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Demographic and health surveys indicate limited impact of condoms and HIV testing in four African countries

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Condom promotion and HIV testing for the general population have been major components of HIV prevention efforts in sub-Saharan Africa's high prevalence HIV epidemics, although little evidence documents their public health impact. Recent enhancements to the large, population-based demographic and health surveys (DHS) and AIDS information surveys (AIS) allow use of these data to assess the population-wide impact of these strategies. We analysed the latest DHS and AIS data from four sub-Saharan African countries with high prevalence, heterosexually transmitted HIV epidemics (Côte d'Ivoire, Swaziland, Tanzania and Zambia; $N = 48\,298$) to answer two questions: 1) Are men and women who use condoms less likely to be HIV-infected than those who do not?; and 2) Are men and women who report knowing their HIV status more likely to use condoms than those who do not? Consistent condom use was associated with lower HIV infection rates for Swazi men but with higher HIV infection rates for women in Tanzania and Zambia; it made no significant difference in the other five sex/country subgroups analysed. Inconsistent condom use was not significantly associated with HIV status in any subgroup. Knowing one's HIV status was consistently associated with higher rates of condom use only among married people who were HIV-positive, even though condom use in this group remained relatively low. Effects of knowing one's HIV status among other subgroups varied. These results suggest that condoms have had little population-wide impact for HIV/AIDS prevention in these four countries. HIV testing appears to be associated with increased condom use mainly among people in stable partnerships who test positive. HIV testing and condom promotion may be more effective when targeted to specific groups where there is evidence of benefit rather than to general populations.

Keywords: AIDS, Côte d'Ivoire, prevention, public health, sub-Saharan Africa, Swaziland, Tanzania, Zambia

Introduction

HIV/AIDS has been a public health disaster in sub-Saharan Africa, reducing life expectancy in some countries by 20 years or more, wiping out the hard-fought gains of decades (UNAIDS 2006). This region, with 12% of the global population, continues to account for 70% of new HIV infections (UNAIDS 2011). Despite unprecedented efforts to make antiretroviral treatment available in the region, there is still no cure and most people with HIV infection still go untreated. Prevention of HIV infection is thus crucial, especially preventing heterosexual transmission in countries where this accounts for most infections. The mainstays of prevention for over 20 years have been condom promotion and HIV testing, receiving up to 39% and 28% of HIV prevention budgets respectively in some

African countries (Uganda AIDS Commission 2007, National AIDS Commission and Government of Lesotho 2011).

Many studies have measured the efficacy of condoms and HIV testing in research settings. Consistent condom use (CCU) is 80–90% efficacious in preventing HIV transmission within known discordant couples (Weller and Davis 2002), although estimates of condom effectiveness in Africa have been lower (Ahmed et al. 2001, Allen et al. 2003). One cohort study of condom effectiveness in a Ugandan population found that while consistent condom use conferred a 63% reduction in risk of HIV infection, inconsistent condom use did not result in a lower of risk of HIV infection (Ahmed et al. 2001).

HIV testing is essential for treatment of HIV disease and for prevention of mother-to-child transmission and could

potentially guide prophylactic use of antiretroviral drugs (Cohen et al. 2011). HIV testing may be offered in a variety of settings, including door-to-door, hospital-based, and through stand-alone services, and the intensity and quality of the counselling associated with various testing modalities varies widely. Testing is often assumed to have a prevention benefit insofar as knowing one's status might have an impact on sexual behaviour (Menziés et al. 2009, Sweat et al. 2011), but evidence for this effect is mixed. Testing accompanied by intensive and high-quality counselling, as offered in a clinical trial, has resulted in higher self-reported condom use in general populations (Coates and The Voluntary HIV-1 Counseling and Testing Efficacy Study Group 2000) and within discordant couples (Allen et al. 1992, Allen et al. 2003). However, other studies that may represent a more typical experience of testing and counselling have found that testing had no impact on behaviour (Matovu et al. 2005) or even that a negative test result — usually more common than a positive result — led to riskier behaviour (Corbett and The Voluntary HIV-1 Counseling and Testing Efficacy Study Group 2007, Sherr et al. 2007). Even in clinical trials, improvements in self-reported condom use have not always been accompanied by expected changes in biological markers of infection (Coates et al. 2000). A meta-analysis of HIV testing and counselling for HIV prevention in developing countries concluded that evidence for counselling and testing as a prevention strategy was limited and that testing and counselling did not have a significant effect on number of sexual partners (Denison et al. 2008).

Measuring the public health effectiveness of condom promotion and HIV testing in practice has proven challenging and controversial. Modelling exercises that begin with the assumption that condoms are effective can produce estimates of large numbers of infections averted by condoms (Johnson et al. 2012). But unlike in epidemics driven by commercial sex or sex between men, there is little evidence that condom promotion has had a measurable impact on the generalised HIV epidemics of Africa (Hearst and Chen 2004, Potts et al. 2008). No studies have measured the overall public health impact of HIV testing in Africa.

Large, population-based national sero-behavioural surveys present one of the best opportunities to examine the public health impact of condoms and testing. However, until the mid-2000s these surveys lacked necessary variables for such analysis, including consistency of condom use, knowledge of HIV status, and blood collection for HIV testing. The demographic and health surveys (DHS) and the similar AIDS information surveys (AIS) conducted throughout Africa now include HIV sero-testing in many countries. In the past, these surveys asked only about condom use at last sex, but they now include additional questions that allow assessment of CCU. They now also ask respondents if they know their HIV status. Thus, for the first time, recent DHS/AIS data can assess two important questions: 1) Are people who report CCU less likely to be HIV-infected?; and 2) Are people who have been tested for HIV more likely to report CCU? We conducted such an analysis using data from four sub-Saharan African countries (Côte d'Ivoire, Swaziland, Tanzania and Zambia).

Methods

DHS are large, national, door-to-door surveys that are conducted roughly every five years in most African countries. DHS uses standardised multistage cluster sampling with interviewer-administered questionnaires, in some cases accompanied by blood collection, of a representative sample of the adult population, generally covering ages 15-49. While originally intended to collect family planning data, DHS has been expanded in recent years with additional measures relevant to HIV/AIDS. The DHS methodology has been described in detail elsewhere (Rutstein and Rojas 2006).

We analysed DHS and other national survey data available at www.measuredhs.com. We selected the four sub-Saharan African countries with the highest prevalence of HIV infection for which available DHS or other national survey data included all of the variables necessary for our analysis at the time we began this study. Swaziland and Zambia conducted DHS in 2006–2007 (CSO and Macro-International Inc. 2008) and 2007 (CSO, Ministry of Health, TDR, University of Zambia, Macro International Inc. 2009) respectively. Côte d'Ivoire's 2005 AIDS Information Survey (*Enquête sur les Indicateurs du Sida*) and Tanzania's 2007–2008 HIV/AIDS and Malaria Indicator Survey (THMIS) used similar methodology to DHS. While these last two surveys did not include many of the domains covered by DHS, questions related to HIV were generally the same. All three types of surveys are conducted under the MEASURE DHS project, and for simplicity, we refer to all surveys used in this study collectively as DHS.

Data were analysed using Stata version 11 (StataCorp 2009). The *p*-values were calculated using weighted variances based on the sampling structure provided with the data. To avoid confounding and because the sampling design did not allow for meaningful combination of sex-country strata, all data were analysed separately by sex and country. The total sample was 48 298, although the sample for each analysis was smaller due to exclusions and missing data. For all analyses, we included only individuals who reported having sex in the past year.

The first analysis examined the association of condom use and HIV status. It excluded all respondents who reported knowing their HIV status to avoid potential effect-cause bias due to knowledge of sero-status affecting subsequent condom use. Consistent condom users were those who reported always using condoms with up to three partners in the past year. This included answering affirmatively a separate question on condom use at last sex. If a respondent replied that he or she did not use a condom at last sex with a partner, no further questions about condom use with that partner were asked. Non-users of condoms gave no indication of condom use in the past year in response to any question. All others were classified as inconsistent condom users. HIV status was based on blood samples collected as part of the DHS survey protocol, and individuals for whom HIV status was not available were not included in the analysis.

Using non-users of condoms as the index category, *p*-values for difference in proportion were calculated for prevalence of HIV infection in the consistent users and

inconsistent users categories in each of the eight sex–country strata. We also performed a multiple logistic regression in each sex–country stratum with condom use as the predictor variable and HIV-positivity as the outcome variable, adjusting for age by five-year group, wealth quintile, urban vs. rural residence, and whether respondents reported more than 1 sexual partner in the past 12 months. Results of the multivariate analyses were similar to those of the unadjusted analysis. Except for a brief narrative description of the multivariate results, we present only the unadjusted results for simplicity.

The second analysis examined the association of knowing one's HIV status and CCU. Respondents were divided into three categories by knowledge of HIV status. Those who reported not knowing their HIV status were used as the index category for all comparisons. Those who reported having been tested and receiving the result were classified as 'known positive' or 'known negative' based on their actual HIV test result in the DHS sero-survey. The questionnaire portion of DHS did not ask respondents to reveal their HIV status, so it was impossible to ascertain if respondents who said they knew their status did so correctly at the time of the survey. Respondents who reported being currently married or living with a steady sexual partner were both classified as 'married'. All others were classified as 'unmarried'. Analyses of the association between knowledge of HIV status and CCU were conducted separately in each of the 16 strata formed by sex, country and marital status.

Results

Characteristics of respondents

While all four of these countries have heterosexually transmitted HIV epidemics, prevalence varied substantially (Table 1). Prevalence was less than 10% in Côte d'Ivoire and Tanzania, higher in Zambia, and highest in Swaziland, where it reached 31.4% among women. As is common in generalised epidemics, HIV prevalence was higher among women than men in all four countries. Consistent condom use was higher among men than women in all countries and was substantially higher in Swaziland than in the other three countries, reaching a maximum of 34.5% among Swazi men.

More women than men reported knowing their HIV status in all four countries, likely reflecting antenatal testing. Men and women in Côte d'Ivoire were less likely to know their status than in the other three countries, which had similar testing rates. In all countries, more women than men classified themselves as married or cohabiting. Marriage rates were substantially lower in Swaziland than in the other three countries: 30.9% for men and 41.5% for women.

Condom use and HIV status

We found no convincing evidence that condom users were less likely to be HIV-infected than people who reported not using condoms (Table 2). HIV prevalence was higher among inconsistent condom users than among non-users of condoms in six of the eight sex–country strata and lower in two, although none of these differences reached statistical significance at $p < 0.05$.

Table 1. Selected characteristics of respondents

	HIV prevalence (%)	Consistent condom use (%)	Knows HIV status (%)	Married or cohabiting (%)
Swaziland, men ($n = 4\ 156$)	19.5	34.5	15.2	30.8
Swaziland, women ($n = 4\ 987$)	31.4	23.6	34.1	41.5
Zambia, men ($n = 6\ 005$)	12.6	13.4	17.4	53.1
Zambia, women ($n = 7\ 146$)	16.6	8.5	32.0	60.4
Côte d'Ivoire, men ($n = 4\ 503$)	2.4	17.0	4.7	46.5
Côte d'Ivoire, women ($n = 5\ 183$)	5.6	6.5	6.0	61.6
Tanzania, men ($n = 6\ 975$)	3.1	12.7	23.8	51.1
Tanzania, women ($n = 9\ 343$)	4.7	7.0	33.0	62.2

Sources: Côte d'Ivoire 2005 AIS; Swaziland 2006/7 DHS; Tanzania 2007/8 THMIS; Zambia 2007 DHS. Numbers are unweighted counts among the respondents analysed in this study and therefore do not match weighted national estimates. The sample size in the left-hand column is for total sample; denominators for percentages vary due to exclusions and missing values

Table 2. HIV prevalence among non-users of condoms, inconsistent condom users, and consistent condom users

	HIV prevalence among non users of condoms (index category)	HIV prevalence among inconsistent condom users	HIV prevalence among consistent condom users
Swaziland, men	30.3% (234/772)	30.4% (84/275)	20.0% (104/521)*
Swaziland, women	32.3% (381/1178)	40.3% (93/229)	37.5% (139/372)
Zambia, men	12.7% (245/1933)	15.0% (48/323)	10.8% (33/302)
Zambia, women	14.1% (320/2269)	11.6% (10/88)	22.0% (36/162)*
Côte d'Ivoire, men	2.4% (38/1596)	0.7% (2/302)	2.5% (11/452)
Côte d'Ivoire, women	6.4% (147/2293)	6.7% (12/185)	2.8% (5/197)
Tanzania, men	5.4% (128/2362)	6.4% (13/202)	4.7% (18/395)
Tanzania, women	6.6% (212/3221)	7.7% (7/89)	12.4% (34/278)*

* $p < 0.05$ compared to non-users users. Sources: Côte d'Ivoire 2005 AIS; Swaziland 2006/7 DHS; Tanzania 2007/8 THMIS; Zambia 2007 DHS. Numbers weighted and p -values computed based on complex survey design

Table 3. Consistent condom usage (CCU) among those who did and those who did not know their HIV status

	Among those who did not know HIV status, per cent reporting CCU		Among those who knew status and were HIV+, per cent reporting CCU		Among those who knew status and were HIV-, per cent reporting CCU	
Swaziland, married men	15.4%	(102/666)	43.2%	(49/113)*	13.3%	(24/177)
Swaziland, unmarried men	46.7%	(422/903)	48.9%	(30/61)	54.9%	(63/115)
Swaziland, married women	10.1%	(102/1009)	25.3%	(67/263)*	13.0%	(66/509)
Swaziland, unmarried women	35.7%	(273/766)	41.5%	(99/238)	29.0%	(94/324)
Zambia, married men	4.4%	(80/1809)	16.8%	(20/122)*	8.3%	(34/408)*
Zambia, unmarried men	29.8%	(229/769)	20.3%	(5/23)	33.7%	(63/188)
Zambia, married women	2.8%	(56/2044)	14.9%	(34/227)*	3.3%	(37/1101)
Zambia, unmarried women	22.1%	(107/484)	34.5%	(30/86)*	25.6%	(59/231)
Côte d'Ivoire, married men	4.8%	(60/1252)	0.0%	(0/9)	2.5%	(2/99)
Côte d'Ivoire, unmarried men	36.1%	(435/1203)	100.0%	(15/15)	45.3%	(47/104)
Côte d'Ivoire, married women	1.0%	(18/1843)	11.5%	(1/12)*	2.5%	(7/290)
Côte d'Ivoire, unmarried women	20.1%	(201/998)	56.4%	(9/16)*	38.7%	(28/72)*
Tanzania, married men	3.2%	(67/2086)	17.1%	(12/68)*	6.2%	(55/886)*
Tanzania, unmarried men	37.3%	(339/908)	29.0%	(3/11)	53.9%	(164/303)*
Tanzania, married women	2.1%	(61/2906)	10.7%	(15/143)*	2.9%	(60/2039)
Tanzania, unmarried women	30.1%	(222/738)	34.1%	(20/59)	34.9%	(171/491)

* $p < 0.05$ for CCU among those who knew their HIV status compared to those who did not know their HIV status

Sources: Côte d'Ivoire 2005 AIS; Swaziland 2006/7 DHS; Tanzania 2007/8 THMIS; Zambia 2007 DHS

Numbers weighted and p -values computed based on complex survey design

For consistent condom use, results varied by sex–country group. Swazi men who reported consistent condom use were significantly less likely to be HIV-positive than those reporting no condom use (20% vs. 30%, $p < 0.05$). However, women in both Tanzania and Zambia were significantly more likely to be HIV-positive if they reported consistent condom use than if they reported no condom use.

The results from the multivariate analysis produced similar results to the unadjusted analysis (data available on request). Inconsistent condom use was not significantly associated with HIV infection in any group. The apparent protective effect of consistent condom use among Swazi men disappeared after adjustment for age because younger men were both less likely to be infected and more likely to use condoms. In the multivariate analysis, consistent condom use was associated with significantly higher HIV prevalence for women in Côte d'Ivoire and in Tanzania and was not associated with significantly lower HIV prevalence in any sex–country group.

Knowing HIV status and CCU

In all 24 strata of sex, country, and knowledge of HIV status, CCU was more common among unmarried people than among married people (Table 3). Married men and women who knew they were HIV-positive were significantly more likely to report CCU than married individuals who did not know their HIV status, except among men in Côte d'Ivoire, for whom numbers were small. Nevertheless, these higher rates of CCU never rose to the levels reported by unmarried men and women.

For people who were unmarried or who tested HIV-negative, the association between knowing HIV status and CCU was mixed. Among those who were unmarried and knew they were HIV-positive, CCU was significantly higher (compared to those who did not know their HIV status) only among women in Zambia and Côte d'Ivoire. CCU was significantly higher among married men who

knew they were HIV-negative in Tanzania and Zambia, but not among married women in any country. Among unmarried people who knew they were HIV-negative, CCU was significantly higher only among men in Tanzania and women in Côte d'Ivoire.

Discussion

The main finding from this analysis of large, population-based surveys in four sub-Saharan African countries with heterosexually transmitted, high prevalence HIV epidemics is the lack of any clear association between condom use and HIV infection. In fact, women in Tanzania and Zambia who reported consistent condom use were significantly more likely to be HIV-infected than women who did not report using condoms, the opposite of the expected association. The analysis excluded people who knew their HIV status, so these results were not confounded by behaviour that resulted from knowing one's status. These findings are disappointing and, at first glance, may seem difficult to reconcile with the proven efficacy of condoms in research studies. But there are several possible explanations.

First, condom use in DHS is based on self report, which may not always be accurate. While there is little incentive for respondents to underreport condom use, there may be a social desirability bias leading to over-reporting of condom use in countries where condoms have been heavily promoted for many years. Large national surveys like DHS have been criticised for underreporting of multiple sexual partnerships, especially for women (Kajubi et al. 2011). Respondents might similarly over-report desirable sexual behaviours such as condom use. Studies using biological markers have shown that claims of consistent condom use in interviews are often inaccurate (Minnis et al. 2009).

A related explanation is that these are cross-sectional results. DHS questions about condoms covered only the past 12 months, while positive HIV sero-status

could represent a much earlier infection. A respondent correctly reporting consistent condom use now may have been infected earlier when not using condoms. Risk of infection also varies over time according to stage of the epidemic. All four countries in this review have mature, high-prevalence, generalised epidemics, characterised by an initial spike in HIV prevalence followed by moderate declines in prevalence in the context of continued substantial incidence. In Swaziland HIV prevalence is estimated to have peaked in 2004 (National Emergency Response Council on HIV/AIDS, Swaziland et al. 2009) before declining to the 2007 level of 26% among adults aged 15–49. In Zambia it is estimated that adult HIV prevalence peaked in the mid-1990s at approximately 16% before stabilising at around 14% (Zambia National HIV/AIDS/STI/TB Council et al. 2009). Tanzania noted a decrease in adult HIV prevalence from 7% to 6% between the first national survey to measure population-based HIV prevalence, in 2003–2004, and the 2007–2008 THMIS (TACAIDS et al. 2008). In Côte d'Ivoire adult HIV prevalence reached an estimated 10% in 1997 before declining to the 5% prevalence measured by the 2005 AIS (INS et al. 2006).

Another possible explanation is that people who use condoms may engage in riskier sexual behaviour, such as multiple and concurrent partnerships, thus offsetting the protective effect of condoms. This might be the most likely explanation for our unexpected finding that women in Tanzania and Zambia who reported consistent condom use were significantly more likely to be HIV-infected than women who did not report using condoms. Other than this, we found little evidence based on the information available that condom users were engaging in behaviours risky enough to negate a strong protective effect of condoms. DHS questions certainly do not capture all aspects of sexual risk, but adjustment for measured covariates (including multiple sexual partners) did not substantially change our results. If condom use is 80–90% effective, there would need to be unmeasured confounders that were both very strong risk factors for HIV infection and highly associated with condom use to obscure such a protective effect.

While all of these phenomena are undoubtedly operating to some extent, they do not change the main finding of this study. Public health impact of condoms may be understood as a rough product of the benefit achieved from long-term CCU multiplied by the proportion of people practising CCU long enough to achieve this benefit. If self-reported CCU in the past year is indicative of long-term CCU, these data indicate little or no protective effect from condoms. If, however, actual CCU has a strong protective effect, this would suggest that most people who report CCU are either not reporting accurately or have not been using condoms long enough to obtain benefits. This argument might be characterised as: 'Condoms work, but one can't see the benefit because almost no one is using condoms long enough and consistently enough to make a difference.' While this might be the case, it would not change the unfortunate conclusion of little or no measureable public health impact from condoms use after years of intensive promotion.

These results provide some evidence that HIV testing can encourage consistent condom use, especially for HIV-infected married people. In this analysis, HIV-positive

married men were more likely to report CCU than HIV-positive married women, suggesting that women may be less able to insist on condom use (even to avoid infecting a spouse) but also that HIV-infected married men are not indifferent to infecting their wives. Unfortunately, most married people continue to have unprotected sex, even when they know that they are HIV-positive. For unmarried people, the effect on CCU of knowing HIV status was inconsistent, although unmarried people reported more CCU than married people in all population strata regardless of whether they knew their status. The fact that married people who knew they were HIV-infected were consistently more likely than those who did not know their status to report CCU, whereas this was not true for unmarried people, raises the question of why married people seem to be more likely than the unmarried to adopt CCU in the presence of HIV infection. Whether the higher condom use observed among some people who know their HIV status represents a good return on the resources invested in HIV testing is a matter of interpretation.

Another important question for deciding if testing is worth the cost is whether the reported higher rates of CCU among those who have been tested (seen mainly among HIV-positive married people) actually prevent HIV infections. This cannot be taken for granted given the other results of this study. Since the best evidence for condom efficacy comes from studies of HIV discordant couples, it seems reasonable to expect some benefit for such couples. But HIV testing in Africa is not usually accompanied by the consistently high quality of counselling, support, ready access to condoms, and follow-up provided to discordant couples in research studies. So condom effectiveness in typical use, even in known discordant couples, may not match efficacy in research settings.

The greatest strengths of DHS data are large sample size and national representativeness. But analysis of general population surveys is a blunt instrument. Results do not necessarily apply to population subgroups not identified in DHS or not included in sufficient numbers to allow for separate analysis. Even if condoms provide little public health benefit overall, this does not mean they are not protective for some individuals and settings, such as in commercial sex or for individuals who use condoms correctly and consistently over the long term and who otherwise would be unable to avoid high risk for HIV infection.

DHS data are limited in the information they provide on behavioural variables, including condom and testing behaviours. Although our multivariate model included demographic variables as well as a measure of sexual risk behaviour (two or more sexual partners in past year), far more detailed data would be needed to adjust comparisons between condom users and non-users fully for other aspects of HIV risk. These data include numbers and types of partners before the past year, circumcision status for men, circumcision status of partner(s) for women, history of sexually transmitted infections and genital sores, and other high risk behaviour including commercial sex, sex between men, and injected drug use. Condom use data were also limited. As noted, if the respondent did not report using a condom at last sex, no further data about condom use in the last year was provided, and such a respondent

was classified as a non-user of condoms in this analysis. Unfortunately, research on condom use often does not extend beyond asking about condom use at last sex. Future research must therefore strive to more adequately explore consistency of condom use over time and in various contexts and relationships.

Similarly, DHS surveys ask respondents if they know their HIV status but do not collect any information on when the respondent was tested, the context or method of such testing, or the intensity or quality of counselling involved. This analysis therefore could not examine the impact of different types of testing and counselling on behaviour. In addition, this analysis could not differentiate people who had tested negative and accurately knew their status at the time of the DHS survey from those who had sero-converted in the interim. These recent sero-converters were considered to know their status and to be HIV-positive in our analysis, although they believed themselves to be negative. Such misclassification, however, is unlikely to have affected our results substantially.

Conclusions

These findings support a more targeted approach to condom promotion and HIV counselling and testing in high-prevalence, generalised epidemics, especially considering the huge sums of money directed at these interventions in current prevention budgets. These results should not be used to argue against making condoms available or against promoting condoms where there is evidence that they may be especially impactful, such as in commercial sex, for men who have sex with men, or in other known settings of high sexual risk. However, these results do provide additional evidence for the growing consensus that widespread condom promotion in generalised heterosexual epidemics should not be a high priority for prevention resources, and that condom promotion should be targeted and emphasise the importance of consistent use (Halperin et al. 2004, Potts et al. 2008, Hearst et al. 2012).

HIV testing programmes might be made more efficient by focusing on couples testing and on providing intensive interventions for couples identified as discordant to protect the uninfected partner. This likely would be a much more effective use of resources than the common current practice of widespread testing with weak or unstandardised counselling, limited follow-up, and poor linkage to other services (PlusNews 2010). Encouraging couples to get tested together would also reinforce an important prevention message that should be emphasised whenever possible: that sex in the context of a generalised HIV epidemic is risky and safer in a stable and exclusive relationship. Couples that test negative should be encouraged to have open discussions about how to stay uninfected, beyond facile and often ineffective advice to use condoms. Testing with a focus on identifying discordant couples could also lay the groundwork for treatment as prevention, when and if sufficient treatment slots become available to treat people who are HIV-positive before they develop advanced immune-suppression (WHO 2012).

Despite their imperfections, DHS and AIS provide the best data available for the general population in many

African countries. These data should be fully exploited, along with efforts to collect more and better data in the future. In particular, additional data on the timing and context of HIV testing and on the associated counselling received would be welcome. More detailed data on condom use and on other aspects of HIV risk would allow better assessment of the effect of condoms. DHS questionnaires address many issues and have become increasingly long and unwieldy over the years, so it may be unreasonable to expect much more from them in this regard. But for AIS and other surveys that focus specifically on HIV/AIDS, this deserves priority. Collecting and analysing such information can and should contribute to evidence-based policy and resource allocation decisions.

In summary, this analysis of very large data sets from four African countries with generalised HIV epidemics does not provide convincing evidence to reject the null hypothesis of no public health impact from condoms and suggests that HIV testing changes behaviour modestly and mainly among married people who test HIV-positive. This adds to the growing evidence that condom promotion and HIV testing should not be the mainstays of prevention efforts in generalised epidemics. HIV testing and condom programmes should be carefully targeted, planned, and monitored to maximise their impact instead of being part of a universal basket of services promoted for everyone regardless of cost or proven efficacy.

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