Knowledge of blood-borne transmission risk inversely associated with HIV infection in sub-Saharan Africa

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Running title: Knowledge of blood-borne HIV transmission risk

Summary

Background: Accurate and comprehensive knowledge of an infectious pathogen's modes of transmission helps people to avoid infection. Growing evidence suggests that blood-borne HIV transmission is widespread in sub-Saharan Africa.

Methodology: I examined the association between knowledge of blood-borne HIV risk and prevalent HIV infection in Demographic and Health Survey data from 16 sub-Saharan African countries. I also searched three on-line databases for evidence of public education campaigns focused on blood-borne HIV risks in these countries.

Results: Knowledge was moderately to strongly inversely related to HIV prevalence at the national level (i.e., countries in which many respondents were aware of blood-borne risk had lower HIV prevalence than countries in which few respondents were aware of such risk). At the individual level, respondents who knew about blood-borne HIV risk were modestly less likely to be infected than those who did not show awareness of this risk, independent of demographic and sexual behavior variables. This relationship was stronger in southern Africa than in west, central, and east Africa. In parallel analyses, knowledge of condom use as a way to prevent HIV was positively associated with prevalent HIV infection at both the national and individual levels. West, central, and east African countries with low to moderate HIV prevalence had implemented public education campaigns that included a focus on blood-borne transmission risks. Such campaigns were absent from high prevalence countries in southern Africa.

Conclusions: These findings suggest that knowledge of blood-borne HIV risk protects against HIV infection and that public education campaigns are important for spreading that knowledge.

Keywords: HIV, public education, iatrogenic disease, blood-borne infection

Introduction

Public education is an essential component of nearly every disease prevention effort. For an infectious disease, individuals with accurate and comprehensive knowledge of the modes of transmission can best protect themselves and others from infection. Persons armed with knowledge of all transmission routes and corresponding practical prevention strategies should, on average, become infected at rates lower than persons lacking such knowledge, if knowledge translates into increased adoption of prevention strategies.

Prior analyses of Demographic and Health Survey (DHS) data shed light on the link between knowledge of HIV transmission modes and HIV infection in Africa. The DHS are large, standardized, national probability sample household surveys of adults (typically persons between the ages of 15 and 49) in developing countries (http://www.measuredhs.com). In data from the 2003 Kenya DHS, knowledge of condom use as a way to prevent HIV was positively related to HIV prevalence at the provincial level [1]. Similarly, in the 2003 Ghana DHS, sexually active Ghanians who endorsed condoms as a way to prevent HIV were more likely to be HIV infected than those who did not endorse condoms [2]. Even after controlling for numerous demographic, HIV knowledge, attitude, and sexual behavior variables, endorsement of condom use was still positively associated with HIV infection.

A growing body of evidence suggests that blood-borne HIV transmission in healthcare, cosmetic care, and ritual settings is widespread in sub-Saharan Africa [3-10]. In related work, Mishra and colleagues [11] examined the association between knowledge of avoiding injections as way to prevent HIV and prevalent HIV infection in 10 DHS conducted in sub-Saharan Africa.

In 16 out of 20 samples (women and men analyzed separately), respondents aware of this prevention strategy were less likely to be infected than those who were unaware of this strategy. However, knowledge of avoiding injections may be a limited measure of awareness of blood-borne HIV risk because it does not specifically refer to avoidance of contact with blood contaminated sharp instruments. Another measure of knowledge of blood-borne risk in the DHS data focuses on avoiding blood transfusions. This measure, too, does not refer specifically to contamination, and in sub-Saharan Africa, affluent, educated urban individuals are probably much more likely than others to be aware of transfusion as a medical practice.

The DHS data include another measure of knowledge of blood-borne HIV risk that is focused on avoiding shared razors or blades. This measure refers to contamination more directly, and razor blades are routinely encountered by Africans for a variety of purposes, such as: shaving hair on the face and head; shaving pubic hair [12]; shaving nasal hair (cilia) [13]; male and female circumcision; incisions for administering traditional herbal remedies, protecting against evil spirits or curses, and bloodletting; scarification; cutting fingernails/toe nails; and traditional and Western surgery. Cases of probable HIV transmission through reuse of unsterilized razors have been documented [14-15]. Also, male and female circumcision were associated with prevalent HIV infection in Kenyan, Lesothoan, and Tanzanian adolescents and virgins [7]. In these countries, circumcision tends to be performed in adolescence or early adulthood in group settings, often with a reused, unsterilized razor or knife blade. Moreover, in a study of Nigerian adults, reuse of unsterilized razors was associated with incident HIV infection [8].

In this article, I report on the association between knowledge of avoiding shared razors and prevalent HIV infection in sub-Saharan Africa. For comparison, I describe parallel analyses of the association between knowledge of condom use and prevalent HIV infection. To elucidate international variation of knowledge of blood-borne HIV risks in sub-Saharan Africa, I also report on whether public HIV education campaigns in countries focused on such risks.

Materials and Methods

Demographic and Health Survey analyses

Data. Sixteen sub-Saharan African DHS data sets contained data on respondent HIV serostatus and knowledge of blood-borne HIV risks: Cameroon (2004) [16], Cote d'Ivoire (2005) [17], Democratic Republic of the Congo (DRC) (2007) [18], Ethiopia (2005) [19], Ghana (2003) [20], Guinea (2005) [21], Kenya (2003) [22], Lesotho (2004) [23], Malawi (2004) [24], Mali (2006) [25], Niger (2006) [26], Rwanda (2005) [27], Senegal (2005) [28], Swaziland (2006-2007) [29], Tanzania (2003-2004) [30], and Zimbabwe (2005-2006) [31]. In these surveys, household participation rates were high (women median = 98%, range = 98%-99.7%; men median = 98%, range = 95%-99.6%), and individual response rates were also high within participating households (women = 95%, range = 90%-98%; men median = 89%, range = 82%-97%). DHS staff obtained dried blood specimens from very large majorities of respondents (women median = 86%, range = 70%-97%; men = 77%, range = 63%-96%).

HIV serostatus was determined with an enzyme linked immunosorbent assay (ELISA) test and confirmed by a different ELISA test (and in some surveys, also by Western blot).

Specimens with discrepant ELISA results were confirmed by further ELISA/rapid tests, HIV serotype assays, and/or Western blot.

I included respondents in analysis if they reported never having tested previously for HIV and also reported awareness of AIDS. HIV counseling may, in some places, involve education about blood-borne and sexual risks, which may confound the relationship between knowledge and serostatus [32]. In the DHS, respondents who did not report awareness of AIDS were not asked about ways to prevent it. In two samples of women (Mali and Niger), 83% had heard of AIDS; in three other samples of women (DRC, Tanzania, and Zimbabwe), 91-99% had heard of AIDS; and in the 27 other samples of women and men, over 99% had heard of AIDS.

In the 16 DHS, respondents were asked "Is there anything a person can do to avoid getting AIDS or the virus that causes AIDS?" Those answering affirmatively were then asked "What can a person do?" Interviewers encouraged and recorded multiple responses, and responses were coded by DHS staff. My main measure of knowledge of blood-borne HIV risk indicates whether a respondent had an answer to this question that was coded as "avoid sharing razors/blades". The only other specific response codes related to blood exposures were "avoid injections" and "avoid blood transfusions", which are less useful measures of knowledge of blood-borne HIV risk, as noted earlier.

In all DHS except those in Kenya and Malawi, before the prior open-ended question, respondents were asked a direct question to assess their perceptions of condom use as a preventive strategy: "Can people reduce their chances of getting the AIDS virus by using a condom every time they have sex?" (This question followed the open-ended question in the

Kenya and Malawi DHS only if a respondent reported knowing a way to avoid getting AIDS.) In the Swaziland DHS, respondents were also asked “Can people get the AIDS virus from open wounds or sores of an infected person?” before the open-ended question about ways to avoid AIDS. I coded respondents who answered “don't know” to any of these knowledge questions (including either part of the open-ended question) as having responded “no”.

Mali is the only country of the 16 with DHS data at two time points (2001 and 2006) on both HIV serostatus and knowledge of avoiding shared razors. Responses to the question about knowledge of condom use as a preventive strategy cannot be compared between the two time points because different question orders and skip patterns in the two surveys resulted in different subsets of respondents answering the question.

Statistical analyses. To examine the ecological associations between the knowledge measures and HIV prevalence in the 16 countries, I computed Pearson correlations between these variables (each represented as a percentage) and displayed the relationship graphically with scatterplots. To investigate these associations at the individual level for each country, I computed cross-classifications, odds ratios, and the associated 95% confidence intervals (CI). I synthesized these results across countries by calculating the common odds ratio (fixed effects model) and Cochran Q heterogeneity chi-square test [33-34]. The common odds ratio is an overall estimate of the relationship across data sets, and the heterogeneity chi-square test assesses whether the variation among the 16 countries' odds ratios reflects heterogeneity, beyond sampling variation, in the association across the 16 countries. To examine the associations further, I calculated the odds ratios, with HIV status as the dependent variable and a knowledge measure as the independent variable, adjusted for sets of covariates in hierarchical fixed effects logistic regression models. In succession, I added country, demographics (age in whole years, rural vs. urban residence, number of years of education, and wealth [quintiles]), and sexual factors (reported number of sex partners in the prior 12 months and whether reported having had a sexually transmitted disease in the prior 12 months) as covariates. For each sample, I also computed the Pearson correlation between the knowledge measures regarding razors and condoms and summarized the results with the median and range of the coefficients. I used SPSS 7.5, RLPlot 1.4 (rlplot.sourceforge.net), and EasyMA [33-34] to perform the analyses.

On-line search of HIV prevention education efforts focused on blood-borne risks

In March and April of 2010, I sought evidence of public education campaigns focused on blood-borne HIV risks in each of the 16 countries by searching three on-line databases: the Google search engine, the US National Library of Medicine Gateway, and the Media/Materials Clearinghouse. For the Google (www.google.com) searches, I used the keywords "[country name]", "HIV", and "razor". For each country's search, I examined at least the first 100 resources identified and continued examining resources until I found 30 consecutive resources to be irrelevant.

For the US National Library of Medicine Gateway (http://gateway.nlm.nih.gov/) searches, I used the keywords "HIV" and "razor". My searches of Google and the US National Library of Medicine were not exhaustive, especially given the limited scope induced by the keyword "razor". However, the razor blade is perhaps the most ubiquitous sharp instrument involving possible blood exposure in daily life in Africa and elsewhere. Any public education campaign about blood-borne HIV risks that excludes explicit mention of razor blades is probably superficial or very narrow.

The Media/Materials Clearinghouse (www.m-mc.org) is an international on-line repository for health communication materials. I performed two types of searches of the Media/Materials Clearinghouse. For the first set, I used the keyword “HIV” for each of the 16 countries as well as for two countries in southern Africa with very high HIV prevalences, Botswana and South Africa. For the second set, I used the keywords “needle”, “syringe”, and “razor” in separate searches. I also inspected potentially relevant annotations and resources referenced in the resources I examined in all of my searches of the on-line databases.

I considered any systematic effort to inform the general public or broad segments of the population (e.g., schoolchildren, persons who attend religious services) about blood-borne HIV risks as evidence of a public education campaign in a country, if the effort occurred before that country's DHS. Examples of such efforts included posters, pamphlets, radio/television spots or shows, novelty items (such as t-shirts, stickers, or games), newspaper spreads, trainings of information disseminators (e.g., religious leaders, teachers), village theater performances, implemented school curricula, and implemented community meetings/workshops. I excluded trainings of healthcare, cosmetic care, and ritual providers because the knowledge transmitted was not necessarily designed to be passed on to the general public. Such providers have a financial incentive to withhold such information from the public (to reduce equipment, supply, labor, and other costs). Moreover, none of the 16 countries included in my analyses had a rigorous system for monitoring and regulating infection control practices in healthcare, cosmetic care, or ritual settings.

To be counted as evidence of a public education campaign focused on blood-borne HIV risks, I further required that the effort must address common blood-borne risks, not just the relatively uncommon exposures of blood transfusion and injection drug use. In my searches, I also recorded any incidentally detected evidence of public education campaigns in countries beyond the 16 included in the other analyses.

Results

Ecological associations

At the national level, the proportion of respondents listing "avoid sharing razors" was moderately to strongly inversely related to HIV prevalence (Tables 1 and 2 and Figures 1 and 2; some country labels have been shifted slightly in the figures to prevent overlap). The Pearson correlations were -.64 ($p < .01$) for women and -.82 ($p < .001$) for men. When HIV prevalence was transformed by the natural logarithm, the correlations increased slightly to -.67 and -.88, respectively. Countries in which there was low awareness of this prevention strategy tended to have high HIV prevalence, and countries in which there was relatively high awareness tended to have low HIV prevalence. In contrast, knowledge of condom use as a prevention strategy was positively related with HIV prevalence (Pearson correlations = .59 [$p < .05$] for women and .27 [$p > .05$] for men) (Tables 3 and 4 and Figures 3 and 4). That is, countries with high proportions of respondents endorsing condoms also tended to have higher HIV prevalence than countries with lower proportions endorsing condoms.

Individual-level associations

At the individual level, the associations between knowledge of prevention strategies and HIV infection generally mirrored the directions observed at the ecological level. There was wide variation across the 16 countries in the direction and magnitude of the bivariate association between knowledge of avoiding shared razors and prevalent HIV infection. On average, respondents with such knowledge were slightly less likely to be infected than those lacking this awareness (Tables 1 and 2). The distinction between the high prevalence countries in southern Africa (Lesotho, Malawi, Swaziland, and Zimbabwe) and the 12 much lower prevalence countries in west, central, and east Africa accounted for much of the international variation. In bivariate analyses, the association was modestly inverse in the higher prevalence countries and was almost null in the lower prevalence countries.

The inverse association between knowledge of avoiding shared razors and prevalent HIV infection in the southern African countries remained after adjustment for demographics and sexual behaviors (Table 5). Also, after adjustment for demographics, knowledge of avoiding shared razors became slightly more inversely related to prevalent infection for other African countries than in bivariate analyses

In nearly every country, women and men who endorsed using condoms as a way to avoid HIV were more likely to be infected than those who did not endorse condoms (Tables 3 and 4). The direction and magnitude of this association did not vary significantly across countries. The positive association between endorsement of condoms and prevalent HIV infection remained clear even after controlling for demographics and sexual behaviors (Table 5). In addition, respondents who listed “avoid sharing razors” were slightly more likely to endorse condoms than those not listing “avoid sharing razors” (across the 16 countries, median r = .09 for both women and men, range = -.05 to .22 for women and -.08 to .23 for men).

Changes in knowledge and HIV prevalence over time in Mali

The proportion of Malians who listed “avoid sharing razors” to prevent HIV increased dramatically between 2001 and 2006 (from 0.2% to 20.2% for women and from 0.2% to 33.0% for men). During the same period, HIV prevalence declined (from 2.0% to 1.5% for women and from 1.3% to 1.1% for men).

Knowledge of transmission through open wounds/sores in Swaziland

In Swaziland, 96% of both women and men agreed that HIV could be transmitted from the open wounds or sores of infected persons.

Recall- vs. recognition-based measurement of knowledge of preventive strategies

The proportion of respondents reporting condom use as a way to prevent HIV was higher when they were asked directly and specifically rather than when asked, in an open-ended question, to list ways HIV could be avoided. In Kenya, direct questioning increased the proportion by 53% for women and 26% for men. In Malawi, direct questioning increased the proportion by 5% for women and 7% for men.

Public education campaigns focused on blood-borne HIV risks

There was on-line evidence of public education campaigns focused to some degree on blood-borne HIV risks before the corresponding DHS in 13 of the 16 countries: Cameroon (Media/Materials Clearinghouse [MMC] item 1 – see Appendix), Cote d'Ivoire (MMC 2, 3), Democratic Republic of the Congo (MMC 4-9), Ethiopia [35] (MMC 10-13), Ghana (MMC 14-20), Guinea [36] (MMC 21-26), Kenya (MMC 27-29), Malawi [37, 38] (MMC 30), Mali [39, 40], Niger (MMC 31, 32), Rwanda (MMC 33), Senegal [41] (MMC 34-37), and Tanzania (MMC 38). Incidentally detected evidence of public education campaigns focused on blood-borne risks was also prominent in other west, central, and east African countries with relatively low HIV prevalence, including Liberia [42], Nigeria (MMC 39-45), Republic of Congo (MMC 46), Sierra Leone [43] (MMC 47), Togo (MMC 48-51), and Uganda [44] (MMC 52-56).

The sources for Malawi include a pamphlet produced by an non-governmental organization (NGO) for parents of schoolchildren that includes brief information about blood-borne risks (MMC 30) and two informal mentions of public education campaigns [37, 38] that I could not confirm further with focused searching on-line. In 2008, two years after the 2006 Mali DHS, a visitor to Mali observed an NGO-produced public education campaign focused on blood-borne HIV risks [45]. I contacted the NGO for information on when the campaign began, but the NGO was unable to provide details. Consistent with the public education campaigns focused on blood-borne HIV risks in Senegal, Senegalese infection control officials recently announced plans [46] to educate the public about patient-observed sterile treatment [47].

Some countries started their educational efforts soon after the epidemic was recognized. For instance, DRC (then Zaire) issued warnings to the public about blood-borne HIV risks in 1987 (MMC 4). That same year, adults in Kinshasa displayed very high awareness of such risks [48].

There was no evidence on-line that Lesotho, Swaziland, and Zimbabwe—the three countries with the highest HIV prevalences of the 16 countries—had implemented any public education campaigns focused on blood-borne HIV risks. Similarly, there was no evidence in the Media/Materials Clearinghouse that Botswana or South Africa had implemented such campaigns, either. Furthermore, a 1993 pamphlet from Zimbabwe (MMC 57) actually contains misinformation about the survival of HIV outside the body.

Discussion

Adults' knowledge of one way to prevent a blood-borne HIV transmission – avoiding shared razors – was moderately to strongly inversely related to HIV prevalence in 16 sub-Saharan African countries. Countries in which many respondents displayed such knowledge had low HIV prevalence, while in high prevalence countries few respondents had this knowledge. In contrast, adults' knowledge of condom use as an HIV prevention strategy was moderately positively associated with HIV prevalence. At the individual level, respondents who knew sharing razors was a risk for HIV transmission were modestly less likely to be HIV infected than those who did not recall this risk. This tendency was stronger in high prevalence than in low prevalence countries, and remained after adjustment for demographic and sexual behavior variables. However, respondents who endorsed condom use as a prevention strategy were mildly more likely to be HIV infected, even after controlling for demographic and sexual behavior variables. In Mali, between 2001 and 2006, knowledge of avoiding shared razors increased substantially as HIV prevalence fell. Furthermore, west, central, and east African countries with low to moderate HIV prevalence had implemented public education campaigns that included a focus on blood-borne transmission risks, but such campaigns were absent from high prevalence countries in southern Africa.

Data from two South African provinces (Northern Cape and KwaZulu Natal) are consistent with the ecological association between knowledge of blood-borne risks and HIV prevalence I observed. In these provinces, HIV prevalences were very high in women receiving antenatal care (16% and 39%, respectively) and correspondingly few mothers of young children in probability sample household surveys listed avoiding reused sharp instruments as a way to prevent HIV transmission (17% and 16%, respectively) [49, 50]. The absolute levels of knowledge of blood-borne HIV risks in these surveys and the DHS surveys I analyzed may have been underestimated. These measures were based on responses to open-ended questions, and my comparison of the open-ended and close-ended questions on condom use in the Kenya and Malawi DHS suggested that direct questioning could have boosted estimates by 5% to 53% for knowledge of avoiding shared razors. Also, in all of these surveys, preceding questions focused on sexual behavior, which may have primed respondents to recall prevention strategies related to sexual rather than blood exposures. Despite these possible measurement problems, it seems likely that knowledge of avoiding shared razors was far from universal even in countries with relatively high levels of measured knowledge.

The individual-level association between knowledge of blood-borne risk and HIV infection may represent knowledge-driven differences in risk behavior that resulted in divergent rates of HIV acquisition. In Nigerian prisoners, knowledge of hepatitis C virus (HCV) transmission modes was inversely associated with prevalent HCV infection [51].

The positive relationship between knowledge of condom use and HIV infection is difficult to interpret. In the 2003 Ghana DHS, knowledge of condom use as a way to prevent HIV was moderately positively related to reported condom use at last sex [2]. If knowledge of condom use were a crude measure of long-term condom use, the positive relationship between knowledge of condom use and HIV infection could reflect the inhibited immunity against HIV associated with condom use in penile-vaginal sex [52, 53]. The epidemiologic evidence on the association between condom use during penile-vaginal sex and incident HIV infection is mixed. In one study of HIV discordant Zambian couples [54], sex without condoms was associated with incident infection. However, in a study of Ugandan HIV discordant couples, condom use was not related to the probability of HIV transmission per coital act [55] and in a large study conducted in Benin, Ghana, India, Nigeria, and South Africa, condom use was positively associated with incident HIV infection [56] . None of these analyses included measures of blood exposures.

It is unclear why the inverse relationship between knowledge of avoiding shared razors and HIV infection is weaker in low prevalence countries. One possible explanation is the low degree of variation in HIV infection in these countries. Also, the potential protective effect conferred by knowledge of avoiding shared razors – if matched by behavior – may extend beyond the person with such knowledge. Knowledgeable persons may ensure that others do not use razors they have used, prevent reuse of razors in their care, warn others not to share razors, and exhibit and encourage safer behavior around sharps generally. In countries where large proportions of adults knew to avoid sharing razors, such “spillover” protection to those without such knowledge could diminish the relationship between knowledge and HIV infection.

Swazis' very high awareness of the risk of HIV transmission through the open wounds or sores of infected persons contrasts starkly with their very low knowledge of avoiding shared razors. In a 2007 survey, 89% of Lesothoan garment workers were aware that HIV could spread through blood contact [57], but very few Lesothoan DHS respondents recalled the risk of shared razors. These results suggest Swazis, Lesothoans, and perhaps Africans generally know that contaminated blood can transmit HIV when the exposure is visible and large. However, contaminated sharps often are not as visibly contaminated, even though contamination invisible to the naked eye can still be infectious for weeks, wet or dry [6,58]. People are not likely to know about the transmission potential of this kind of contamination unless specifically educated.

It is puzzling why countries in west, central, and east Africa included a focus on blood-borne risks in their public HIV education campaigns, and countries in southern Africa did not. The efforts of the non-governmental SidAlerte network may have contributed to the more comprehensive educational campaigns in the former set of countries. The SidAlerte network operated from 1987 (prior to incorporation) until 1998 with significant involvement in Benin, Burkina Faso, Burundi, Cameroon, Cote d'Ivoire, DRC (then Zaire), Guinea, Mali, Republic of Congo, Rwanda, Senegal, and Togo. SidAlerte emphasized prevention of blood-borne HIV transmission in all of its activities, including: the production and distribution of magazines and newsletters for health professionals, NGO staff, and government officials; formation and training of hygiene (infection control) committees for healthcare systems and individual healthcare facilities; public education campaigns in several SidAlerte countries; and other prevention and care activities that varied across the SidAlerte network [59] (G. Upham, personal communication, March 31, 2010). “SidAlerte Magazine” (in French) and “TB and HIV” (in French and English versions) were SidAlerte's primary publications (peak circulations approximately 30,000 and 60,000 respectively) [60] (G. Upham, personal communication, March 31, 2010). SidAlerte's involvement may well have been critical in those countries where it was active. However, SidAlerte's work does not necessarily account for the public education campaigns on blood-borne HIV risks initiated in other countries in the region (e.g., Sierra Leone, Ghana, Niger, Nigeria, Uganda, and Ethiopia) where SidAlerte was not substantially involved.

Prevention planners working in southern Africa excluded warnings of blood-borne risks from their public HIV education campaigns. This omission is particularly poignant because they had access to the same epidemiologic information as planners in countries elsewhere in sub-Saharan Africa and had more time to develop responses as the HIV epidemic unfolded later in southern Africa than elsewhere on the continent. Officials in southern African governments clearly were aware of the risks of blood-borne HIV transmission early in the epidemic, as they implemented educational workshops for traditional healers in southern Africa that included a focus on hygienic practices for invasive procedures [61-67]. In these workshops, the high risk of blood-borne transmission was conveyed in unmistakable terms. To illustrate, after one such workshop, a participant remarked: “I used to use one razor for five people -- I used to kill people” [68]. (These workshops, incidentally, reached very small fractions of traditional healers [61, 64].) Yet, as of April, 2010, five of the largest public HIV education campaigns in South Africa (South African National AIDS Council National HIV Counseling and Testing Campaign [www.sanac.org.za], loveLife [www.lovelife.org.za], Siyayinqoba Beat It [www.beatit.co.za], Brothers for Life [www.brothersforlife.org], and Scrutinize [www.scrutinize.org.za]) omit information on how to prevent blood-borne HIV transmission. Many NGOs that implemented HIV education campaigns in southern Africa, as well as several international and foreign agencies that funded them, also were involved with campaigns elsewhere in Africa that did focus on blood-borne HIV risks. Thus, the various evidence suggests that prevention planners in southern Africa deliberately deprived the public of knowledge of how to avoid blood-borne HIV transmission.

International and foreign aid agencies have not insisted that blood-borne risks for HIV infection are addressed in the public education campaigns that they support in Africa and elsewhere. This stance conflicts with the heavy emphasis on avoiding blood-borne risks in HIV education programs for primary school students in rich countries [69, 70], travelers to poor (especially African) countries [71-73], and employees of the United Nations working in poor countries [74, 75].

Despite the political incentives to deny blood-borne risks [76], countries that included a focus on blood-borne risks in their public HIV education campaigns may well have averted larger epidemics as a result. In the case of Mali, increased knowledge of blood-borne risks corresponded to a decrease in HIV prevalence. Birungi [77] noted many Ugandans adopted injection practices that likely reduced their risk of HIV acquisition following the “massive anti-AIDS education campaigns that began in 1985 [that] warned people about the dangers of sharing unsterilized needles and syringes” (p. 1458). These behavior changes were accompanied by concurrent declines in HIV transmission [78].

My investigation has several limitations. First, with the DHS data, it is not possible to link the knowledge of avoiding shared razors to a comparable reported behavior. Second, it is not clear how much knowledge of other blood-borne HIV risks respondents who listed “avoid sharing razors” have, or how DHS staff coded responses related to blood-borne risks beyond the three narrow categories (avoidance of transfusion, injections, and shared razors) used. Fourth, the on-line search of public education campaigns almost certainly did not yield a complete inventory of programs implemented in the 16 countries. Nonetheless, the search results likely do indicate whether blood-borne risks were a significant focus of the campaigns carried out in a country. Fifth, the on-line search was conducted in English. Consequently, there may have been even more evidence on-line of public education campaigns focused on blood-borne risks than I could detect in countries where English was not commonly used. Finally, I generally was not able to determine the scope, intensity, duration, and recency of most public education campaigns I identified in the on-line search.

Health officials have an ethical duty to warn the African public about blood-borne HIV risks. Where such efforts are now absent, they should be started immediately; where such efforts are underway, they should be emphasized further and sustained. Public education campaigns should not only highlight blood-borne HIV risks comprehensively but also communicate practical strategies for avoiding the risks [47, 79]. Adding a focus on blood-borne risks to existing public education campaigns would cost little. Observational evaluations could also be performed in conjunction with the initiation and expansion of campaigns focused on blood-borne risks to investigate the connections between knowledge and behavior and incident infection, as well as individuals' sources of knowledge about blood-borne HIV risks.

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Appendix

The list below includes the Media/Material Clearinghouse (MMC) codes for public HIV education materials focused on blood-borne HIV risks. Each item can be located in the MMC database at http://m-mc.org/mmc_search.php by using the item's three letter country code and following number in the "search all fields" field.

1 = PL CAM 53

2 = PL IVO 14

3 = PO IVO 38

4 = PO ZAI 10

5 = PL ZAI 51

6 = PO ZAI 51

7 = PL ZAI 55

8 = PL ZAI 56

9 = PO CON 5

10 = PO ETH 40

11 = PO ETH 46

12 = PO ETH 60

13 = PO ETH 68

14 = PL GHA 79

15 = PL GHA 140

16 = PO GHA 103

17 = PL GHA 142

18 = PO GHA 107

19 = PL GHA 109

20 = TR GHA 36

21 = PO GUI 8

22 = PO GUI 10

23 = PO GUI 11

24 = PL GUI 13

25 = FC GUI 2

26 = TD GUI 22

27 = PO KEN 11

28 = PL KEN 93

29 = PL KEN 325

30 = PL MAL 30

31 = PO NIG 2

32 = PO NIG 11

33 = PL RWA 16

34 = PO SEN 22

35 = PL SEN 35

36 = TD SEN 33

37 = TD SEN 34

38 = PO TAN 96

39 = PO NGA 183

40 = PO NGA 237

41 = PO NGA 253

42 = PO NGA 342

43 = TD NGA 129

44 = PL NGA 262

45 = PL NGA 521

46 = PO CON 5

47 = PO SIR 26

48 = PO TOG 5

49 = PO TOG 11

50 = PO TOG 12

51 = PO TOG 14

52 = PO UGA 38

53 = PO UGA 41

54 = PO UGA 54

55 = PO UGA 56

56 = PO UGA 86

57 = PL ZIM 85

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Figure 1. Scatterplot of knowledge of avoiding shared razors and HIV prevalence for women, 16 countries in sub-Saharan Africa. Labels indicate first three letters of the country (MLW = Malawi).

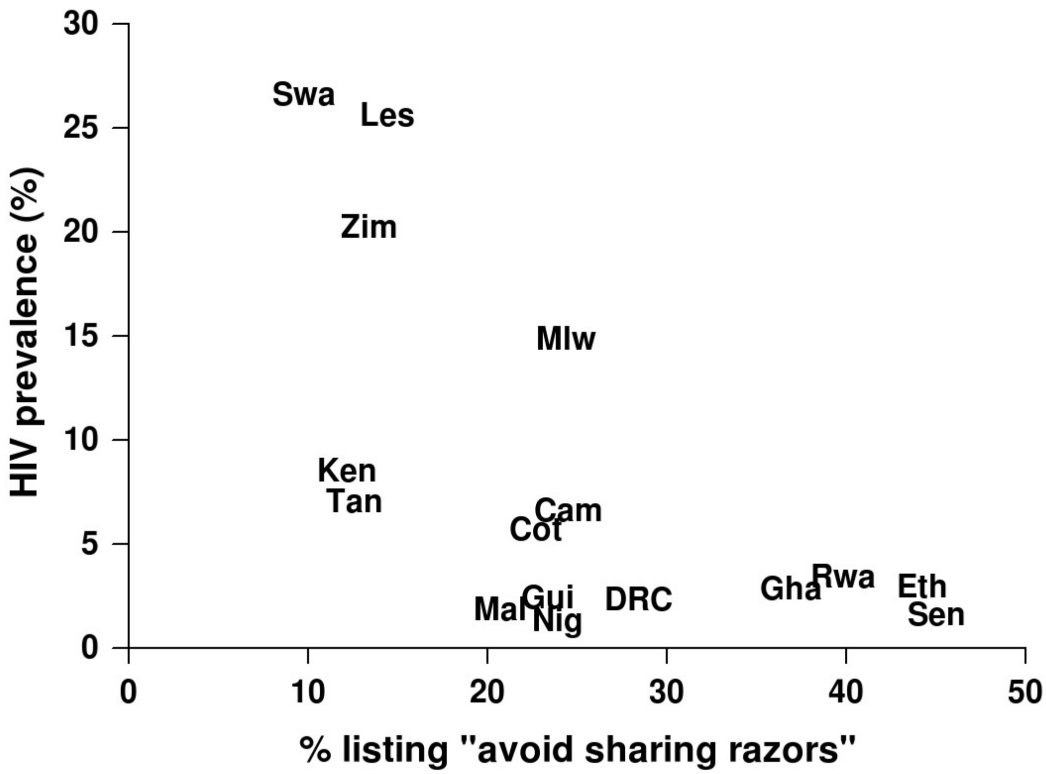

Figure 2. Scatterplot of knowledge of avoiding shared razors and HIV prevalence for men, 16 countries in sub-Saharan Africa. Labels indicate first three letters of the country (MLW = Malawi).

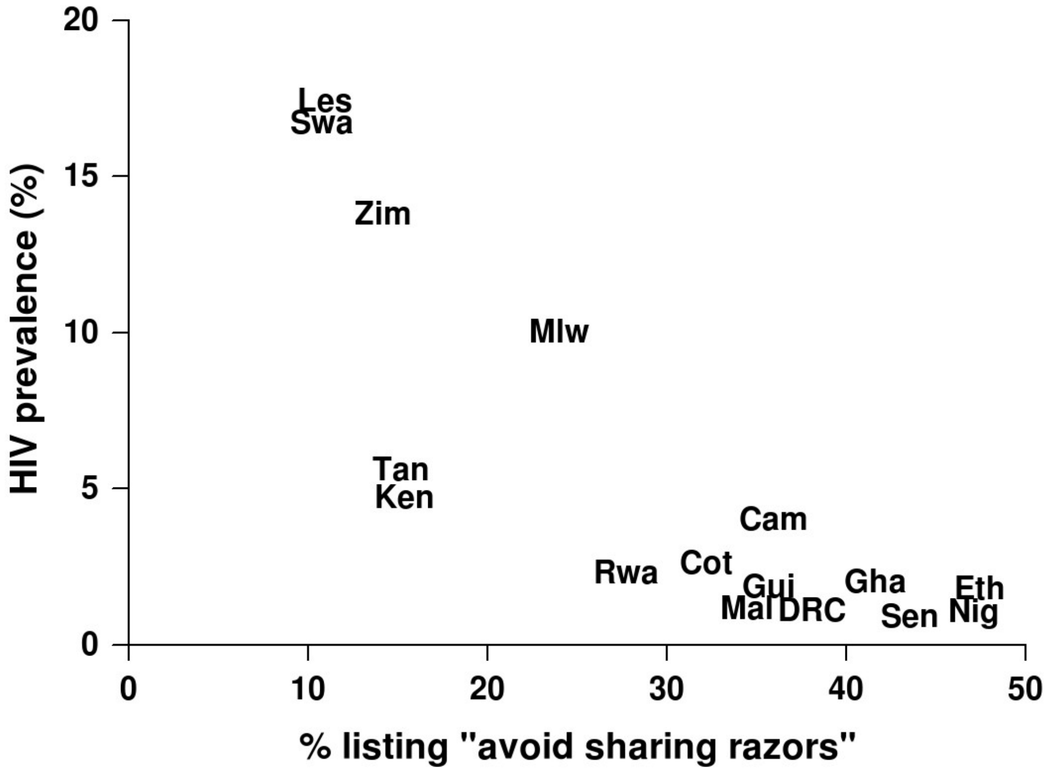

Figure 3. Scatterplot of knowledge of condom use and HIV prevalence for women, 16 countries in sub-Saharan Africa. Labels indicate first three letters of the country (MLW = Malawi).

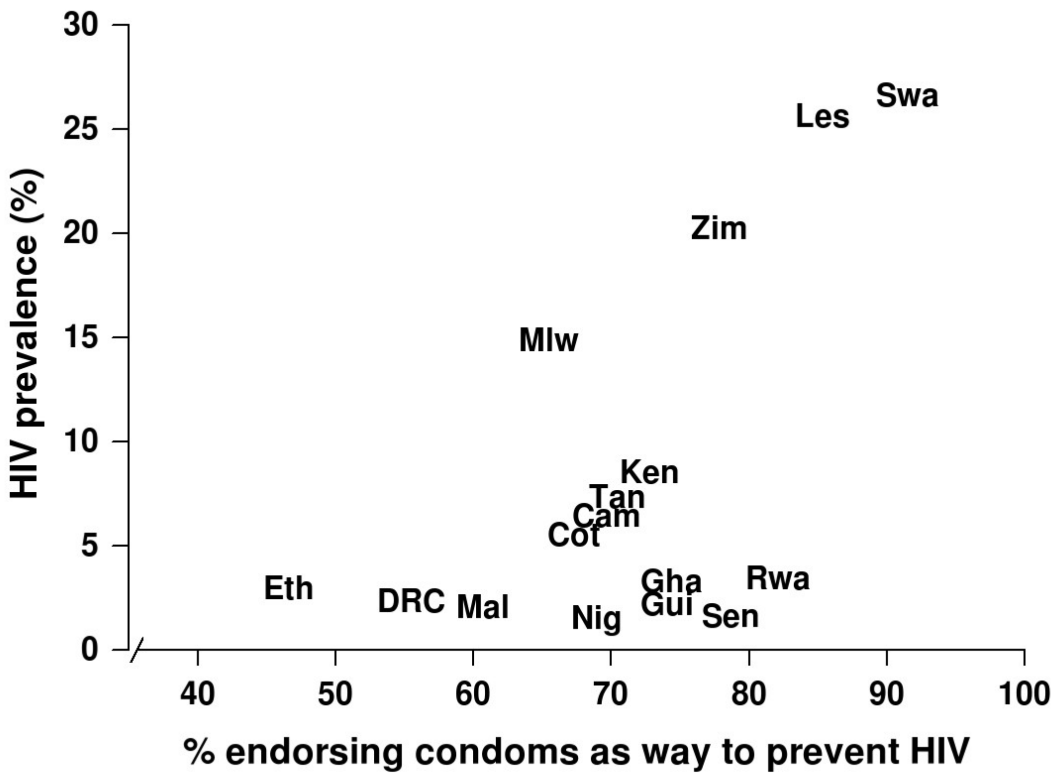

Figure 4. Scatterplot of knowledge of condom use and HIV prevalence for men, 16 countries in sub-Saharan Africa. Labels indicate first three letters of the country (MLW = Malawi).

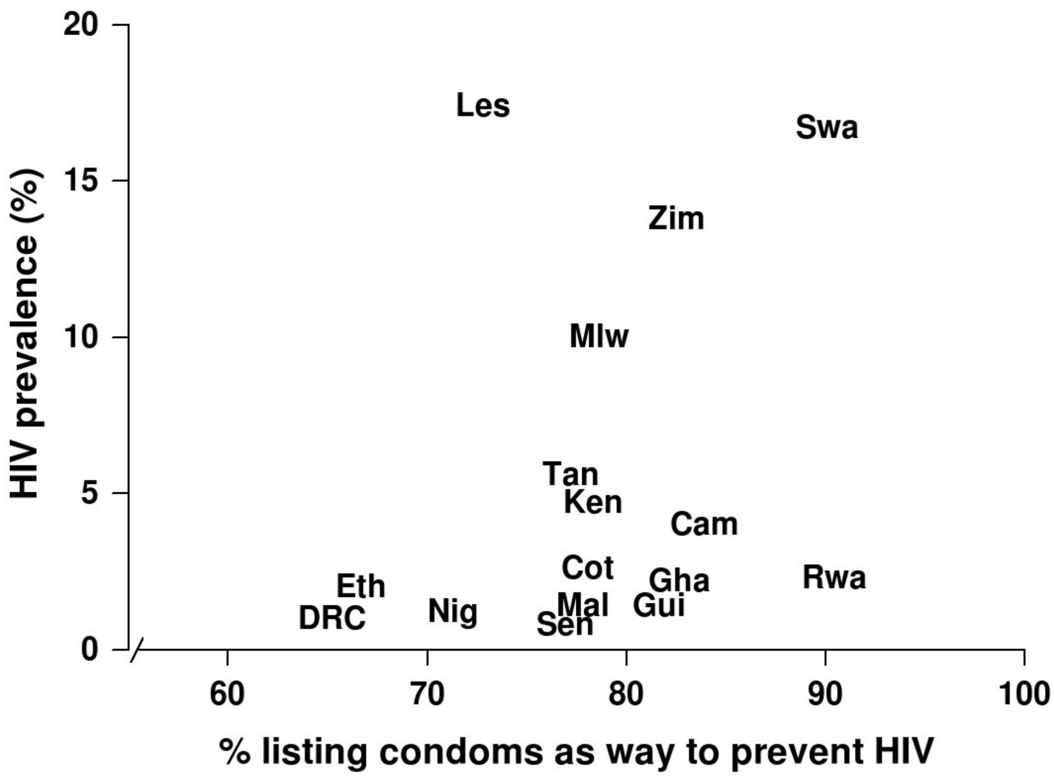

Figure Captions

Figure 1. Scatterplot of knowledge of avoiding shared razors and HIV prevalence for women, 16 countries in sub-Saharan Africa. Labels indicate first three letters of the country (MLW = Malawi).

Figure 2. Scatterplot of knowledge of avoiding shared razors and HIV prevalence for men, 16 countries in sub-Saharan Africa. Labels indicate first three letters of the country (MLW = Malawi).

Figure 3. Scatterplot of knowledge of condom use and HIV prevalence for women, 16 countries in sub-Saharan Africa. Labels indicate first three letters of the country (MLW = Malawi).

Figure 4. Scatterplot of knowledge of condom use and HIV prevalence for men, 16 countries in sub-Saharan Africa. Labels indicate first three letters of the country (MLW = Malawi).

Table 1. Individual-level association between listing "avoid sharing razors" as a way to prevent HIV and prevalent HIV infection, women

Country	n	Overall HIV prevalence (%)	% who listed "avoid sharing razors"	HIV prevalence (%) for respondents who: Listed "avoid sharing razors"	Did not list "avoid sharing razors"	OR (95% CI)
Cameroon	3,964	5.8	22.6	60/895 (6.7)	171/3069 (5.6)	1.22 (0.90-1.65)
Cote d'Ivoire	3,526	5.4	22.2	46/783 (5.9)	144/2743 (5.2)	1.13 (0.80-1.59)
Dem. Rep. Congo	4,059	1.7	26.5	20/1076 (1.9)	48/2983 (1.6)	1.16 (0.68-1.96)
Ethiopia	4,810	2.3	42.8	57/2057 (2.8)	53/2753 (1.9)	1.45 (0.99-2.12)
Ghana	4,660	2.4	36.0	39/1678 (2.3)	75/2982 (2.5)	0.92 (0.62-1.36)
Guinea	3,631	1.8	21.9	17/797 (2.1)	47/2834 (1.7)	1.29 (0.74-2.26)
Kenya	2,734	7.9	10.5	18/287 (6.3)	199/2447 (8.1)	0.76 (0.46-1.25)
Lesotho	2,364	25.0	12.9	64/306 (20.9)	526/2058 (25.6)	0.77 (0.58-1.03)
Malawi	2,423	14.2	22.7	93/551 (16.9)	252/1872 (13.5)	1.31 (1.01-1.69)
Mali	4,420	1.4	20.2	10/895 (1.1)	50/3525 (1.4)	0.79 (0.40-1.56)
Niger	4,243	0.9	22.5	16/956 (1.7)	21/3287 (0.6)	2.65 (1.38-5.09)
Rwanda	4,217	2.8	38.0	39/1601 (2.4)	78/2616 (3.0)	0.81 (0.55-1.20)
Senegal	4,053	1.0	43.4	17/1761 (1.0)	24/2292 (1.0)	0.92 (0.49-1.72)
Swaziland	2,704	26.0	8.0	31/217 (14.3)	672/2487 (27.0)	0.45 (0.31-0.67)
Tanzania	5,152	6.4	11.0	33/569 (5.8)	298/4583 (6.5)	0.89 (0.61-1.28)
Zimbabwe	5,519	19.6	11.8	98/653 (15.0)	983/4866 (20.2)	0.70 (0.56-0.87)
		Summaries		Common OR	Heterogeneity X^2 (df)	
		All 16 countries		0.94 (0.86-1.04)	50.33 (15), $p < .001$	
		Southern Africa[1]		0.81 (0.70-0.93)	23.49 (3), $p < .001$	
		West, Central, and East Africa[2]		1.08 (0.95-1.22)	17.50 (11), $p = .09$	

Table 1. Individual-level association between listing “avoid sharing razors” as a way to prevent HIV and prevalent HIV infection, women (continued)

[1]Lesotho, Malawi, Swaziland, and Zimbabwe
[2]Cameroon, Cote d'Ivoire, Democratic Republic of the Congo, Ethiopia, Ghana, Guinea, Kenya, Mali, Niger, Rwanda, Senegal, and Tanzania

Table 2. Individual-level association between listing "avoid sharing razors" as a way to prevent HIV and prevalent HIV infection, men

				HIV prevalence (%) for respondents who:		
Country	n	Overall HIV prevalence (%)	% who listed "avoid sharing razors"	Listed "avoid sharing razors"	Did not list "avoid sharing razors"	OR (95% CI)
Cameroon	4,233	3.6	34.0	52/1440 (3.6)	100/2793 (3.6)	1.01 (0.72-1.42)
Cote d'Ivoire	3,255	2.2	30.7	26/999 (2.6)	47/2256 (2.1)	1.26 (0.77-2.04)
Dem. Rep. Congo	3,705	0.9	36.2	12/1343 (0.9)	21/2362 (0.9)	1.01 (0.49-2.05)
Ethiopia	4,535	1.3	46.0	22/2288 (1.1)	36/2447 (1.5)	0.71 (0.42-1.22)
Ghana	3,868	1.6	39.9	21/1544 (1.4)	42/2324 (1.8)	0.75 (0.44-1.27)
Guinea	2,720	1.2	34.2	12/929 (1.3)	21/1791 (1.2)	1.10 (0.54-2.25)
Kenya	2,425	4.3	13.7	16/332 (4.8)	89/2093 (4.3)	1.14 (0.66-1.97)
Lesotho	1,860	17.0	9.4	30/175 (17.1)	287/1685 (17.0)	1.01 (0.67-1.52)
Malawi	1,998	9.6	22.3	32/445 (7.2)	159/1553 (10.2)	0.68 (0.46-1.01)
Mali	3,265	0.9	33.0	13/1076 (1.2)	15/2189 (0.7)	1.77 (0.84-3.74)
Niger	2,808	0.8	45.7	7/1282 (0.5)	16/1526 (1.0)	0.52 (0.21-1.26)
Rwanda	3,701	1.9	25.9	13/959 (1.4)	56/2742 (2.0)	0.66 (0.36-1.21)
Senegal	3,017	0.5	41.9	5/1264 (0.4)	9/1753 (0.5)	0.77 (0.26-2.30)
Swaziland	2,910	16.3	9.0	28/262 (10.7)	446/2648 (16.8)	0.59 (0.39-0.89)
Tanzania	4,068	5.2	13.6	26/553 (4.7)	185/3515 (5.3)	0.89 (0.58-1.35)
Zimbabwe	4,582	13.4	12.6	65/576 (11.3)	549/4006 (13.7)	0.80 (0.61-1.05)
		Summaries		Common OR	Heterogeneity X^2 (df)	
		All 16 countries		0.86 (0.76-0.97)	16.74 (15), p = .34	
		Southern Africa[1]		0.76 (0.64-0.91)	3.73 (3), p = .29	
		West, Central, and East Africa[2]		0.94 (0.80-1.10)	9.98 (11), p = .53	

Table 2. Individual-level association between listing “avoid sharing razors” as a way to prevent HIV and prevalent HIV infection, men (continued)

[1]Lesotho, Malawi, Swaziland, and Zimbabwe
[2]Cameroon, Cote d'Ivoire, Democratic Republic of the Congo, Ethiopia, Ghana, Guinea, Kenya, Mali, Niger, Rwanda, Senegal, and Tanzania

Table 3. Individual-level association between endorsing condoms as a way to prevent HIV and prevalent HIV infection, women

Country	n	Overall HIV prevalence (%)	% who endorsed condoms	HIV prevalence (%) for respondents who: Endorsed condoms	Did not endorse condoms	OR (95% CI)
Cameroon	3,964	5.8	67.2	170/2662 (6.4)	60/1302 (4.6)	1.41 (1.04-1.91)
Cote d'Ivoire	3,521	5.4	65.4	133/2302 (5.8)	57/1219 (4.7)	1.25 (0.91-1.72)
Dem. Rep. Congo	3,706	1.7	53.0	37/1964 (1.9)	26/1742 (1.5)	1.27 (0.76-2.10)
Ethiopia	4,807	2.3	44.8	74/2154 (3.4)	36/2653 (1.4)	2.59 (1.73-3.87)
Ghana	4,662	2.4	72.1	89/3360 (2.6)	25/1302 (1.9)	1.39 (0.89-2.18)
Guinea	3,628	1.8	72.1	51/2614 (2.0)	13/1014 (1.3)	1.53 (0.83-2.83)
Kenya	2,309	8.5	70.6	159/1630 (9.8)	38/679 (5.6)	1.82 (1.27-2.63)
Lesotho	2,368	24.9	83.3	509/1972 (25.8)	81/396 (20.5)	1.35 (1.04-1.76)
Malawi	2,317	14.3	63.3	210/1466 (14.3)	122/851 (14.3)	1.00 (0.79-1.27)
Mali	3,735	1.5	58.8	33/2195 (1.5)	22/1540 (1.4)	1.05 (0.61-1.81)
Niger	3,472	1.0	67.1	23/2331 (1.0)	12/1141 (1.1)	0.94 (0.47-1.89)
Rwanda	4,216	2.8	79.7	96/3360 (2.9)	21/856 (2.5)	1.17 (0.73-1.89)
Senegal	4,055	1.0	76.6	35/3106 (1.1)	6/949 (0.6)	1.79 (0.75-4.27)
Swaziland	2,685	26.0	89.2	637/2395 (26.6)	62/290 (21.4)	1.33 (0.99-1.79)
Tanzania	5,099	6.4	68.4	250/3488 (7.2)	78/1611 (4.8)	1.52 (1.17-1.97)
Zimbabwe	5,353	19.6	75.8	853/4058 (21.0)	196/1295 (15.1)	1.49 (1.26-1.77)
		Summaries		Common OR	Heterogeneity X^2 (df)	
		All 16 countries		1.39 (1.28-1.51)	23.39 (15), p = .08	
		Southern Africa[1]		1.32 (1.18-1.48)	7.18 (3), p = .07	
		West, Central, and East Africa[2]		1.47 (1.31-1.65)	14.53 (11), p = .21	

Table 3. Individual-level association between endorsing condoms as a way to prevent HIV and prevalent HIV infection, women (continued)

[1]Lesotho, Malawi, Swaziland, and Zimbabwe
[2]Cameroon, Cote d'Ivoire, Democratic Republic of the Congo, Ethiopia, Ghana, Guinea, Kenya, Mali, Niger, Rwanda, Senegal, and Tanzania

Table 4. Individual-level association between endorsing condoms as a way to prevent HIV and prevalent HIV infection, men

Country	n	Overall HIV prevalence - %	% who endorsed condoms	HIV prevalence (%) for respondents who: Endorsed condoms	Did not endorse condoms	OR (95% CI)
Cameroon	4,228	3.6	82.2	125/3476 (3.6)	27/752 (3.6)	1.00 (0.66-1.53)
Cote d'Ivoire	3,249	2.2	76.7	57/2493 (2.3)	16/756 (2.1)	1.08 (0.62-1.90)
Dem. Rep. Congo	3,695	0.9	63.5	20/2347 (0.9)	12/1348 (0.9)	0.96 (0.47-1.96)
Ethiopia	4,532	1.3	65.4	49/2965 (1.7)	9/1567 (0.6)	2.91 (1.43-5.94)
Ghana	3,864	1.6	81.1	54/3135 (1.7)	9/729 (1.2)	1.40 (0.69-2.85)
Guinea	2,709	1.2	80.3	30/2175 (1.4)	3/534 (0.6)	2.48 (0.75-8.14)
Kenya	2,198	4.6	76.8	83/1687 (4.9)	18/511 (3.5)	1.42 (0.84-2.38)
Lesotho	1,862	17.0	71.4	231/1330 (17.4)	86/532 (16.2)	1.09 (0.83-1.43)
Malawi	1,968	9.7	77.1	147/1517 (9.7)	44/451 (9.8)	0.99 (0.70-1.42)
Mali	3,265	0.9	76.5	21/2497 (0.8)	7/768 (0.9)	0.92 (0.39-2.18)
Niger	2,803	0.8	70.0	18/1963 (0.9)	4/840 (0.5)	1.93 (0.65-5.73)
Rwanda	3,700	1.9	88.8	63/3287 (1.9)	6/413 (1.5)	1.33 (0.57-3.08)
Senegal	3,017	0.5	75.5	12/2279 (0.5)	2/738 (0.3)	1.95 (0.44-8.72)
Swaziland	2,906	16.3	88.5	422/2572 (16.4)	52/334 (15.6)	1.06 (0.78-1.46)
Tanzania	4,056	5.2	75.8	165/3073 (5.4)	46/983 (4.7)	1.16 (0.83-1.62)
Zimbabwe	4,581	13.3	81.1	509/3714 (13.7)	102/867 (11.8)	1.19 (0.95-1.49)
		Summaries		Common OR	Heterogeneity X^2 (df)	
		All 16 countries		1.16 (1.04-1.30)	13.10 (15), p = 0.64	
		Southern Africa[1]		1.11 (0.96-1.27)	0.83 (3), p = 0.84	
		West, Central, and East Africa[2]		1.26 (1.05-1.50)	10.86 (11), p = 0.49	

Table 4. Individual-level association between endorsing condoms as a way to prevent HIV and prevalent HIV infection, men (continued)

[1]Lesotho, Malawi, Swaziland, and Zimbabwe
[2]Cameroon, Cote d'Ivoire, Democratic Republic of the Congo, Ethiopia, Ghana, Guinea, Kenya, Mali, Niger, Rwanda, Senegal, and Tanzania

Table 5. Adjusted odds ratios between knowledge of prevention strategies and prevalent HIV infection for respondents in southern Africa

	Avoid sharing razors		Use condoms	
Covariates	Women[1]	Men[2]	Women[3]	Men[4]
Southern Africa				
Country	0.78 (0.68-0.90)	0.76 (0.33-0.90)	1.32 (1.18-1.48)	1.15 (1.02-1.29)
Country, demographics	0.80 (0.70-0.92)	0.85 (0.70-1.02)	1.30 (1.16-1.46)	1.29 (1.14-1.45)
Country, demographics, sexual behaviors	0.80 (0.70-0.92)	0.86 (0.71-1.04)	1.26 (1.13-1.42)	1.21 (1.07-1.37)
West, central, and east Africa				
Country	1.06 (0.94-1.20)	0.93 (0.80-1.09)	1.48 (1.32-1.67)	1.29 (1.08-1.54)
Country, demographics	0.92 (0.81-1.05)	0.88 (0.75-1.04)	1.37 (1.21-1.54)	1.28 (1.07-1.53)
Country, demographics, sexual behaviors	0.91 (0.80-1.03)	0.88 (0.75-1.04)	1.36 (1.20-1.54)	1.26 (1.05-1.10)
All 16 countries				
Country	---	0.85 (0.75-0.95)	1.40 (1.29-1.52)	1.19 (1.08-1.31)
Country, demographics	---	0.87 (0.77-0.99)	1.35 (1.24-1.46)	1.26 (1.14-1.39)
Country, demographics, sexual behaviors	---	0.88 (0.78-0.99)	1.33 (1.22-1.44)	1.23 (1.11-1.36)

Note: For these results, southern Africa includes Lesotho, Malawi, Swaziland, and Zimbabwe. West, central, and east Africa includes Cameroon, Cote d'Ivoire, Democratic Republic of the Congo, Ethiopia, Ghana, Guinea, Kenya, Mali, Niger, Rwanda, Senegal, and Tanzania. 95% confidence intervals are in parentheses. Demographics include age, rural/urban residence, wealth, and education. Sexual behaviors include number of sex partners in the previous 12 months and sexually transmitted disease in the previous 12 months.

Table 5. Adjusted odds ratios between knowledge of prevention strategies and prevalent HIV infection for respondents in southern Africa (continued)

[1]For the different models, sample sizes range from 12,712 to 13,010 in southern Africa and from 49,005 to 49,469 in west, central, and east Africa.
[2]For the different models, sample sizes range from 11,262 to 11,350 in southern Africa and from 41,196 to 41,600 in west, central, and east Africa..
[3]For the different models, sample sizes range from 12,645 to 12,719 in southern Africa and from 46,731 to 47,174 in west, central, and east Africa.
[4]For the different models, sample sizes range from 11,262 to 11,350 in southern Africa and from 40,912 to 41,600 in west, central, and east Africa.