determinants of not having any of three common misconceptions about AIDS transmission[a] - probit model results

	Rural						Urban			
	Without cluster fixed effects		With cluster fixed effects		With community covariates		Without cluster fixed effects		With cluster fixed effects	
	Marginal effect	Coefficient	Marginal effect	Coefficient	Marginal effect	Coefficient	Marginal effect	Coefficient	Marginal effect	Coefficient
Age (base=15-19)										
20 to 24	0.048	0.153**	0.057	0.179**	0.044	0.138**	-0.053	-0.134	-0.058	-0.147
		(2.19)		(2.40)		(1.94)		(-1.31)		(-1.36)
25 to 29	-0.003	-0.009	0.004	0.014	-0.006	-0.021	-0.030	-0.076	-0.073	-0.182
		(-0.10)		(0.15)		(-0.23)		(-0.58)		(-1.30)
30 to 39	0.067	0.212**	0.084	0.263***	0.066	0.208**	0.011	0.029	-0.041	-0.103
		(2.50)		(2.84)		(2.45)		(0.24)		(-0.75)
40 to 49	0.081	0.251**	0.093	0.287**	0.083	0.255**	0.094	0.236	0.015	0.039
		(2.38)		(2.50)		(2.39)		(1.49)		(0.22)
Education										
Years of primary education	0.054	0.178***	0.053	0.174***	0.057	0.187***	0.068	0.170***	0.051	0.127***
		(5.86)		(5.24)		(6.11)		(4.77)		(2.88)
Years of post primary education	0.045	0.147***	0.044	0.145***	0.046	0.150***	0.056	0.142***	0.050	0.125***
		(3.83)		(3.61)		(3.82)		(4.05)		(3.35)
Education x Age	0.000	-0.001	0.000	0.000	0.000	-0.001	0.000	-0.001	0.000	-0.001
		(-0.77)		(-0.47)		(-0.91)		(-1.09)		(-0.50)
Household asset index	0.097	0.319***	0.060	0.197**	0.090	0.293***	0.009	0.024	0.002	0.004
		(4.53)		(2.12)		(4.08)		(0.83)		(0.12)
Listen to the radio	0.124	0.386***	0.115	0.360***	0.121	0.376***	0.089	0.225***	0.062	0.156**
		(7.68)		(6.57)		(7.25)		(3.00)		(1.97)
Religion (base=Chistianity)							-0.296	-0.816***	-0.322	-0.879***
Islam	-0.187	-0.944***	-0.103	-0.396*	-0.183	-0.901***		(-3.23)		(-3.07)
		(-6.07)		(-1.75)		(-5.60)	-0.168	-0.428***	-0.236	-0.607***
No religion	-0.120	-0.432***	-0.115	-0.416***	-0.120	-0.431***		(-3.23)		(-2.81)
		(-5.82)		(-4.60)		(-5.45)	-0.380	-1.141***	-0.386	-1.116***
Traditional religion	-0.103	-0.389***	-0.078	-0.285**	-0.101	-0.377***		(-3.77)		(-3.82)
		(-3.54)		(-2.44)		(-3.59)				

continued

Table 3. Women 15-49 - Determinants of not having any of three common misconceptions about AIDS transmission[a] - probit model results *continued*

	Rural						Urban			
	Without cluster fixed effects		With cluster fixed effects		With community covariates		Without cluster fixed effects		With cluster fixed effects	
	Marginal effect	Coefficient	Marginal effect	Coefficient	Marginal effect	Coefficient	Marginal effect	Coefficient	Marginal effect	Coefficient
Province (base=Antananarivo)										
Fianarantsoa	0.025	0.081	--	--	0.041	0.130	-0.051	-0.128	--	--
		(0.75)		--		(1.12)		(-0.68)		--
Toamasina	0.111	0.335***	--	--	0.125	0.374***	0.106	0.269**	--	--
		(3.31)		--		(3.31)		(2.18)		--
Majunga	0.177	0.515***	--	--	0.213	0.612***	0.14	0.354***	--	--
		(4.64)		--		(5.18)		(3.09)		--
Tulear	0.067	0.209	--	--	0.062	0.192	(0.01)	(0.03)	--	--
		(1.52)		--		(1.31)		(-0.23)		--
Antsiranana	0.440	1.194***	--	--	0.436	1.183***	0.37	1.091***	--	--
		(9.68)		--		(9.66)		(7.670)		--
Relationship to household head										
Self	0.039	0.123	0.031	0.099	0.036	0.114	0.007	0.018	-0.028	-0.071
		(1.58)		(1.19)		(1.43)		(0.16)		(-0.62)
Daughter of head	0.038	0.122**	0.049	0.156**	0.031	0.099*	-0.001	-0.002	-0.044	-0.110
		(2.16)		(2.38)		(1.81)		(-0.02)		(-1.22)
Other	-0.048	-0.165*	-0.053	-0.183*	-0.053	-0.184*	-0.005	-0.012	-0.061	-0.153
		(-1.72)		(-1.72)		(-1.89)		(-0.13)		(-1.59)
Commune Characteristics										
Distance to clinic	--	--	--	--	-0.017	-0.055***	--	--	--	--
		--		--		(-2.63)		--		--
Access to provincial road	--	--	--	--	0.012	0.039	--	--	--	--
		--		--		(0.50)		--		--
Access to national road	--	--	--	--	0.061	0.197***	--	--	--	--
		--		--		(2.83)		--		--
Constant		-1.466		-0.839		-1.585		-0.976		-0.065
		(-12.40)		(-3.83)		(-11.00)		(-6.07)		(-0.41)
Log-Likelihood		-2212.12		-2052.92		-2112.73		-1362.61		-1278.75
Number of Observations		4669		4465		4472		2370		2312

Notes

[a] That a healthy-looking person cannot have the HIV virus, that mosquito bites transmit HIV/AIDS; that a person can get HIV/AIDS by kissing someone.

T-statistics in parentheses. Standard errors are adjusted to account for within-cluster correlations.

*Significant at *10%; **significant at 5%; ***significant at 1%

Table 4. Determinants of ever having used a condom, urban sexually active women 15-49 – probit results

	Without cluster fixed effects		With cluster fixed effects	
	Marginal effect	Coefficient	Marginal Effect	Coefficient
Age (base=15-19)				
20 to 24	0.045	0.192	0.069	0.245
		(1.07)		(1.18)
25 to 29	0.012	0.049	0.021	0.077
		(0.28)		(0.39)
30 to 39	0.011	0.051	0.009	0.034
		(0.36)		(0.22)
40 to 49	-0.021	-0.101	-0.048	-0.190
		(-0.58)		(-0.99)
Education				
Years of primary education	0.034	0.157***	0.032	0.122**
		(3.73)		(2.53)
Years of post primary education	0.013	0.057***	0.014	0.053***
		(3.56)		(2.81)
Listen to the radio	0.048	0.222**	0.049	0.191
		(1.93)		(1.47)
Religion (base=Christianity)				
Islam	0.107	0.399	0.116	0.378
		(1.10)		(0.79)
No religion	-0.045	-0.225	-0.030	-0.117
		(-1.03)		(-0.42)
Province (base=Antananarivo)				
Fianarantsoa	-0.040	-0.198	--	--
		(-1.13)		--
Toamasina	-0.009	-0.041	--	--
		(-0.35)		--
Majunga	0.002	0.011	--	--
		(0.06)		--
Tulear	0.010	0.047	--	--
		(0.31)		--
Antsiranana	0.022	0.095	--	--
		(0.58)		--
Relationship to household head (base=spouse)				
Self	0.013	0.058	0.012	0.046
		(0.45)		(0.33)
Daughter of head	0.024	0.106	0.014	0.051
		(1.03)		(0.43)
Other relationship to the head	0.011	0.048	-0.008	-0.029
		(0.37)		(-0.20)
Household asset index	0.017	0.075**	0.005	0.018
		(2.08)		(0.50)
Constant		-2.007		-1.299
		(-9.51)		(-5.96)
Log-likelihood		-774.31		-767.02
N		1898		1668

Note: T-statistics in parentheses. Standard errors are adjusted to account for within-cluster correlations.

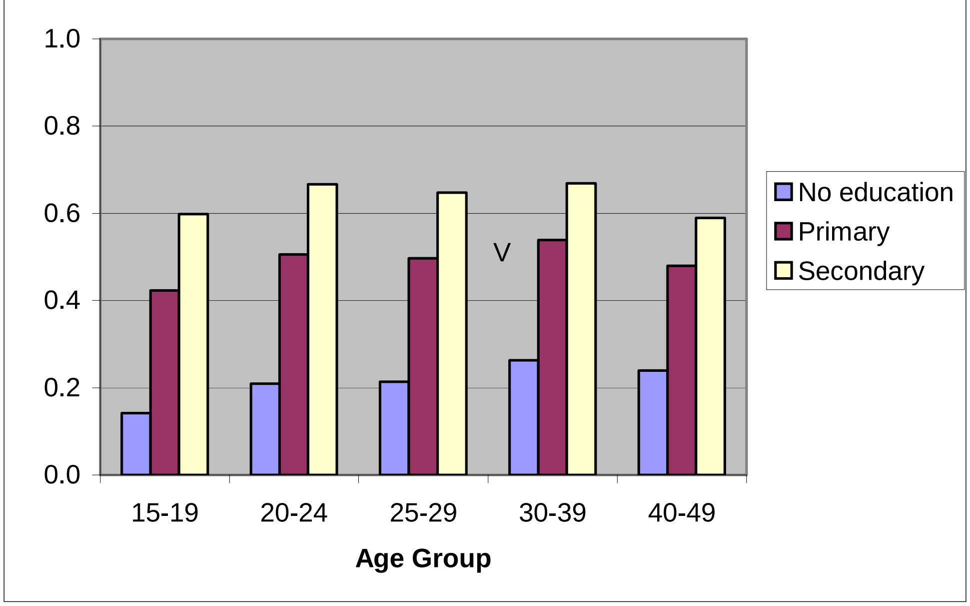

Figure 1a: Predicted Prob. of knowing one or both means of HIV prevention, rural.

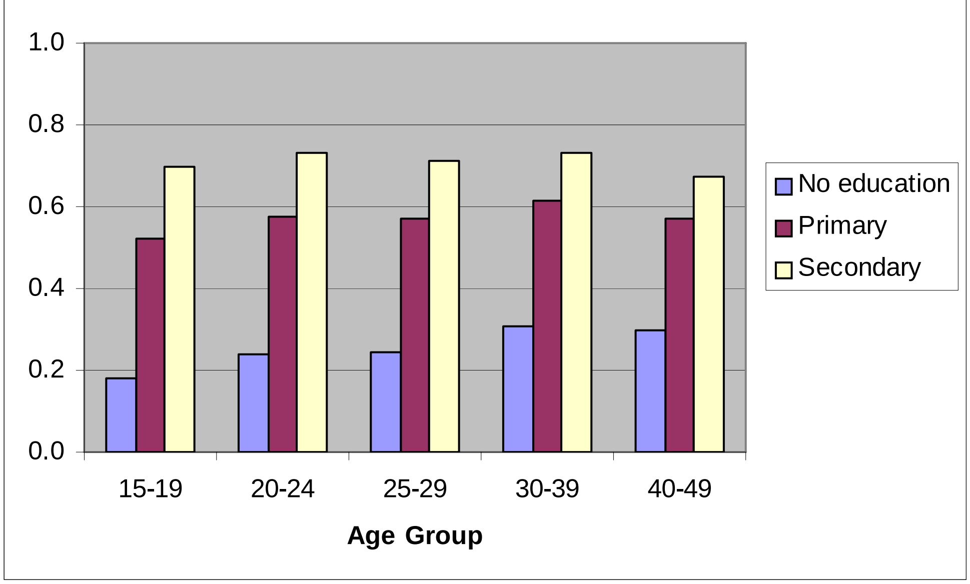

Figure 1b: Predicted Prob. of knowing one or both means of HIV prevention, urban

Note: Primary columns refer to 5 years of primary education, and post-primary to 4 years of secondary schooling.

Appendix: Sample Characteristics

	Rural (N = 4684)		Urban (N = 2376)	
	Means	Standard deviation	Means	Standard deviation
Age				
15 to 19	0.217	0.412	0.228	0.420
20 to 24	0.188	0.391	0.187	0.390
25 to 29	0.172	0.377	0.163	0.370
30 to 39	0.267	0.443	0.252	0.434
40 to 49	0.156	0.363	0.170	0.376
Education				
Years of primary education	2.468	1.929	3.745	1.785
Years of post primary education	0.445	1.250	2.137	2.780
Listen to the radio every day	0.303	0.460	0.636	0.481
Religion				
Christian	0.707	0.455	0.876	0.329
Islam	0.007	0.082	0.008	0.089
No religion	0.231	0.422	0.102	0.303
Traditional religion	0.055	0.228	0.013	0.115
Province of residence				
Antananarivo	0.296	0.457	0.444	0.497
Fianarantsoa	0.231	0.421	0.132	0.338
Toamasina	0.144	0.352	0.138	0.345
Majunga	0.126	0.332	0.107	0.309
Tulear	0.127	0.333	0.118	0.322
Antsiranana	0.076	0.264	0.062	0.240
Relationship to the head				
Spouse of head	0.580	0.494	0.477	0.500
Head	0.109	0.311	0.112	0.316
Daughter of head	0.211	0.408	0.256	0.437
Other relationship to the head	0.099	0.299	0.151	0.358
Household asset index	-0.283	0.440	0.722	1.354
Commune Characteristics				
Distance to clinic (km)	1.113	6.874	–	–
- Access to provincial road	0.437	0.496	–	–
Access to national road	0.352	0.478	–	–

* Sample of sexually active women

REFERENCES

Becker, G. (1993), *Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education*. 3rd Edition, The University of Chicago Press, Chicago.

Becker, S. and L. Ashraf (1997), 'Husband-Wife Communication on Family Planning and Couple's Current Contraceptive Use in Kenya', *International Family Planning Perspectives,* Vol. 23, No. 1, pp. 15–20.

Blanc, A. K. (2000), 'The Relationship Between Sexual Behavior and Level of Education in Developing Countries', Report prepared for UNAIDS.

Blanc, A. K., B. Wolff, A. J. Gage, A. C. Ezeh, S. Neema, and J. Ssekamatte-Ssebulbe (1996), *Negotiating Reproductive Outcomes in Uganda*. Macro International Inc, Calverton, MD, and Institute of Statistics and Applied Economics, Uganda.

Boerma, J., 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,* Vol. 78, pp. i97-i105.

Carael, M. (1995), 'Sexual behavior,' in J. Cleland and B. Ferry (eds.), *Sexual Behaviour and AIDS in the Developing World*, Taylor and Francis, London.

Cohen, B. and J. Trussell (1996), 'Preventing and Mitigating AIDS in Sub-Saharan Africa', National Academy Press, Washington, D.C.

De Walque, D. (2002), 'How Does the Impact of an HIV/AIDS Information Campaign Vary with Educational Attainment? Evidence from Rural Uganda', University of Chicago.

Direction Generale de la Jeunesse, Madagascar (1999), 'Rapport sur les Enquetes CAP (Connaissances, Attitudes, Pratiques) sur la Sante de la Reproduction des Adolescents', Ministere de la Jeunesse et des Sports -Direction Generale de la Jeunesse, Madagascar, FNUAP.

Filmer, D. (1998), 'The Socioeconomic Correlates of Sexual Behavior: A Summary of Results From an Analysis of DHS data', Available at http://www.iaen.org/limelette/html/lim07.htm

Gersovitz, M. (2005), 'The HIV Epidemic in Four African Countries Seen through the Demographic and Health Surveys', *Journal of African Economies*, Vol. 14, No. 2, pp.191–246.

Gersovitz, M., H. Jacoby, F. Seri Dedy, and A. Goze Tape (1998), 'The Balance of Self-Reported Heterosexual Activity in KAP Surveys and the AIDS Epidemic in Africa', *Journal of the American Statistical Association*, Vol. 93, No. 443, pp. 875–883.

Glick, P. and M. Razakamanantsoa (2006), 'The Distribution of Public Expenditures in Madagascar over the 1990s: Increasing Progressivity without Economic Growth,' *Journal of African Economies,* Vol. 15, No. 3, pp. 399-433.

Glick, P, and D. E. Sahn (2007), 'Changes in HIV/AIDS Knowledge and Testing Behavior in Africa: How Much and for Whom?' *Journal of Population Economics*, Vol. 20, No. 2, pp. 382–422.

Glick, P, and D. E. Sahn (2008), 'Are Africans Practicing Safer Sex? Evidence from Demographic and Health Surveys for Eight Countries', *Economic Development and Cultural Change,* Vol. 56, No. 2, pp. 397–439.

Glick, P., D. E. Sahn, and S. D. Younger (2006), 'An Assessment of Changes in Infant and Under-Five Mortality in Demographic and Health Survey Data for Madagascar', Cornell Food and Nutrition Policy Program Working Paper No. 207, Cornell University, Ithaca, NY.

Gonzales, G., E. Ranorolalao, and C. Ravalondrazana (1998), 'Evaluation des Activités d'IEC sur les MST/SIDA Auprès des Jeunes de 10 à 29 ans des Régions de Toliary et de Toamasina', PNLS (Programme National de Lutte contre les MST et le SIDA).

Greene, W. H. (2002), 'The Behavior of the Fixed Effects Estimator in Nonlinear Models', Manuscript., New York University.

Gregson, S., T. Zhuwau, R. M. Anderson and S. K. Chandiwana (1998), 'Is There Evidence for Behaviour Change in Response to AIDS in Rural Zimbabwe?' *Social Science and Medicine*, Vol.46, No.3, pp. 321–330.

Gwatkin, D. R. and Deveshwar-Bahl, G. (2001), 'Inequalities in Knowledge of HIV/AIDS Prevention: An Overview of Socio-Economic and Gender Differentials in Developing Countries', Study for the Population Services International, World Bank, Washington, DC.

Ingham, R. (1995), 'AIDS: Knowledge, Awareness and Attitudes,' in J. Cleland and B. Ferry (eds.), *Sexual Behaviour and AIDS in the Developing World.*, Taylor and Francis, London.

Kruse, N. and F. Behets (2001), 'Recherches Opérationnelles Conduite à Diégo-Suarez Pour Ameliorer la Prévention et la Prise en Charge des IST Chez les Travailleuses du Sexe à Madagascar', Ministry of Health, Family Health International, Population Council USAID, Madagascar.

Lawrance, Emily (1991), 'Poverty and the Rate of Time Preference: Evidence from Panel Data', *Journal of Political Economy*, Vol. 99, No. 3, pp. 54–77.

Macro International (1998), *Madagascar Demographic and Health Survey 1997*, Macro International Inc., Calverton, MD.

Martin, T. and F. Juarez (1994), 'Women's Education and Fertility in Latin America: Exploring the Significance of Education for Women's Lives', DHS Working Paper, No.10. Macro International, Inc., Calverton, MD.

Medecins du Monde (2001), 'Lutte Contre les MST/SIDA Dans les Villes d'Antananarivo et Tuléar', Programme National de Lutte contre les MST et le SIDA.

Messersmith, L .J., T. Kane, A. Odebiyi, and A. Adewuyi (1994), 'Patterns of Sexual Behaviour and Condom Use in Ile-Ife, Nigeria: Implications for AIDS/STD Prevention and Control', Johns Hopkins University Population Center Working Paper 94-07.

Paternostro, S., J. Razafindravonona, and Stifel, D. (2001), 'Changes in Poverty in Madagascar: 1993-1999', Cornell University Food and Nutrition Policy Program Working Paper 120, Cornell University Ithaca, NY. Available at http://www.cfnpp.cornell.edu/images/wp120.pdf

Projet Multisectoriel de Prévention des IST/SIDA (2002), *Plan Strategique National 2001-2005*, Projet Multisectoriel de Prévention des IST/SIDA - Madagascar.

PSI (Population Services International) (2001), 'Connaissances, Attitudes, Pratiques des Jeunes de 15 a 24 ans de Tamatave en Matière de Planification Familiale, de Prévention et de Traitement des IST/SIDA', PSI Madagascar.

Sahn, D. and D. Stifel (2003), 'Exploring Alternative Measures of Welfare in the Absence of Expenditure Data', *Review of Income and Wealth*, Vol. 49, No. 4, pp. 463–489

USAID Population, Health and Nutrition Programs/HIV/AIDS Division, and IMPACT (Implementing AIDS Prevention and Care Project) (1999), *Key Talking Points: Madagascar and HIV/AIDS.*

Vandemoortele, J. J. and E. E. Delamonica (1999), *AIDS Conspires Against the Poorest*, UNICEF, New York.

World Health Organization (WHO), Department of Reproductive Health and Research (RHR), (2001), *Programming for male involvement in reproductive health*. Report of the meeting of WHO Regional Advisers in Reproductive Health.