

HIV Communication Programs, Condom Use at Sexual Debut, and HIV Infections Averted in South Africa, 2005

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BACKGROUND

Background: Since the 1990s, communication programs in South Africa have promoted HIV prevention, especially condom use. Although HIV prevalence stabilized after 2000, surveys have not clarified how prevention behavior contributed to that change. We present a secondary statistical analysis of the 2005 national South African Human Sciences Research Council survey that reveals how condom use at sexual debut—which normally occurs before infection from unprotected sex—may have contributed to the reduction in HIV infection.

Methods: Threats from measured and unobserved confounding variables are addressed through the use of several complementary statistical methods including structural equation modeling with multivariate probit regression and propensity score matching. The latter is used to create statistically comparable groups of those who used and did not use condoms at sexual debut to estimate the number of HIV infections averted attributed to this behavior.

Results: After controlling for 17 socioeconomic variables, awareness of HIV communication programs had a positive, dose-response relationship with self-reported condom use at sexual debut. Those who used condoms at sexual debut were 1.38 times more likely to have remained uninfected. HIV-negative status was 3.6 percentage points higher among those who used condoms at sexual debut, corresponding to an estimated 139,835 infections averted among sexually active adults by 2005. Never using injectable drugs and having 1 trusted partner also predicted HIV-negative status.

Conclusions: We found a relationship between HIV communication awareness and condom use at sexual debut. Condom use at sexual debut, in turn, was associated with lower subsequent HIV risk.

Key Words: HIV/AIDS prevention, communication campaigns, structural equation modeling, propensity score matching, condom use

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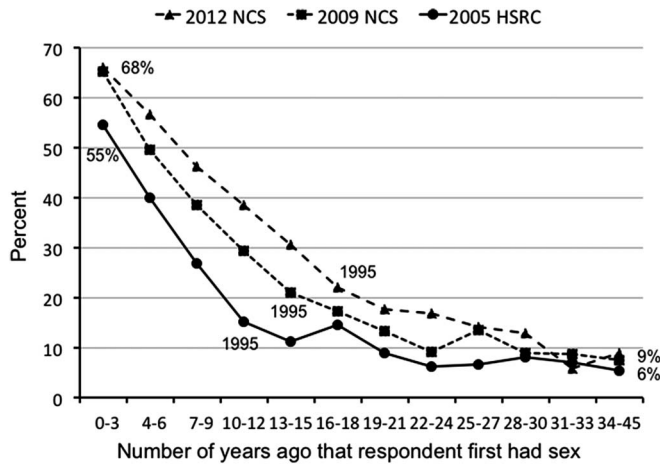
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As early as 2001 there was evidence from prospective experiments that condoms, if used consistently, reduced the rate of HIV incidence.^{1,2} Condom use at sexual debut is important because of its documented link with subsequent consistent condom use.^{3,4} Thus, protecting oneself from infection at sexual debut improves the chances of avoiding infection, by subsequent behavior, at a later point. Research has also confirmed a relationship between condom use at sexual debut and reduced risk of chlamydia, gonorrhea, and other sexually transmitted infections.⁵

Over the past 20 years, communication programs in South Africa have educated the public about AIDS, emphasizing use of condoms. Over this period, HIV prevalence in antenatal clinics increased from 10% in 1995 to around 20% in 2000 and then to 29% by 2008.⁶ HIV prevalence among adults, as estimated from national surveys leveled off from 15.6% in 2002, 16.2% in 2005, to 16.9% in 2008. Condom use at last sex increased from less than 10% before 2000 to 27.3% in 2002, 35.4% in 2005, to 62.4% in 2008.⁷ Some stabilization came from the decrease in HIV incidence among youth younger than 20 years—1.0%–0.6% for 15-year-olds, 1.2%–0.5% for 16-year-olds, and 1.5%–0.6% for 17-year-olds, which one study suggested was “probably due to increased condom use.”⁷ Mathematical modeling suggested that declines in HIV incidence between 2000 and 2008 were probably because of increased condom use.⁸ A systematic review of HIV/AIDS mass communication campaigns has shown that they have increased condom use.⁹ Secondary analysis of the 2008 Human Sciences Research Council survey found a positive association between exposure to HIV communication programs and condom use at last sex.¹⁰

Yet doubts remain that this change can be attributed to condom use, primarily because, at the individual level of measurement in population surveys, the correlation between condom use at sexual debut and HIV-positive status can be positive rather than negative. Many may already be infected before they start using condoms consistently or because condoms are used inconsistently and/or incorrectly.

The role of condom use at sexual debut has been overlooked. Figure 1 presents an analysis of 3 national surveys that shows the upward trend in condom use at sexual debut by “sexual generation,” the difference between current age and age at sexual debut, grouped into 3-year cohorts.^{11,12} In the 2005 survey, condom use at sexual debut 34–45 years ago was 6%. It remained at that level until around 1995, when it suddenly increased over the next 10 years to 55%. Subsequent surveys found the same trend, but with condom use at



N = 8,198; 6,746; 7,068, respectively; p<0.001

FIGURE 1. Condom use at sexual debut by number of years ago respondent first had sex.

sexual debut reaching 68% by 2008. The consistency among the 3 national surveys indicates high measurement reliability. Each new cohort is presumably HIV negative up until the time of the first sexual encounter, with the exception of mother-to-child transmission and infected needle use. Later infection would result from irregular or improper condom use after sexual debut.

Statistical analysis of this relationship at the individual level is missing due in part to the lack of cohort data at the population level that can track individual behavior over time as well as the programs that promote them. Overlooked are advances in statistical analysis that allow for enhanced causal arguments from cross-sectional data if conducted after interventions have been implemented and specific assumptions hold. This article presents a secondary statistical analysis of the 2005 national South African Human Sciences Research Council survey to examine whether protection from HIV infection (remaining HIV negative) might be attributed to condom use at sexual debut and other prevention behaviors.¹¹ Two interrelated hypotheses are tested: that HIV communication programs have an indirect effect on HIV status through their direct effect on condom use at sexual debut and that condom use at sexual debut assists in the prevention of HIV infection.

METHODS

Sampling

All persons over 2 years of age living in households in South Africa were sampled by means of a multi-stage disproportionate, stratified sampling approach, using a sampling frame provided by Statistics South Africa for the 2001 census. The data were adjusted for nonresponse and weighted by gender, age, race, locality type, and province to produce a representative sample of the population. Our analysis used a subsample of 6829 adults aged 15–84 years who reported having sexual intercourse during the previous 12 months

(sexually active), answered the question about condom use at sexual debut, and agreed to be tested for HIV. This subsample represents a frequency-weighted population of 18,922,667 adults.

Measurement

During household interviews, blood specimens were collected on absorbent paper and then tested for HIV using the Vironostika HIV-1 Uniform II Plus O assay (bioMerieux, Durham, NC), then all HIV-positive samples were retested with a second enzyme-linked immunosorbent assay test (Vitros ECI; Ortho Clinical Diagnostics, Rochester, NY). Condom use was measured with 2 yes/no questions: “Did you use a condom the first time you had sexual intercourse?” and “Did you use a condom the last time you had sex?” “Have you ever used any drug by injection?” measured the risk from using injectable drugs. Faithfulness to 1 sex partner was ascertained from those who said being faithful or trusting their partner was a reason they did not feel at risk for HIV infection.

Exposure to AIDS communication programs was measured by asking respondents how many of 8 specific HIV/AIDS communication programs they were aware of—the government’s *Khomanani* program (38% aware), loveLife (52%), Soul City (64%), Soul Buddyz (46%), provincial government campaigns (23%), Gazlam (49%), *Tsha Tsha* (45%), and *Takalani* Sesame (55%)—summed to create a continuous scale from 0 to 8 (Cronbach alpha = 0.88). For the analysis, we used multiple linear regression to obtain a predicted measure of “program awareness.” This created a measure that is exogenous to condom use at sexual debut and thus eliminates the potential threat of reverse causality, a requirement for a causal inference.¹³ To account for contextual influences on condom use behavior, we measured burden of disease as the average level of HIV infection in one’s sampling cluster, excluding oneself (non-self mean). The natural log of this measure was used to adjust for skewness.

Statistical Analysis

We used a combination of existing statistical methods to test the assumptions required for enhancing causal arguments. These include structural equation modeling with multivariate probit regression to test the path from communication awareness to condom use to HIV status, and propensity score matching (PSM) with sensitivity analysis to estimate the proportion of HIV-negative status that can be attributed to condom use at sexual debut. These complementary statistical methods provide mutually reinforcing strength to arguing that statistical associations might have a cause element.^{14–16} Such a multi-method approach provides a useful alternative to the randomized controlled trial (RCT), which may not be feasible at the national level and may lack generalizability when there is nonrepresentativeness of research participants.

Structural equation modeling examines two or more endogenous (dependent) variables, which are covariates in the other equations. It requires testing for exogeneity (independence) of these covariates in their respective equations and

controlling for potential confounding variables. A successful exogeneity test helps reduce the threat of reciprocal causality and self-selection bias—the voluntary exposure to treatment rather than random assignment. It also requires that theoretical assumptions be made to define the equations in the SEM. In this analysis, 3 interrelated equations are used, corresponding to the following testable theoretical path model:

$$y_{1it} = \beta_0 + \beta_1 y_{2it} + \beta_2 \mathbf{X}_{it} + \varepsilon_{1it}, \quad (1)$$

$$y_{2it} = \delta_0 + \delta_1 y_{3it} + \delta_2 \mathbf{Z}_{it} + \varepsilon_{2it}, \quad (2)$$

$$y_{3it} = \gamma_0 + \gamma_1 \mathbf{W}_{it} + \varepsilon_{3it}. \quad (3)$$

where y_{1it} is HIV status, y_{2it} is condom use at sexual debut, and y_{3it} is awareness of the 8 communication programs for subject i measured at time t . \mathbf{X}_{it} , \mathbf{Z}_{it} , and \mathbf{W}_{it} are matrices of exogenous, socioeconomic, and demographic control variables and other explanatory variables. Coefficients β , δ , and γ are parameters to be estimated from the data with regression analysis, and ε_{1it} , ε_{2it} , and ε_{3it} are the disturbance terms (residuals from the fit of each model to the data). Multivariate probit regression is used to estimate the parameters of HIV-negative status and condom use at sexual debut. The continuous variable, awareness of communication programs, is analyzed by ordinary least squares (linear) regression to obtain the predicted variable used in the other 2 equations.¹⁷

The test for exogeneity of condom indicates if there are unobserved/omitted variables that may account for its observed relationship with HIV status and if the relationship could be reciprocal (reverse causality). We use multivariate probit regression to test if correlation (rho coefficient) of the 2 residual terms, ε_{2it} and ε_{1it} , is significantly different from zero. If so, y_{2it} (condom use at sexual debut) can be considered exogenous in the equation for HIV status and a causal inference would be strengthened.¹⁸

PSM seeks to emulate the random assignment characteristic of RCTs by constructing an untreated, counterfactual control group that is statistically equivalent to those treated.¹⁹ As with RCTs, the average estimated difference between the treatment and constructed control might be interpreted as causal. Logistic regression is used to calculate the propensity score for each respondent, the probability of being treated (condom use at sexual debut), that is conditional on a set of the measured confounding variables. Matching treated and untreated cases based on this propensity score creates a control group in which all included covariates are balanced (statistically equivalent) between those treated and those not treated.²⁰

PSM assignment is said to be “strongly ignorable” (conditionally independent) when, conditional on the observed covariates, there are no systematic, unobserved pre-treatment differences between exposed and unexposed subjects that are related to the outcome being studied.^{21,22} If the multivariate probit regression tests are systematic, then unobserved, pre-treatment differences are likely to exist. If the correlation of the residuals (rho) is confirmed as not statistically significant, these differences are less likely to exist.

Residual terms that are not statistically significant are more likely to be randomly rather than systematically related; hence, the results of the PSM mimic what would be obtained if random assignment was used.²³ Sensitivity analysis supports the robustness of PSM by statistically simulating a potential binary confounding variable and then adding it to the propensity score calculation to see how much it would affect the original conditional independence assumption.^{24,25}

RESULTS

The descriptive statistics for HIV status and the 17 socioeconomic variables used in the regressions for the SEM are reported in column 2 of Table 1. The average rate of HIV-negative status for those sexually active in the past 12 months ($N = 6829$) is 83.3% (conversely, 16.7% HIV positive). The next 3 columns present the estimated parameters of the SEM for HIV communication awareness, condom use at sexual debut, and HIV-negative status, and their 95% confidence intervals (CIs). Likelihood ratio tests were performed to justify exclusion of nonsignificant variables from each equation, required to identify the model.

Fit of the Structural Equation Model to the Data

The variance explained (adjusted R^2) by the model for communication program awareness is 0.41, 0.20 for condom use at last sex, and 0.18 for HIV-negative status (pseudo- R^2). Fit of the models to the data was estimated with the Stukel likelihood ratio χ^2 goodness-of-fit test.^{26,27} A model that fits well has a χ^2 statistic small enough that it is not statistically significant, indicating no difference between the model and the data.

The model for condom use at sexual debut satisfies this criterion ($\chi^2 = 0.82$, $P > 0.66$) as does the model for HIV-negative status ($\chi^2 = 5.13$, $P > 0.08$). The multivariate probit analysis shows that the correlation of the residual terms, rho, from the condom use and HIV status equations is not statistically significant [rho = -0.048 ; $\chi^2 = 1.06$ (1df), $P > 0.30$].

Condom Use at Sexual Debut

The strongest predictors of awareness of communication programs are frequency of television viewing, radio listening, newspaper reading, and discussion of AIDS in community meetings, which are generally the primary channels used to promote condom use. The multivariate probit coefficient for the impact of predicted communication awareness on condom use at sexual debut is 0.056 ($P < 0.001$, 95% CI: 0.02 to 0.09), adjusting for all other variables.

Figure 2 shows the adjusted marginal effects of predicted awareness of communication programs on condom use at sexual debut. The strongest impact is on youth aged 15–24 years (upper trend line). This finding is consistent with the aggregate-level trend in Figure 1, which shows an inflection point in condom use at sexual debut beginning in the mid-1990s. The graph reveals a dose–response effect of the likelihood of communication exposure on condom use at

TABLE 1. Results of the Linear Regression for HIV Communication Program Awareness and Multivariate Probit Regression for HIV-Negative Status in South Africa in 2005

Variables	Descriptive Statistics Weighted Mean or % (Range)	Linear Regression	Multivariate Probit Regression			
		HIV Communication Awareness	Condom Use at Sexual Debut		HIV-Negative Status	
		Standardized Beta Coefficient	Probit Coefficient	95% CI	Probit Coefficient	95% CI
Negative HIV status	83.3%					
Predicted HIV communication program awareness	4.0 (0–8)		0.056*	0.02 to 0.09	—	—
Used a condom at sexual debut	21.7				0.25†	0.06 to 0.44
Faithful to 1 partner that I trust	48.5	—	—	—	0.15*	0.06 to 0.25
Ever used injectable drugs	4.8	—	—	—	−0.21‡	−0.38 to −0.03
HIV prevalence in one’s sampling cluster (log):	11.4 (0–1)	—	—	—	−0.15†	−0.26 to −0.04
TV viewing frequency	3.2 (1–4)	0.373*	—	—	—	—
Radio listening frequency	3.4 (1–4)	0.071*	—	—	—	—
Newspaper reading frequency	2.3 (1–4)	0.138*	—	—	—	—
Community HIV/AIDS meetings	17.3	0.118*	—	—	—	—
Female gender	59.1	—	−0.12†	−0.19 to −0.04	−0.19†	−0.28 to −0.10
Single marital status	43.8	0.026‡	0.31*	0.21 to 0.40	−0.30*	−0.40 to −0.20
Age (yr)	35.9 (15–84)					
44–96 (ref.)	27.5	ref.	0.00		0.00	
25–43	46.4	0.103*	0.44*	0.32 to 0.56	−0.50*	−0.63 to −0.37
15–24	26.0	0.148*	1.24*	1.09 to 1.39	−0.33*	−0.49 to −0.16
Age of sexual debut	18.5 (10–57)	—	0.03*	0.02 to 0.05	—	—
Ever forced to have sex	2.3	0.031*	—	—	—	—
Education level						
Primary or less	28.3	ref.	0.00		0.00	
Secondary	37.5	0.121*	0.16†	0.05 to 0.28	−0.03	−0.14 to 0.07
Matric/tertiary	34.2	0.165*	0.32*	0.19 to 0.46	0.15‡	0.02 to 0.27
Employment status						
Unemployed (ref.)	49.0	ref.	0.00		0.00	
Employed	40.6	0.002	−0.05	−0.14 to 0.04	0.10‡	0.00 to 0.20
Pensioner	2.6	−0.042*	−0.07	−0.39 to 0.24	1.01†	0.19 to 1.83
Student	7.8	0.031†	0.46*	0.31 to 0.60	0.51*	0.32 to 0.70
Any level of poverty	51.2	0.027‡	—	—	−0.11‡	−0.20 to −0.02
Type of residence						
Urban formal (ref.)	54.7	ref.	0.00		0.00	
Urban informal	12.7	−0.017	0.00	−0.14 to 0.14	−0.10	−0.23 to 0.02
Tribal	21.2	−0.106*	−0.07	−0.22 to 0.07	0.07	−0.04 to 0.20
Rural formal	11.4	−0.075*	0.03	−0.15 to 0.22	0.04	−0.10 to 0.19
Racial group						
African (ref.)	62.5	ref.	0.00		1.00	
White	9.5	−0.323*	0.76*	0.58 to 0.94	0.93*	0.62 to 1.23
Colored	19.9	−0.127*	0.19†	0.05 to 0.32	0.57*	0.41 to 0.72
Indian	8.1	−0.116*	0.64*	0.46 to 0.82	1.20*	0.82 to 1.57
Province						
Western Cape (ref.)	14.5	ref.	0.00		0.00	
Eastern Cape	12.9	0.029	−0.10	−0.27 to 0.06	−0.14	−0.37 to 0.09

(continued on next page)

TABLE 1. (Continued) Results of the Linear Regression for HIV Communication Program Awareness and Multivariate Probit Regression for HIV-Negative Status in South Africa in 2005

Variables	Linear Regression		Multivariate Probit Regression			
	Descriptive Statistics	HIV Communication Awareness	Condom Use at Sexual Debut		HIV-Negative Status	
		Weighted Mean or % (Range)	Standardized Beta Coefficient	Probit Coefficient	95% CI	Probit Coefficient
Northern Cape	05.9	-0.011	0.01	-0.18 to 0.20	-0.19	-0.47 to 0.10
Free State	7.1	-0.006	0.19‡	0.01 to 0.37	-0.51*	-0.74 to -0.27
Kwazulu-Natal	17.4	-0.006	-0.06	-0.24 to 0.11	-0.67*	-0.89 to -0.45
Northwest	07.4	0.015	0.21‡	0.02 to 0.40	-0.29‡	-0.54 to -0.04
Gauteng	17.1	0.005	0.11	-0.04 to 0.27	-0.42*	-0.63 to -0.21
Mpumalanga	8.0	0.003	0.18	-0.03 to 0.39	-0.62*	-0.85 to -0.39
Limpopo	9.8	-0.020	0.05	-0.15 to 0.26	-0.10	-0.35 to 0.15
No. cases§	6829	6829	6829		6829	
Adj. var. explained (R ²)		0.41				
Pseudo-R ²			0.20		0.18	
Goodness of fit						
LR χ^2 ¶			0.82		5.13	
Probability			<i>P</i> > 0.662		<i>P</i> > 0.077	
Exclusion tests						
LR χ^2		6.65 (7)	13.22 (9)		13.75 (9)	
Probability		<i>P</i> > 0.466	<i>P</i> > 0.153		<i>P</i> > 0.132	
Correlation of residuals (rho) for condom use at sexual debut and HIV-negative status						
Rho			-0.048			
χ^2			1.06 (1)			
Probability			<i>P</i> > 0.30			

Emdash indicates exclusion of nonsignificant variables excluded for model identification.

**P* < 0.001, using STATA's svy survey commands to adjust for cluster sampling and provincial stratification and to adjust for cluster sampling in the multivariate probit analysis.

†*P* < 0.01, using STATA's svy survey commands to adjust for cluster sampling and provincial stratification and to adjust for cluster sampling in the multivariate probit analysis.

‡*P* < 0.05, using STATA's svy survey commands to adjust for cluster sampling and provincial stratification and to adjust for cluster sampling in the multivariate probit analysis.

§Sample of respondents who have had sexual intercourse in the past 12 months (sexually active) and who were tested for HIV during the survey.

||Stukel likelihood ratio, goodness-of-fit test. A nonsignificant result indicates that there is no statistically significant difference between the regression model and the data.

¶Likelihood ratio test of no statistically significant difference with variables excluded from the model.

sexual debut, starting at 41.4% for the lowest level of awareness and increasing to 51.4% for the highest level. For the total sample, this response increases from 18.4% to 24.6%. It is lowest for ages 25–43 years, increasing from 13.0% to 17.9%, which is not statistically significant.

HIV-Negative Status

The impact of condom use at sexual debut on maintaining one's negative HIV status is positive and statistically significant (0.25; 95% CI: 0.06 to 0.44). Negative status is also significantly more likely among those who say they are not at risk for infection because they are faithful and/or trust their sexual partner, among those with tertiary or higher education, students and pensioners, and white, colored, and Indians compared with blacks. HIV-negative status is significantly less likely among those who ever used

injectable drugs, females, singles, the 2 youngest age groups, and those living in communities (clusters) with a higher rate of HIV prevalence. Condom use at last sex is not statistically significant.

Propensity Score Matching

Model 2 from the SEM is used for the propensity score analysis with 2 nonconfounding variables excluded, predicted communication awareness, and age at sexual debut. The propensity score (probability) ranges from 0.016 to 0.907 for the region of common support (overlap) of treated and untreated; 12 cases were excluded because of lack of common support. The analysis resulted in 9 strata (blocks) along this probability continuum that are balanced with the exception of 1 variable, secondary education, in the second strata (N = 837) with *P* = 0.001. In the remaining 8 strata,

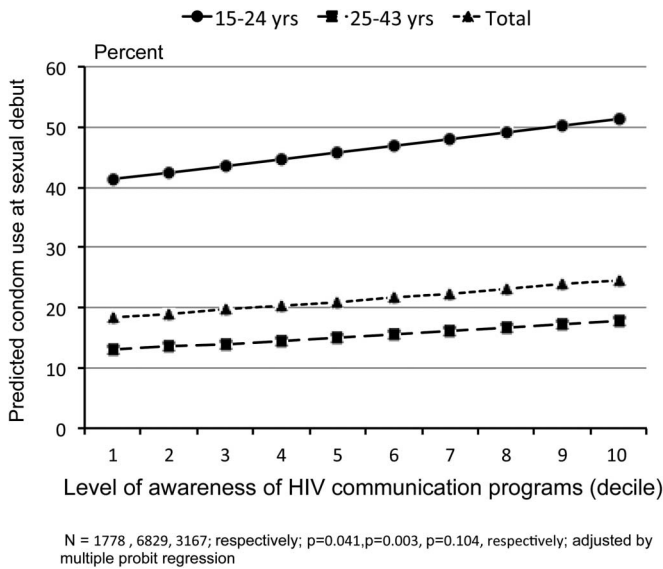


FIGURE 2. Level of condom use at sexual debut by level of predicted awareness of 8 HIV prevention communication programs.

there are no statistically significant differences between the treated and untreated cases for any of 7 variables used to calculate the propensity score, mimicking random assignment on these variables.

Stratified matching over 8 balanced strata yielded an average treatment effect on the treated (ATT) of 0.034 (bootstrap, analytical standard error (SE) = 0.011; 95% CI: 0.01 to 0.06).

ATT estimated with nearest neighbor matching was similar, 0.036. As a percentage of all those who used condoms at sexual debut who remained HIV negative, a difference in HIV-negative status of 4.0% (3.4/85.8) may seem small, but as a percentage of those who were infected, 23.9% (3.4/14.2), the difference is substantial. It reflects a 24% lower rate of HIV-positive status for those who used condoms at sexual debut.

Among the population of 18,922,667 (frequency weighted) sexually active adults in South Africa to whom these results apply, 20.5% (3,884,302) reported using condoms the first time they had sex. The PSM estimate means that 3.4% would have become HIV positive if they had not used condoms. This amounts to an estimated 132,066 HIV infections that were averted ($0.034 \times 3,884,302$) because of condom use at sexual debut.

Results from the sensitivity analysis (data not shown) of this PSM imply that the estimate is robust to potential violations in the assumption of strong ignorability (conditional independence).²⁸ A simulated omitted variable similar in magnitude to that of single marital status when added to the PSM reveals that the causal effect of condom use at sexual debut on HIV-negative status would still be large and significant. An omitted variable capable of nullifying the estimated causal effect would have to be able to double the odds of condom use at sexual debut and increase the odds of HIV-negative status almost 8-fold. It is reasonable to assume that variables of such magnitude are rare; hence, the estimate from

PSM with the 7 measured variables is not likely to be threatened by potential missing variables.

DISCUSSION

The aggregate and individual levels of analyses indicate that HIV communication programs have made important contributions to the national AIDS response since 1995. The SEM results support the hypothesis that communication has an indirect effect on HIV infection by inducing condom use at sexual debut. SEM and PSM support the hypothesis that using a condom at sexual debut increases the likelihood of maintaining one’s HIV-negative status.

Some who used condoms at sexual debut were not protected over time. Follow-up regression analysis on just the subsample that used condoms at sexual debut (N = 1480) revealed that those who used a condom the last time they had sex were 0.61 less likely to have become infected. Those who were subsequently infected were 2.2 times more likely to be women than men, 6.5 times more likely to be 25–43 years old, 2.5 times more likely to be from a sampling cluster with HIV infection, 3.7 times more likely to be living in KwaZulu Natal province, and 1.8 times more likely to say they did not “trust a partner as a reason for feeling at risk” for infection.

The principal limitation of this kind of study is that we cannot be sure that characteristics of those who are aware of HIV communication programs and who used condoms at sexual debut might not be systematically different from the characteristics of others, such that the observed associations with condom use and HIV-negative status, respectively, are not causal but instead reflect unmeasured behavioral and other confounding variables.

The statistical methods used in this analysis, however, were designed to test and minimize this threat. PSM helps by constructing a statistically equivalent control group for condom use at sexual debut, but its effectiveness depends on variables explicitly included in the analysis; omitted variables may still be a threat. If the regression models fit the data well, SEM can increase confidence that the PSM assumption of strong ignorability—no difference between treated and untreated in ways that would affect the outcome—has been satisfied, but it cannot completely rule out this threat. It, too, is only as effective as the variables that are included in the regressions. Multivariate probit regression provides tests for this possibility statistically, but even nonsignificant relationships might still bias the results. The PSM simulation of potential missing variables offers some support that this would be unlikely: The effect size has to be relatively high for omitted variables to bias the observed results, and they would also have to be independent of the measured variables.

The self-reporting of data is another limitation of this study. HIV status is based on a laboratory test. Memory of one’s first sexual experience is expected to be good, but social desirability may bias the report of condom use. The consistency of this measure across 3 surveys (Fig. 1) indicates a high degree of reliability in terms of stability over time. The reliability of all the remaining variables remains unknown, but the fact that their relationships with the 3

dependent variables are consistent with theory and results from other surveys implies a minimally acceptable level of reliability and validity.

CONCLUSIONS

The study has found evidence that 3 HIV prevention methods offered some protection in the population by 2005, especially condom use at sexual debut, which increased dramatically among youth during the previous 10 years. Further analysis revealed condom use at last sex adds to that initial protection. The multivariate nature of the study sheds light on many other factors that contribute to, or hinder, disease prevention—information that may help improve prevention programs. To maintain and increase the protective effect of condom use at sexual debut, prevention programs should place emphasis on condom use at sexual debut and on consistent and correct use thereafter, noting that it has become the social norm for South Africa.

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