

Sexual Activity, Safe Sex and HIV/AIDS:
Evidence from South Africa

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Abstract

We estimate the determinants of sexual activity and condom use in a sample of 15 to 49 year old black South Africans using data from the first South African (and international) nationally representative household survey that has included both behavioral surveillance data and testing for HIV status. We specify a model of condom use and sexual activity which accounts for sample selection arising from the fact that only those who are sexually active can use a condom. We also investigate the extent to which our results are robust to unobserved effects. We establish a series of results. Married individuals and those who have first sexual debut early are less likely to use a condom. As expected, the difficulty in obtaining a condom when needed reduces the likelihood that it will be used. Male and females behave quite differently with respect to their knowledge, or perception of their HIV status. The latter has no incidence on the likelihood that males will use a condom. However, married men who are HIV positive are more likely to use a condom. Women who know their HIV status (positive or negative) are more likely to use a condom.

Keywords: HIV/AIDS, South Africa, Condom Use, Sexual Activity

1 Introduction

Background and objective Southern Africa has the highest HIV/AIDS prevalence worldwide (UNAIDS 2002), with estimates of 600 to 1,000 AIDS-related deaths daily in South Africa only. If the infection trend persists there is evidence that the economic consequences may be daunting for that region (Arndt and Lewis 2000, Bell, Devarajan and Gersbach 2003). Although the medical management of the effects of HIV infection is improving, there is neither cure nor vaccine yet. In this context, behavioral prevention is ‘today’s vaccine’. This prompts us to investigate the determinants of condom use and secondary sexual abstinence. As these behaviors are efficient, cheap, and require little skill, it is of interest to discover more about what is conducive to their adoption. We address this question by using data from the first South African (and international for that matter) nationally representative household survey that has included both behavioral surveillance data and testing for HIV status.

How we differ We address a number of new behavioral questions. As respondents report the perception of their HIV-status, while we know their true status, we can determine if such perception affects condom use and sexual activity. We also investigate whether community factors, which capture the social network of the individual, are related to safe sex practices. Finally, we can make inferences which hold for the whole population because of the characteristics of the survey. This must be contrasted with most studies of HIV prevention behavior which use surveillance surveys and whose conclusions can only be ascribed to the relevant sub-populations.¹

Methodology In estimating the determinants of condom use, we account for sample selection arising from sexual abstinence. Those who use condoms must be sexually active and, as a result, do not constitute a random sample of the population. Failure to do so may yield inconsistent parameter estimates and lead to wrong policy inferences.² Moreover, the decision to be sexually

active, or to use a condom, may depend on unobserved individual, or household, characteristics. For instance, some people may not use a condom because of the individual-specific unobserved accrued pleasure they get from sex without a condom (Varga 1997, Agha, Kusanthan, Longfield, Klein and Berman 2002, Rao, Gupta, Lokshin and Jana 2003). Studies of sexual behavior which those unobserved factors implicitly assume they are either correctly proxied by some observed variables, or are independent of the explanatory variables. If these assumptions are violated, the failure to account for unobserved characteristics will yield inconsistent estimates.

Context Most evaluation studies conclude that behavioral interventions are only moderately effective in bringing about desired effects (Kelly 2000). Amongst the themes which have been prominent is the context of behavior change, and particularly the extent to which behavior change is voluntary versus conditional on predisposing factors (UNAIDS 1990, Kelly, Parker and Lewis 2001).³ Many countries have promoted a three-fold behavioral prevention approach, often sloganised as ABC for “Abstain, Be faithful, Condomize” (Heald 2002). These are the three most widely promoted behavioral prevention responses to HIV/AIDS. However, for our purposes, because of the availability of data and estimation constraints, we focus on secondary sexual abstinence which includes those who have never had sex before and those who have had sex before, but no longer have sex. Nevertheless, in addressing HIV prevention behavior we acknowledge that we should not overlook the many non-behavioral responses to HIV/AIDS which include, health systems development, blood screening, and prevention of mother to child infection (Skordis and Natrass 2002).

To the best of our knowledge, there is no HIV/AIDS study which verify whether their results are robust to sample selection, unobserved individual and community effects. Failure to do so may lead to wrong inferences about the determinants of condom use and sexual behavior, and be translated into wrong policies. Most important in terms of reducing the spread of the epidemic, important upstream factors driving the epidemic and preventing uptake of interventions may be ignored.

Focus We choose South Africa because it is the country with the most HIV positive individuals. We restrict our attention to black South Africans aged 15 to 49 years for a number of reasons. They are the biggest population group in South Africa (80% of the population), and are on average much poorer than the other three racial groups (Bhorat, Leibbrandt, Maziya, van der Berg and Woolard 2001). South Africa remains deeply divided along racial lines, and in terms of most behavioral, cultural, political and economic indicators because of Apartheid. Hence, working with one population group reduces the extent to which unobserved characteristics, which are common to one group, can influence our results. Moreover, the sample size for the other three population group is quite small. The age-group of interest is those who can potentially be sexually active. It therefore makes sense to remove young children and those who are above a certain age.

Descriptive statistics A full descriptive analysis of the survey can be found in Nelson Mandela Foundation (2002). The survey confirms the high HIV prevalence rate in South Africa. We find that 13.3 per cent of all 15 to 49 year old South Africans in the survey are HIV positive. However HIV prevalence differs greatly by racial group: 18.4% among blacks, 7.4% among coloreds, 5.8% among whites and 1% among Indians. Black females have the highest infection rate (19%) while black males have a slightly lower infection rate of 17%. Among the HIV positive individuals, only 23% report knowing of their HIV status.

Results Our estimates indicate that many determinants of condom use and sexual activity are different for males and females. First, knowledge of one's HIV status does not seem to affect the likelihood that a male is sexually active or use of a condom. However, HIV positive females are more likely to make use of a condom. Second, older females are more likely to make use of a condom while the opposite holds for males. Third, females who attend the funeral of someone who died of AIDS related diseases are more likely to use a condom, while that variable is not statistically significant on the sample of males. There are however some similarities in the behavior of men and

women. Both poorly educated males and females are less likely to use a condom. The same is true for married persons presumably because they are in a stable relationship or they may not want to break each other's trust by using a condom. Using a condom in a marriage may amount to an admission of unfaithfulness. However, married HIV positive males who know their status are more likely to use a condom.

The difference between male and female behaviors in respect to the perception of their HIV status may reflect the different circumstances under which males and females are tested for HIV. While most females know their status because they are tested when pregnant, most are tested for insurance policies or because they wanted to know their status. In fact, there are significantly fewer males than females who have undergone a HIV test. While pregnant females would have been counselled prior to the test and after, many males may simply have taken the test at a lab with no counselling. This would certainly affect their responses to knowledge of status. It is also possible that this difference in behavior arises because females are more altruistic than males. In any case, although males do not change their condom-use behavior upon knowing their HIV status, it is appropriate to encourage HIV testing for both males and females. Indeed, as long as males reveal their status, their female partners may be able to protect themselves by convincing the partner to use a condom.

Layout The remainder of the paper is as follows. We first describe the extent of the HIV/AIDS prevalence in South Africa and the characteristics of HIV positive individuals in the survey in Section 2. We set up a model and identify the variables which are likely to affect an individual's decision to use a condom and sexual activity in section 3. We report and discuss the estimates of the model in section 4. Finally section 5 concludes. The estimates are reported in the Appendix A and the Tables are in Appendix B.

2 The Survey

A representative sample of the South African population was surveyed in 2002 to assess HIV/AIDS prevalence, risk behavior and characteristics of the respondents. The survey has two main advantages over existing ones (i) it is representative of the South African population, and (ii) each respondent's HIV reactivity was tested using a saliva sample. We therefore have the true HIV status of all respondents. The sample consists of 9 963, among whom 8 428 who gave a usable saliva specimen to test for HIV reactivity. The sample may not be very representative of whites, and Indians because of difficulty encountered to interview these population groups. There is evidence of response biases among whites and Indians. This is one reason why they are excluded from the empirical investigation. The data collection and laboratory procedures are summarized in Appendix A.

The main characteristics of the survey, namely HIV prevalence by race, age group and gender, are given in Table 1. On average, 13.3% of South Africans aged 15 to 49 are HIV positive. However there are important differences by race and gender. Black females have the highest infection rate at 19.5 per cent, while black males have a slightly lower rate at 17%. The higher infection rate of females follows the well documented fact that, *ceteris paribus*, females are more likely to be infected than males during a heterosexual encounter (UNAIDS 2002). That blacks have the highest infection rate, more than twice that of coloreds, is in part a reflection of the higher incidence of poverty among blacks than the three other races, a situation inherited from apartheid-era policies (Barnett and Whiteside 2002).⁴

The survey also confirms the evidence that in Sub-Saharan Africa, almost all HIV positive individuals are heterosexuals. Only 1 and 2 per cent of all HIV positive males and females respectively, report having had same-sex encounters during the past 12 months. The high prevalence rate among heterosexuals is characteristic of all Sub-Saharan Africa countries and differs remarkably from the

HIV prevalence in developed countries. There is also clear evidence that those who are in their late twenties and early thirties are those with the highest HIV prevalence: 28% of those in that age category are HIV positive.

The knowledge of one's HIV status is presumably important in understanding the dynamics of the disease. Respondents were asked whether they know of their HIV status. They may know their status for a number of reasons. For example, they may have voluntarily had a blood test or, they were requested to have one for insurance purposes. The distribution of reasons for getting a HIV test is summarized in Table 4.

Table 4: Knowledge of one's HIV Status

	Males		Females	
	Number	% HIV positive	Number	% HIV positive
Number of respondents	1448	17%	1895	19.5%
Number who had a HIV test prior to the survey	235	20%	415	23%
Reason for having a HIV test prior to the survey				
Applied for an insurance policy	46	7%	25	24%
Instructed by the employer	21	5%	3	0%
Wanted to take out a loan	7	1%	5	0%
Sick	33	6%	43	33%
Pregnant or partner is pregnant	3	0%	170	22%
To start a new sexual relationship	3	1%	8	0%
Wanted to know their HIV status	60	12%	60	23%
Blood was taken at the doctor or clinic	17	5%	37	27%
Other reasons	45	10%	49	33%

Note: The sample is restricted to blacks of 15 to 49 years old. The percentage of HIV-positive individuals is calculated for each reason which was given to get a HIV test. The respondent is classified as HIV positive if the saliva sample obtained at the end of the survey contains the HIV.

Although respondents were asked whether they had a HIV test, and whether the result was communicated to them, they were not asked to report the date. While a HIV-positive individual does not change status, this is not necessarily true for a HIV-negative person. That person may

either be a false negative when the test was performed or may have acquired the virus in the period between the test and when the survey was conducted. Hence, instead of the knowledge of one's HIV status, we shall refer to the perception of one's HIV status, bearing in mind that those who know they are positive have full knowledge of their status. It is of interest that only 30 per cent of respondents know their HIV status, and only 23 per cent of those who are HIV positive know their status.

Respondents were also asked how old they were when they had sex for the first time. The mode age for first sexual intercourse was 18, with a large share of the black population having had sex between 14 and 16 (20%). A small share of respondents report having their first sexual intercourse before that age (1.3%). Moreover young males are far more promiscuous than young females. They account for the largest share of multi-partner sexual intercourse. This may indicate that many young males are having sex with a few females who may be in the sex trade, or, still males may inflate the number of sexual partners while females underreport because of social norms.

It is clear that sexual abstinence guarantees not contracting HIV through sexual contact, and using a condom during sexual intercourse is a safe means of not being infected by HIV. In the survey 23.4% of respondents aged 14 years and older reported having not had sex over the past 12 months. In the 15-49 year old African population 72% of blacks report being sexually active, and the remainder either abstain (12%) or have never had sex (15%). Among those who are sexually active, the overwhelming majority (89%) report being in a monogamous relationship. Although many respondents have been in stable relationships for some time, and other abstain from sex, this does not mean that they have had only one lifetime partner. There is well documented evidence of serial monogamy and in this case the risk of contracting and disseminating the virus are high.

Many of those who do not know their HIV status practise unsafe sex (Table 2). Only 35% of HIV positive individuals used a condom during their last sexual intercourse, while 44% of those who know they are HIV positive do. That many know they are HIV positive and do not use a

condom begs an explanation. There are two possibilities. First the partner of a HIV positive person may also be HIV positive in which case a condom is of no protection use. A condom is then one contraceptive technique among many. Not using a condom is chosen if there is a positive utility benefit from intercourse without a condom than with one.

However, many HIV positive individuals report not knowing the HIV status of their partner. For those persons, the explanation may be found in the moral hazard of knowing one is HIV positive, and this is the second possible explanation. Although a chilling thought, a purely egoistic person would not derive any benefit from using a condom once he or she is already infected (Levy 2002, see, in particular, the complacency result). If one assumes that having unprotected sexual intercourse cannot damage one's health any further (abstracting from other non life-threatening sexually transmitted diseases), then it is sufficient that the instantaneous utility from it be greater than without a condom. As a result people have sex without a condom.

Of particular interest is the HIV status, and safe sex choices, of sexually active individuals who are in a monogamous relationship for at least one year (Table 3). Forty five per cent of those who know their status did not use a condom in their last intercourse even though they did not know their partner's HIV status. Moreover, although there are few respondents in that category (16), 62% of those who claim they know their status and are HIV positive, but ignore their partner's status, do not use a condom. As has been documented in other studies, the non use of a condom may be viewed as signalling that one trusts one's partner. This is especially true for HIV negative individuals. For instance, a woman who knows she is HIV negative may find it difficult, because of unequal bargaining power in the relationship, to ask her partner to use a condom although she runs the risk of being infected.

Although the descriptive analysis provided in this section gives a good picture of HIV prevalence in South Africa, it fails to isolate the impact of each variable on both sexual activity and condom

use. This requires a multivariate analysis where we account for sample selection from the fact that those who use a condom must be sexually active. The next section presents such a model.

3 Methodology

We start by setting up a simple model of sexual activity and condom use. We explain how we account for sample selection arising from condom users being a non-random subset of those who are sexually active. We then discuss the impact of unobserved individual's characteristics on the parameter estimates and suggest a solution to verify the extent to which our estimates are robust.

3.1 Model

Consider an individual i who derives utility a_i^* from his or her sexual activity status. The benefits from being sexually active a_i^* is a linear function of a vector of characteristics \mathbf{X}_i :

$$a_i^* = \mathbf{X}_i\boldsymbol{\beta} + v_i \tag{1}$$

where $\boldsymbol{\beta}$ is a vector of parameters and v is a mean-zero error term. However, we do not observe a_i^* but only if the individual is sexually active. Denoting an individual's sexual activity status by a_i , it follows that

$$a_i = \begin{cases} 1 & \text{if } a_i^* \geq 0 \Leftrightarrow v_i > -\mathbf{X}_i\boldsymbol{\beta} \\ 0 & \text{otherwise} \end{cases} \tag{2}$$

If the individual has decided to be sexually active, then he chooses whether or not to use a condom. Let u_i^* denote the net benefits from using a condom. Condoms have two uses. The first one is as a contraceptive method. The second one is as a protection against sexually transmitted disease.

Assume the net benefits from using a condom is a linear function of a vector of characteristics \mathbf{Z}_i . Only those who are sexually active choose whether or not to use a condom. In other words this is a case of sample selection. It follows that the conditional expected net benefits for individual i to use a condom equals:

$$E(u_i^* | a_i = 1) = \mathbf{Z}\boldsymbol{\gamma} + E(\varepsilon_i | v_i > -\mathbf{X}_i\boldsymbol{\beta}) \quad (3)$$

where $\boldsymbol{\gamma}$ is a vector of parameters, E is the expectations operator and ε_i is a mean-zero error term and the covariance between and equals $\varphi \in (-1, 1)$. However, we do not observe the net benefits from condom use but only whether a condom is or is not used. Let u_i denote an individual's condom use status such that if it equals 1 a condom is used, but it equals 0 otherwise.

We estimate (2) and (3) by maximum-likelihood while accounting for sample selection which allows us to obtain consistent parameter estimates. As noted by Heckman (1979) not accounting for sample selection may lead us to over or underestimate the impact of some variables on condom use. For instance, it is possible that knowledge of one's HIV status prompts one to be less sexually active, while those who are sexually active make less use of a condom. By using only the sub-sample of individuals who are sexually active, we may not be able to find such an effect.

3.2 Identifying Variables

The estimation of (2) and (3) requires that we have at least one identifying variable which explains the choice of being sexually active but not of condom use. In our quest to find some variables we used the following rationale. Sexual activity can be seen as the outcome of the number of solicitations which the man or woman is subjected to. If someone were to live by himself or herself in an island, then it is very likely that this person will be sexually inactive. Sexual activity is a function of the likelihood that one is more or less likely to find a suitable partner.

We therefore construct some identifying variables based on the characteristics of the enumerator's areas which is a given an area comprising between 80 and 250 households. There are 632 enumerator areas (EAs) which appear in the survey. Only a sample of households were surveyed, with an average of 11 individuals surveyed in each EA. Given the relatively small number of people in an area, we will assume that those people share a number of common characteristics which affect their sexual behavior but not their condom use.

The first identifying variable is the number of people in the enumerator's area. This is obtained directly by aggregating the data from the survey. *Ceteris paribus*, we expect people to be more sexually active the larger the enumerator's area because the potential for sexual matches is greater. The second identifying variable is the male-female ratio in the enumerator's area which is also obtained by aggregating the data from the survey. Females who live in an area where there are many males may find it easier to find a partner. The opposite holds if they live in an area where there are many males.

We realize there are limits to using those identifying variables. Ideally we would have liked to obtain some physical characteristics of the individuals to use identifying variables of sexual activity and not of condom use. However, finding such variables is an open challenge and needs further research. In the hope of verifying the extent to which our results are robust, we also account for unobserved characteristics as explained next.

3.3 Unobserved Characteristics

The specification in Section 3.1 implicitly assumes that we can observe all respondents' relevant characteristics for sexual behavior and condom use. However this is not necessarily the case. For example, it is very likely that a respondent's unobserved risk aversion matters for condom use, if having sex without a condom is viewed as a risk-taking behavior (Philipson and Posner 1993).⁵ Omitting that variable means that the maximum likelihood estimates of the bivariate probit will

be inconsistent if the omitted variable is correlated with other explanatory variables, such as the respondent's education for instance. Ideally, one would want to include an individual specific effect in (2) and (3). In this case, the benefits from being sexually active given by (2) becomes:

$$a_i^* = \mathbf{X}_i\boldsymbol{\beta} + f_i + v_i \quad (4)$$

where f_i is i 's fixed effect Unfortunately, estimating (4) requires both time series and cross section (panel) data which is not available.

As a second best solution, we assume that people who live in a particular area have the same unobserved characteristics. We therefore rewrite (4) as:

$$a_{ij}^* = \mathbf{X}_{ij}\boldsymbol{\beta} + \delta_j + v_{ij} \quad (5)$$

where δ is a dummy variable if the respondent lives in area j and 0 otherwise. Ideally one would like to use the smallest possible area so as to capture similar individuals. However, the cost of such a strategy is the increase in the number of parameters to be estimated. We therefore include as fixed effect the municipal area which captures a larger geographical area than the enumerator one. In the survey there are 66 municipal areas. However, the addition of those 66 new fixed effects still compel us to estimate the sexual activity and condom use equations separately. This allows us to gauge the extent to which the bivariate probit estimates are robust. We perform a similar transformation to (4) for the determinants of having sex with a condom. In other words we add the respondent's area of residence as an explanatory variable (through a fixed effect) in (3).

Using the municipal area to capture unobserved variables also accounts for unobserved socio-economic environment characteristics of the area of residence and district level differences. Ideally we would have obtained a more proximal parameter, which could have been the enumerator areas used in the survey but the number of participants in some of the enumerator areas was too low to

allow for this. However, one should bear in mind that there still is some heterogeneity within a municipal area.

4 A Discussion of our Results

The estimates of the determinants of sexual activity and condom use are reported in Table 4 for males and in Table 5 for females. We report three set of estimates obtained (i) from the logit model, (ii) by including fixed effects to account for unobserved effects and (iii) the bivariate probit. The estimates are allowed to differ between women and men so as to capture any difference which may arise in their sexual activity and condom use behaviors. In the present discussion, we focus on the results obtained from the bivariate probit model.

The Dependent Variables The measures of the dependent variables are the following. There are two possible measures of sexual activity which are available in the survey. Respondents were asked if they ever had sexual intercourse (80% of respondents had) and if they had sexual intercourse during the past twelve months (70% of all respondents were). We choose to use the second measure which captures secondary abstinence. Some individuals may not have had sex since the start of the HIV/AIDS epidemic for other reasons. Including them in our sample may bias our results. Hence, we say that is sexually active if he or she reports having had a sexual intercourse during the past twelve months.

The second explanatory variable is whether the respondent used a condom. Once again there are a number of alternatives available in the survey. Individuals reported whether they had ever used a condom, and if they used a condom during their last sexual intercourse. We are interested in seeing how the characteristics of the individuals affect their current condom use. This means we cannot use the first measure because someone may have used a condom a long time ago and not used it since then. We therefore use the second measure.⁶

Funeral Attendance Theoretically, the expected effect of attending the funeral of someone whom one knows to have died of AIDS-related diseases, on sexual behavior and condom use is not clear. When we observe a respondent has attended such a funeral, we can assume the respondent is somehow related (friend, family, neighbor or colleague) to the dead person. Hence, the respondent knows someone who is close to him has died because of AIDS. Moreover, we can also assume that the respondent has some knowledge of the lifestyle of the dead. He can use the additional information that the person died because of AIDS to update his priors (using Bayes rule for example) that the dead person became infected with HIV because of his sexual behavior.

Assuming the respondent updates his priors in such a manner could lead him to behave quite differently depending on his preferences and own past behaviors. First, if the respondent and the dead person had the same pattern of sexual behavior (and even partners), the updated conditional probability that the respondent is HIV positive is very high. Assume the individual is purely egoistic and derives additional pleasure from unprotected sex, then he should be more prone to having unprotected sex because he knows this has little, or no, effect on his lifetime expected utility. If the individual is altruistic, this mitigates that effect and induces him to adopt a less risky behavior. Second, if the person has just started a risky sexual activity, this may prompt him to revise his sexual behavior and engage in less risky behavior.

We find that males and females behave very differently in how they process this additional information. On the one hand, males who attended such a funeral are more likely to be sexually active, but are not more or less likely to use a condom. In addition to information processing, it may be true that those males who attend funerals are more sexually active for network reasons. Hence, they are already more sexually active than those who have not attended such funerals. On the other hand, females' sexual activity is unaffected by attending such funeral but they are more likely to use a condom. Our results are robust to any specification used. We therefore feel confident in their implications.

Education We can identify two mutually reinforcing effects of education. First, those who are better educated are more likely to be aware of the risks of unsafe sex.⁷ Second, it is well documented that individuals with more education earn higher wages and incomes (Mincer 1974).⁸ Hence, *ceteris paribus*, better educated individuals have more to lose from choosing unsafe sex. We should therefore expect better educated people to use condoms more often than those who are not educated. As for the impact on sexual activity, a priori, the effect is unclear because in itself it is not a risky behavior if people use a condom or have sex with the same HIV negative person. However, better educated individuals earn higher wages and, *ceteris paribus*, may have more disposable income to purchase sexual favors, or may be more attractive as partners because of their wealth and education.

We first distinguish between those who have completed at least primary education and those who have not. Next we separate those who have no more than primary education between those who have never attended school and those who have some schooling. This allows us to capture whether literacy and exposure to some schooling, for instance, matters for sexual activity and condom use. Once again the results are different for males and females. Starting with males we find that both specifications, the least educated are less likely to use a condom and be sexually active. Education does not seem to matter for females decision be sexually active. As for condom use, both males and females who have some primary education are less likely to use a condom than those who have completed primary school. These results hold across for the three estimators.

Reported Knowledge of Status The knowledge, or perception, of one's HIV status has different implications for male and female sexual behavior and condom use. Only HIV-positive males who ignore their status behave differently from other males. This group of men is more likely to be sexually active than others, except in the bivariate Probit model where the coefficient positive but not statistically significant. In all three specifications, the knowledge of perception of one's HIV status does not affect men's likelihood to use a condom. As for females, those who do not know

they are HIV negative are less likely to be sexually active than anyone else. This result may arise because such females may have some private information about their past sexual behavior from which they can infer they were not at risk of acquiring HIV. However, females who know their HIV status (positive or negative) are more likely to use a condom than those who do not know their status.

The different behavior of males and females, conditional on the knowledge (or perception) of their HIV status may be the consequence of the different channels through which they come to know about their status (see Table 4). On the one hand, most females know their status because they are tested for HIV when pregnant. On the other hand, most males come to know of their status either when they are tested for an insurance policy or if they want to know their status. In fact, because many females are tested for HIV when they are pregnant, this explains why a larger share of females than males had a HIV test before the survey was conducted. If we remove women who know their status because they were pregnant, a larger share of surveyed males than females know their HIV status.

There are two possible ways to explain this difference in behavior between men and women. First, the mode of knowing how one becomes HIV positive may affect sexual behavior and condom use through the counselling which takes place before and after the test. Pregnant women are counselled before and after the test, while males may simply have taken the test at a lab with no counselling. This would certainly affect their responses to knowledge of status. Second, the difference in behavior may also arise because men and women may have different preferences and risk aversion. We cannot distinguish between the magnitude of those two effects on an individual's behavior. This question is left for future work.⁹

Marriage Having sex without a condom cannot always be equated with risky behavior. If both partners are HIV-free and do not engage in sex with anyone else, then sex without a condom does not involve chances of acquiring the virus. We could expect married couples to have sex more often

than those who are not married because they may want to have children or for pleasure. We include a dummy variable which equals 1 if the person is married as an explanatory variable of condom use.

The marriage effect is significant for both males and females in explaining both condom use and sexual activity. Married people are more likely to be sexually active. Moreover, being married decreases the likelihood of using condoms, all other things being equal. This is not unexpected and shows that condom use is difficult to maintain in long term relationships. Interestingly, the finding holds true even when knowledge of partners status and knowledge of own HIV status are taken into account. This suggests that being married and having an ongoing sexual relationship mediates against condom use even in the presence of strong reasons to use condoms.

However, the combination of being married and knowing one's HIV status reveals some interesting behavior. It is of great interest that married men who know they are HIV positive are more likely to use a condom. However, the opposite holds for females. The implications of this result are important because it means the promotion of condom use amongst married couples is likely to succeed when men are encouraged to go for a test.

So as to account for the fact that a respondent may use a condom with only some partners, we also investigate whether the number of sexual partners which the respondent had in the past twelve months explains the decision whether or not to use a condom. We find that the number of partners is not statistically significant for either males or females, and irrespective of the specification. This result would indicate that those who are more sexually promiscuous are not more inclined to adopt safe sex practises.

Condom Availability A central issue related to HIV/AIDS prevention is the availability of condoms in developing countries. We find that the difficulty with which respondents can find a condom when they need one has a negative effect on the likelihood that they will use one. This

confirms the intuition that constraints on condom availability is detrimental to their use. Our result points to the importance of increasing the ease with which someone can have access to a condom when in need.

Moreover, it is often assumed that the place of residence is an important determinant of condom use. Interestingly, we find that women who live on a farm, as opposed to an urban area or a rural informal settlement, are more likely to have used a condom during the last sexual intercourse. This may arise because females who live on a farm knows where to access condoms. On the other hand, males who live on farms are less likely to use a condom. This may indicate that many males on the farm do not have sexual partners who live on the farm because otherwise they should exhibit the same pattern of condom behavior.

Age While older males are less likely to use a condom, the opposite holds for older females, when all other factors are taken into account. This is partly contrary to the descriptive finding of Parker and Bavani (2003) who report that a more young people than old people used condoms in the last sexual encounter. Whereas our findings confirm the relation of condom use and age in males, it refutes that for females. There are a number of possible explanations, but perhaps the most important is that women's ability to determine whether or not condoms are used is limited by their bargaining power in relationships. This power arguably increases with age. As expected older people are less likely to be sexually active. The finding probably reflects different patterns of sexual relations across the age range. Older people are more likely to be married and to be in permanent relationships. They are also more likely to have lower rates of partner turnover.

Sexual Debut Both males and females who had sex for the first time at a older age are more likely to have used a condom. This finding is in line with the commonly held assumption that early sex age and condom use indicate a high risk exposure factor. It therefore appears that delaying sexual debut may prompt people to adopt safe sex behavior.

Religion The subjective importance of religion amongst men increases the likelihood they use condoms. This is an interesting finding as it shows a significant relationship between religiosity and HIV prevention behavior, even after controlling for sexual activity. It has often been assumed that religious feeling has little bearing on prevention behavior in South Africa. Interestingly, when sexual activity is not taken account, the relationship between religiosity and condom use is not statistically significant.

5 Conclusion

In this study we have investigated the determinants of sexual behavior and condom use among black South Africans aged 15 to 49. We have tried to control for unobserved effects and taken into account that only sexually active individuals can use a condom. This is a fundamental step in the analysis of behavioral risk prevention, but it is often overlooked. Contrary to most previous HIV/AIDS studies we have access to a representative sample where the true HIV status of the respondent is known.

Our main results are the following. Married individuals and those who have an early first sexual debut are less likely to use a condom. As expected, the difficulty in obtaining a condom when needed reduces the likelihood that it will be used. Male and females behave quite differently with respect to their knowledge, or perception of their HIV status. The latter has no incidence on the likelihood that males will use a condom. However, married men who are HIV positive are more likely to use a condom. Women who know their HIV status (positive or negative) are more likely to use a condom.

We acknowledge that much remains to be done to verify the robustness of our results, especially in finding identifying variables of sexual activity and not condom use. This requires collecting new information and redefining measures.¹⁰ In future work we plan to move beyond cross-sectional data

to account for unobserved individual effects and construct a panel for South Africa. This may also allow us to better understand how knowledge of one's HIV status affects sexual behavior as well as the conditions of delaying sexual debut.

Notes

¹This result from failing to ask whether a behavior could occur in all members of a defined set. For instance, the percentage of youth who have ever used a condom is often calculated with reference to all young people rather than only those who have had sex (CASE 1999).

²As an illustration of how sample selection may matter, consider the following. It is often implied that because exposure to an educational television series and HIV prevention behavior are correlated means watching the the series causes the prevention behavior (cf. Soul City, 1990). This overlooks that those who are inclined to watch the particular programme may be the same ones who are inclined to practice that behavior. In this case, the problem lies with the fact that watching the series and practicing the behavior are both choice variables, just as sexual activity and condom use.

³As it happens the debates are about understanding the relationships between what are essentially endogenous variables. This problem besets the behavioral sciences generally, and is highlighted by the pressing demands to deliver solutions in the face of the HIV/AIDS epidemic.

⁴Indeed Michaud and Vencatachellum (2003, Table 1) document that an average black household was 7 times poorer than a white one in 1993. In fact, this number underestimates the wealth gap because there are far more persons in a black households than in white ones, and there is evidence of serious wealth underreporting among white respondents.

⁵Similarly, one can argue that the respondent's beauty will play a role in his or her sexual activity. On a related topic, Hamermesh and Biddle (1994) finds positive returns to beauty on the labor market.

⁶We acknowledge that not all cases of secondary abstinence are by choice. Some people cannot have sexual intercourse because of disability, medical reasons. Similarly, rape and various less extreme forms of sexual coercion are imposed. In those cases sexual activity and condom use are not choice variables. However, such data is not available to us.

⁷de Walque (2002) finds that educated individuals have been more responsive to HIV/AIDS information campaigns in Uganda.

⁸Michaud and Vencatachellum (2003) provide evidence on increasing returns to education in South Africa.

⁹Recall that those who report they are HIV negative may have acquired the virus in the window between when they had the test and when the survey was conducted. However, these results hold whether or not one accounts for sample selection arising from those who have not had sex in the last 12 months or for unobserved fixed effects.

¹⁰Skip patterns in surveys frequently mean that contributory factors to sexual behavior for the sexually inactive (for example, masturbation behavior) are not collected. This requires that much more thinking needs to be put into understanding contributory factors, rather than only outcome measures. Moreover, the association between prevention behavior indicators is often framed within a semantics of causality. Peal () shows that the language of association and the language of causal inference have different grammar and syntax. She points out that statistical associations derived from any form of equation cannot by definition lead to causal inferences. She points to the need for a language of causal inference. Without this, she suggests, health research is condemned to being a circular and descriptive science.

A A description of the survey

The survey was implemented between March and September 2002. A cross-sectional sample based on a master sample of 10,197 households drawn from 1,010 2001 census enumeration areas out of the total 86,000 was used. Those in special institutions (e.g. hospitals, military camps, old age homes, schools and university hostels) were excluded. The survey was designed to be racially, geographically representative, and to have adequate respondents in sub-samples. This took into account a 70% response rate and HIV seroprevalence of 20%. Respondents were interviewed and tested in their homes and own languages.

The fieldwork was carried in two phases.

1 Three activities were undertaken: (i) populating the master sample, (ii) notifying the heads of selected households about the study, and (iii) collecting the sampling frame of respondents aged 2 years and above from each household that agreed to participate in the study. A sampling frame of 31,321 people was drawn up after the notification phase from a total of 10,197 visiting points or households that agreed to participate in the study. Those households were among the 970 enumeration areas that had six or more households agreeing to participate in the survey. Three members of each consenting household were randomly selected as follows: one adult aged 25 and above, one youth aged 15-24 and one child aged 2-14 years. This yielded a sample of 14,450 respondents. However, only 13,518 were contacted due to time and logistics constraints.

2 Individual interviews were conducted with 9,963 respondents who agreed to take part in the study. The interviews were based on four main questionnaires for four age groups (over 24, 15-24, 12-14, 2-11). A copy of the questionnaire is available upon request. Parents or guardians were interviewed as proxies for children aged 2-11 years, while all others were interviewed

directly. Oral fluid specimens for HIV testing were collected from 8,840 who consented. Children were also required to provide the oral fluid specimens for HIV antibody testing.

Oral fluid specimens were collected by means of the Orasure HIV-1 Oral Specimen Collection Device. Three laboratories, linked to three medical schools virology departments, conducted ELISA tests on the specimens. The HIV test results from 8,824 respondents were successfully anonymously linked with the behavioral questionnaires via bar codes. The reader is referred to NMF/HSRC (2002) for a more detailed description of the survey.

B Tables

Table 1
A representative sample of South Africans aged 15 to 49 years

HIV Status							
Race	Positive		Negative		Not Available	Total	Share HIV positive
	Know	do not know	Know	do not know			
Black	122	411	377	1 982	451	3 343	18.4%
White	9	14	199	174	79	475	5.8%
Coloured	15	59	218	712	102	1 106	7.4%
Indian	1	4	158	341	133	637	1.0%
Other	1	1	0	5	3	10	28.6%
Total	148	489	952	3 214	768	5 571	13.3%
Males							
Black	39	171	137	890	211	1448	17.0%
White	3	10	94	80	32	219	7.0%
Coloured	6	22	82	308	44	462	6.7%
Indian	1	1	79	158	60	299	0.8%
Other	0	1	0	3	1	5	25.0%
Total	49	205	392	1439	348	2433	12.2%
Females							
Black	83	240	240	1 092	240	1 895	19.5%
White	6	4	105	94	47	256	4.8%
Coloured	9	37	136	404	58	644	7.8%
Indian	0	3	79	183	73	338	1.1%
Other	1	0	0	2	2	5	33.3%
Total	99	284	560	1 775	420	3 138	14.1%

Table 2: Blacks who used a condom during their last intercourse and knowledge of status

HIV Status							
	Positive		Negative		Not Available	Total	Share HIV positive
	Know	do not know	Know	do not know			
Males							
yes	15	57	49	276	68	465	397
no	24	114	88	614	143	983	840
Total	39	171	137	890	211	1448	1237
Share of NO	38%	33%	36%	31%	32%	32%	68%
Females							
yes	39	74	81	235	62	491	429
no	44	166	159	857	178	1404	1226
Total	83	240	240	1092	240	1895	1655
Share of NO	47%	31%	34%	22%	26%	26%	74%
Use a condom	44%	32%	34%	26%	29%	29%	29%

Table 3
Blacks aged 15-49 who are sexually active, monogamous during the past 12 months and did not use a condom

HIV Status						
Knowledge of partner status	Positive		Negative		Not Available	Total
	Know	do not know	Know	do not know		
yes	6	15	44	25	12	102
no	10	58	31	262	66	427
Total	16	73	75	287	78	529

Table 5-A Determinants of condom use

Black Males aged 15 to 49

Dependent variable equals 1 if condom used during last sexual intercourse, 0 otherwise

Explanatory variables	Estimator					
	Logit		Logit with Fixed effects		Bivariate Probit	
Age	-0.12	(1.18)	-0.27	(6.78) ***	-0.13	(1.56)
Age squared divided by 100	0.00	(0.89)	0.35	(6.12) ***	0.00	(1.15)
Dummy equals 1 if married, 0 otherwise	-0.76	(3.06) ***	-0.63	(5.17) ***	-0.77	(3.67) ***
Number of partners divided by 100	0.00	(1.23)	-0.07	(1.01)	0.00	(1.18)
Subjective importance of religion	0.51	(1.82)	0.26	(1.86) *	0.52	(1.83) *
Age of first sexual intercourse	0.23	(1.25)	0.18	(2.14) **	0.23	(1.44)
Knows own status and is HIV positive	-1.49	(1.28)	-0.62	(1.41)	-1.52	(1.51)
Does not know status and is HIV positive	0.29	(1.06)	0.02	(0.12)	0.28	(0.96)
Knows own status and is HIV negative	0.34	(0.72)	0.03	(0.11)	0.34	(0.84)
Never attended school	-0.31	(0.68)	-0.03	(0.11)	-0.31	(0.64)
Has attended primary school	-0.88	(3.65) ***	-0.40	(2.82) ***	-0.88	(3.93) ***
Lives in the urban-informal area	0.14	(0.50)	0.13	(0.70)	0.16	(0.50)
Lives in an urban-formal area	0.10	(0.41)	0.08	(0.79)	0.12	(0.52)
Lives on a farm	-0.38	(0.96)	-0.26	(1.29)	-0.35	(0.81)
Circumcised	0.25	(1.25)	0.16	(1.33)	0.24	(1.10)
Attended the funeral who died of AIDS related diseases	0.00	(0.01)	-0.09	(0.96)	0.00	(0.01)
Dummy equals 1 if difficult to obtain a condom when needed, 0 otherwise	-1.22	(2.21) **	-0.71	(3.03) ***	-1.23	(2.24) **
Married and knows own status and is HIV positive	2.63	(2.08) **	1.34	(2.92) ***	2.65	(2.60) ***
Married and does not know own status and is HIV positive	-0.20	(0.34)	-0.01	(0.04)	-0.20	(0.42)
Number of children	-0.11	(1.51)	-0.06	(1.25)	-0.11	(1.12)
Constant	1.68	(0.94)	4.83	(7.47) ***	1.68	(1.25)

Table 5-B Determinants of Sexual Activity

Black Males aged 15 to 49

Dependent variable equals 1 if the respondent had sexual intercourse during the past twelve months, 0 otherwise

Explanatory variables	Estimator					
	Logit		Logit with Fixed effects		Bivariate Probit	
Age	0.61	(11.88) ***	0.61	(12.70) ***	0.54	(15.71) ***
Age squared divided by 100	-0.88	(10.48) ***	-0.88	(11.05) ***	-0.74	(13.23) ***
Knows own status and is HIV positive	0.03	(0.05)	0.05	(0.07)	-0.29	(0.76)
Does not know status and is HIV positive	0.52	(1.89) *	0.50	(2.07) **	0.23	(1.34)
Knows own status and is HIV negative	0.46	(1.11)	0.46	(1.11)	0.33	(1.53)
Married	0.81	(2.73) ***	0.80	(2.89) ***	0.70	(4.50) ***
Married and knows own status and is HIV positive	-0.81	(0.83)	-0.85	(0.97)	-0.24	(0.50)
Married and does not know own status and is HIV positive	0.01	(0.01)	0.00	(0.00)	-0.13	(0.37)
Never attended school	-0.78	(2.32) **	-0.78	(2.49) ***	-0.58	(2.66) ***
Has attended primary school	-0.25	(1.50)	-0.25	(1.47)	-0.29	(2.59) *
Lives in the urban-informal area	0.03	(0.12)	0.03	(0.15)	-0.04	(0.30)
Lives in an urban-formal area	0.25	(1.51)	0.25	(1.52)	0.13	(1.01)
Lives on a farm	0.76	(2.67) ***	0.78	(2.75) ***	0.63	(3.30) ***
Migrant	0.47	(2.29) **	0.45	(2.10) **	0.26	(1.67) *
Attended the funeral who died of AIDS related diseases	0.45	(2.64) ***	0.45	(2.79) ***	0.33	(2.91) ***
Number of individuals in the enumerator's area where the respondent lives	0.01	(0.89)	0.01	(0.80)	0.07	(0.18)
Male/Female ratio in the enumerator's area where the respondent lives	0.03	(0.95)	0.02	(0.73)	0.04	(1.86) *
Constant	-8.81	-12.21 ***	-8.77	(12.88) ***	-9.02	(17.44) ***
Correlation between the two error terms					-0.83	
Wald test of independent equations					20.86	
P-value associated to the Wald test					0.00	

Notes

The T-ratio corrected for heteroscedasticity is in parenthesis next to the estimate.

***, ** and * denote the coefficient is significantly different from 0 at the 1, 5 and 10 percent levels respectively.

The categories of reference are: Does not know one's status and is HIV negative

Table 6-A Determinants of condom use

Black females aged 15 to 49

Dependent variable equals 1 if condom used during last sexual intercourse, 0 otherwise

Explanatory variables	Estimator		
	Logit	Logit with Fixed effects	Bivariate Probit
Age	0.15 (1.92) **	0.18 (2.84) ***	0.12 (3.19) ***
Age squared divided by 100	0.00 (2.20) **	0.00 (3.22) ***	0.21 (3.98) ***
Dummy equals 1 if married, 0 otherwise	-0.94 (4.45) ***	-0.92 (3.93) ***	-0.43 (3.82) ***
Number of sexual partners divided by 100	-0.09 (0.71)	-0.06 (0.61)	-5.23 (0.71)
Subjective importance of religion	0.40 (1.23)	0.31 (0.90)	0.26 (1.47)
Age of first sexual intercourse	0.25 (1.58)	0.18 (1.30)	0.14 (1.83) *
Knows own status and is HIV positive	0.36 (1.00)	0.23 (0.82)	0.34 (1.73) *
Does not know status and is HIV positive	0.07 (0.26)	0.14 (0.46)	0.08 (0.48)
Knows own status and is HIV negative	0.28 (1.03)	0.25 (0.76)	0.35 (2.02) **
Never attended school	-0.24 (0.74)	-0.26 (0.61)	-0.11 (0.50)
Has attended primary school	-0.37 (1.80) *	-0.32 (1.78) *	-0.17 (1.70) *
Lives in the urban-informal area	0.36 (1.48)	0.20 (1.12)	0.13 (1.09)
Lives in an urban-formal area	0.23 (1.18)	0.18 (0.94)	0.13 (1.30)
Lives on a farm	0.51 (1.50)	0.53 (2.01) *	0.35 (2.52) **
Circumcised		Not applicable	
Attended the funeral who died of AIDS related diseases	0.26 (1.53)	0.23 (1.57)	0.13 (1.61) *
Dummy equals 1 if difficult to obtain a condom when needed, 0 otherwise	-1.45 (2.69) ***	-0.22 (3.21) ***	-0.09 (2.71) ***
Married and knows own status and is HIV positive	0.93 (1.54)	-1.38 (2.93) ***	-0.76 (3.31) ***
Married and does not know own status and is HIV positive	0.31 (0.78)	1.03 (1.66) *	0.44 (1.32)
Number of children	-0.19 (2.66) ***	0.32 (0.72)	0.01 (0.03)
Constant	-3.42 (2.53) ***	-3.64 (3.34) ***	-2.67 (4.44) ***

Table 6-B Determinants of Sexual Activity

Black females aged 15 to 49

Dependent variable equals 1 if the respondent had sexual intercourse during the past twelve months, 0 otherwise

Explanatory variables	Estimator		
	Logit	Logit with Fixed effects	Bivariate Probit
Age	0.26 (3.45) ***	0.26 (3.18) ***	0.15 (3.44) ***
Age squared divided by 100	-0.45 (4.19) ***	-0.45 (3.74) ***	-0.26 (4.07) ***
Knows own status and is HIV positive	0.79 (1.59)	0.78 (1.67) *	0.49 (2.22) **
Does not know status and is HIV positive	0.36 (1.43)	0.37 (1.60) *	0.22 (2.05) **
Knows own status and is HIV negative	1.24 (3.07) ***	1.24 (3.65) ***	0.67 (3.67) ***
Married	0.50 (2.58) ***	0.49 (2.15) **	0.30 (2.56) ***
Married and knows own status and is HIV positive	-0.46 (0.61)	-0.48 (0.71)	-0.22 (0.63)
Married and does not know own status and is HIV positive	-1.20 (2.42) **	-1.20 (3.48) ***	-0.62 (3.32) ***
Never attended school	0.16 (0.54)	0.16 (0.59)	0.05 (0.35)
Has attended primary school	0.12 (0.60)	0.11 (0.61)	0.06 (0.60)
Lives in the urban-informal area	-0.24 (0.98)	-0.23 (1.23)	-0.14 (1.26)
Lives in an urban-formal area	0.07 (0.37)	0.08 (0.50)	0.03 (0.31)
Lives on a farm	0.30 (1.41)	0.93 (2.31) **	0.53 (2.84) ***
Migrant	0.91 (2.19) **	0.29 (1.42)	0.16 (1.47)
Attended the funeral who died of AIDS related diseases	-0.10 (0.60)	-0.10 (0.86)	-0.06 (0.75)
Number of individuals in the enumerator's area where the respondent lives	0.01 (1.81) *	0.01 (1.56)	0.97 (2.32) **
Male/Female ratio in the enumerator's area where the respondent lives	-0.08 (1.18)	-0.08 (1.22)	-0.05 (1.22)
Average education of females in the respondent's municipality	0.01 (1.84) *	0.01 (2.28) **	0.01 (1.98) **
Average education of males in the respondent's municipality	0.03 (0.45)	0.01 (0.16)	0.01 (0.32)
Number of children	0.08 (1.25)	0.07 (1.25)	0.05 (1.52)
Constant	-2.93 (2.28) **	-2.86 (1.81) *	-1.63 (2.07) **
Correlation between the two error terms			0.996
Wald test of independent equations			8.21
P-value associated to the Wald test			0.0042

Notes

The T-ratio corrected for heteroscedasticity is in parenthesis next to the estimate.

***, ** and * denote the coefficient is significantly different from 0 at the 1, 5 and 10 percent levels respectively.

The categories of reference are: Does not know one's status and is HIV negative

References

- Agha, Sohail, Thankian Kusanthan, Kim Longfield, Megan Klein, and John Berman (2002) 'Reasons for non-use of condoms in eight countries in Sub-Saharan Africa.' Working Paper 49, Population Service International, Washington D.C., October
- Arndt, C., and J. D. Lewis (2000) 'The macro implications of HIV/AIDS in South Africa: A preliminary assessment.' *South African Journal of Economics* 68(5), 856–87
- Barnett, Tony, and Alan Whiteside (2002) *AIDS in the Twenty-First Century. Disease and Globalization* (New York, N.Y.: Palgrave Macmillan)
- Bell, Clive, Shantayanan Devarajan, and Hans Gersbach (2003) 'The long-run economic costs of AIDS: Theory and an application to South Africa.' World Bank
- Bhorat, Haroon, Murray Leibbrandt, M. Maziya, Servaas van der Berg, and Ingrid Woolard (2001) *Fighting Poverty: Labour Markets and Inequality in South Africa* (University of Cape Town Press)
- CASE (1999) 'Let the sky be the limit: Soul city 1 evaluation report.' CASE Johannesburg
- de Walque, Damien (2002) 'How does the impact of an HIV/AIDS information campaign vary with educational attainment? evidence from rural Uganda.' Mimeo, University of Chicago
- Hamermesh, Daniel S., and Jeff E. Biddle (1994) 'Beauty and the labor market.' *The American Economic Review* 84, 1174–1194
- Heald, S. (2002) 'It's not as simple as ABC: HIV/AIDS prevention in Botswana.' *African Journal of AIDS Research*
- Heckman, James (1979) 'Sample selection bias as a specification error.' *Econometrica* 47, 153–161
- Kelly, K. (2000) 'Communicating for action: A contextual evaluation of youth response to HIV/AIDS.' Sentinel Site Monitoring and Evaluation Project for the Beyond Awareness Campaign Department of Health, Pretoria, South Africa
- Kelly, K. J., W. Parker, and G. Lewis (2001) 'Reconceptualising behaviour change in the HIV/AIDS context.' In *Socio-political and psychological perspectives on South Africa*, ed. C. Stones (London: Nova Science)
- Levy, Amnon (2002) 'A lifetime portfolio of risky and risk-free sexual.' *Journal of Health Economics* 21, 993–1007
- Michaud, Pierre-Carl, and Désiré Vencatachellum (2003) 'Human capital externalities in South Africa.' *Economic Development and Cultural Change* 51(3), .
- Mincer, Jacob (1974) *Schooling, Experience, and Earnings* (New York and London: National Bureau of Economic Research and Columbia University Press)
- Nelson Mandela Foundation (2002) (Pretoria, South Africa: South African National HIV Prevalence, Behavioural Risk and Mass Media)
- Philipson, Thomas, and Richard A. Posner (1993) *Private Choices and Public Health: the AIDS Epidemic in an Economic Perspective* (Cambridge: Harvard University Press)
- Rao, Vijayendra, Indrani Gupta, Michael Lokshin, and Smarajit Jana (2003) 'Sex workers and the cost of safe sex: The compensating differential for condom use in calcutta.' *Journal of Development Economics*. Forthcoming
- Skordis, Jolene, and Nicoli Nattrass (2002) 'Paying to waste lives: the affordability of reducing mother-to-child transmission of HIV in South Africa.' *Journal of Health Economics* 21(21), 495–421
- UNAIDS (1990) 'Trends in hiv incidence and prevalence: Natural course of the epidemic or results of behavioural change?' Geneva
- (2002) 'Report on the global HIV/AIDS epidemic.' Geneva, Switzerland
- Varga, Christine A. (1997) 'Sexual decision-making and negotiation in the midst of AIDS: youth in KwaZulu-Natal South Africa,.' *South Africa* 7(Supplement 3), 45–67