Published in final edited form as:

Health Psychol. 2013 August ; 32(8): 860–868. doi:10.1037/a0030554.

Understanding HIV Transmission Risk Behavior Among HIV-Infected South Africans Receiving Antiretroviral Therapy: An Information—Motivation—Behavioral Skills Model Analysis

Susan M. Kiene,

Department of Community Medicine and Health Care, University of Connecticut School of Medicine

William A. Fisher,

Departments of Psychology and Obstetrics and Gynaecology, University of Western Ontario, London, Ontario, Canada

Paul A. Shuper,

Centre for Addiction and Mental Health, Toronto, Ontario, Canada, University of Toronto, Toronto, Ontario, Canada

Center for Health, Intervention, and Prevention, University of Connecticut

Deborah H. Cornman,

Center for Health, Intervention, and Prevention, University of Connecticut

Sarah Christie,

Center for Health, Intervention, and Prevention, University of Connecticut

Susan MacDonald,

Enhancing Care Initiative, Nelson Mandela School of Medicine, University of KwaZulu-Natal, Durban, South Africa

Sandy Pillay,

Enhancing Care Initiative, Nelson Mandela School of Medicine, University of KwaZulu-Natal, Durban, South Africa

Gethwana Mahlase, and

Zimnandi Zonke Trading Enterprises, Pietermaritzburg, South Africa

Jeffrey D. Fisher

Center for Health, Intervention, and Prevention, and Department of Psychology, University of Connecticut

Abstract

The current study applied the Information—Motivation—Behavioral Skills (IMB) model (J. D. Fisher & Fisher, 1992; W. A. Fisher & Fisher, 1993) to identify factors associated with HIV transmission risk behavior among HIV-infected South Africans receiving antiretroviral therapy

(ART), a population of considerable significance for curtailing, or maintaining, South Africa's generalized HIV epidemic. HIV prevention information, HIV prevention motivation, HIV prevention behavioral skills, and HIV transmission risk behavior were assessed in a sample of 1,388 South Africans infected with HIV and receiving ART in 16 clinics in KwaZulu-Natal, South Africa. Results confirmed the assumptions of the IMB model and demonstrated that HIV prevention information and HIV prevention motivation work through HIV prevention behavioral skills to affect HIV transmission risk behavior in this population. Subanalyses confirmed these relationships for HIV transmission risk behavior overall and for HIV transmission risk behavior with partners perceived to be HIV-negative or HIV-status unknown. A consistent pattern of gender differences showed that for men, HIV prevention information and HIV prevention motivation may have direct links with HIV preventive behavior, while for women, the effects of HIV prevention information and HIV prevention motivation work through HIV prevention behavioral skills to affect HIV preventive behavior. These IMB model-based findings suggest directions for HIV prevention interventions with South African men and women living with HIV and on ART as an important component of overall strategies to contain South Africa's generalized HIV epidemic.

Keywords

IMB Model; HIV Transmission Risk; HIV-Infected; Antiretroviral Therapy; South Africa

South Africa currently confronts the world's most extensive HIV epidemic (UNAIDS, 2009). Some 5.6 million South Africans are living with HIV, the prevalence of HIV infection in the 15–49 year age range is approximately 18%, and the incidence of HIV infection is 1.8% per year in this age range (UNAIDS, 2009). Over 450,000 new HIV infections occur in South Africa each year, and there are more than 300,000 AIDS-related deaths annually (UNAIDS, 2009). At the same time, however, notable progress in fighting the HIV epidemic has occurred in South Africa: some 50% of South Africans infected with HIV with CD4 counts of < 200 currently receive antiretroviral therapy (ART), making possible the management of HIV as a chronic disease and preventing progression to AIDS, and provision of ART to prevent mother-to-child infection has risen to close to 100% (Shisana et al., 2009).

While an increasing number of South Africans living with HIV are receiving ART (UNAIDS, 2009), research concerning the prevalence and correlates of HIV transmission risk behavior among those receiving ART is sparse. The significance of HIV transmission risk behavior among South Africans on ART is underscored by the fact that adherence to ART among South Africans infected with HIV is variable (Chabikuli et al., 2010), virologic failure among South Africans infected with HIV and treated with ART is not uncommon (Chabikuli, et al., 2010; Mee et al., 2008), and ART drug resistance has been found in a high proportion (>80%) of South Africans infected with HIV who have been treated and who have experienced virologic failure (Marconi et al., 2008). The individual and population health implications of HIV transmission risk behavior among South Africans infected with HIV who may experience suboptimal therapy adherence, virologic failure, and drug resistance are potentially significant. Individuals who are infected with HIV and on ART

who have experienced virologic failure may serve as relatively healthy but infectious sources of drug resistant virus and contribute to the maintenance of South Africa's generalized HIV epidemic, and experience health- and life-threatening progression of HIV disease themselves.

With respect to understanding the occurrence and correlates of HIV transmission risk behavior among South Africans infected with HIV who are on ART, Eisele and colleagues (Eisele et al., 2009) reported a decrease from 43.7% to 23.2% in unprotected sex at last sexual contact in a one-year prospective study of HIV patients on ART. No corresponding decline in unprotected sex was observed in a parallel cohort of HIV-infected individuals who were waiting to receive therapy. According to Eisele et al. (2009, p. 1101), however, "...no hypothesized factors that we measured [e.g., AIDS stigma, disclosure of HIV status, belief that ART reduces HIV-infected person's need to practice safer sex] were found to have significantly affected the observed drop in unprotected sex...." within the cohort receiving ART. In related research on a sample of 735 South Africans with HIV who had recently started antiretroviral medication, Peltzer and Ramlagan (2010) reported a significant decline in unprotected sexual contacts over time. HIV-infected individuals on ART who continued to report unprotected sex were more often men and those with less education, lower adherence to medication, higher CD4 counts, greater reported AIDS stigma, and alcohol use at last sex. In an earlier study of 152 South Africans with HIV who were on ART, Kiene and colleagues (Kiene et al., 2006) found that nearly half of respondents reported vaginal or anal sexual intercourse during the preceding three months and 30% of these reported unprotected intercourse during this time. A total of 171 unprotected sex events were reported by the HIV-infected ART-treated cohort during this interval, and 40% of these unprotected acts were with partners who were perceived to be HIV-negative or whose HIV status was unknown. Alcohol use during sex, being forced to have sex, sex with a partner perceived to be HIV-infected, and sex with a casual partner were correlated with higher levels of unprotected sex, whereas HIV-status disclosure was related to less unprotected sex.

While informative, existing studies do not include formal theoretical tests of behavioral science models of factors that influence HIV transmission risk behavior among HIV-infected South Africans on ART, nor do they systematically explore potential differences in correlates of HIV transmission risk behavior with HIV-negative or HIV-status unknown compared to HIV-positive partners. Research concerning correlates of risky sexual activity between HIV-infected South Africans on ART and partners who are perceived to be HIV-negative or HIV-status unknown is of special importance for understanding potentially high risk of infection sexual behaviors. Moreover, in view of entrenched gender differences in relationship power and sexual risk behavior in South Africa (Dunkle et al., 2004; Measham et al., 2004) systematic study of gender differences in theorized correlates of HIV-transmission risk behavior in HIV-infected South African men and women on ART is also clearly required.

In an effort to advance our understanding of HIV transmission risk behavior among HIV-infected South Africans on ART, the current research brings to bear a well-articulated and well-researched conceptualization, the Information—Motivation—Behavioral Skills (IMB)

model of HIV preventive behavior (J. D. Fisher & Fisher, 1992; J. D. Fisher, et al., 2009; W. A. Fisher & Fisher, 1993). According to the IMB model, HIV prevention information, HIV prevention motivation, and HIV prevention behavioral skills are fundamental determinants of HIV risk and HIV preventive behavior. From the perspective of the IMB model, *HIV prevention information* that is directly relevant to the practice of preventive behavior is a prerequisite for engaging in preventive action. *HIV prevention motivation* to act on what one knows about HIV prevention, including personal motivation (attitudes towards personally undertaking preventive actions) and social motivation (perceived social support for engaging in preventive actions), is an additional prerequisite of HIV preventive behavior. *HIV prevention behavioral skills* for effectively engaging in HIV preventive actions are a third prerequisite for undertaking HIV preventive behavior and determine whether even well-informed and well-motivated individuals are capable of initiating and maintaining HIV preventive behavior effectively.

The IMB model specifies that the effects of HIV prevention information and HIV prevention motivation may work through the application of HIV prevention behavioral skills to affect HIV preventive behavior. Well-informed and well-motivated individuals are expected to apply the complex and novel behavioral skills that may be required for the effective and continued performance of HIV preventive actions. For example, a well-informed and well-motivated female with an intransigent male partner may need to engage in complex and skilled behavioral performances to ensure that she and her partner initiate and maintain condom use over time. Direct links between HIV prevention information, HIV prevention motivation, and HIV preventive behavior may also be observed, particularly in cases in which complex behavioral performances are not needed to effect HIV prevention. For example, a well-informed and well-motivated male may unilaterally use a condom without needing to engage in a complex and skilled sequence of behavioral acts to do so. We note that the IMB model has received considerable empirical support with respect to the hypothesized links among constructs and as a conceptual and practical basis for the design and implementation of successful HIV prevention interventions (see J. D. Fisher, Fisher, and Shuper, 2009, for a review of this research).

The current study involved the assessment of HIV prevention information, HIV prevention motivation, HIV prevention behavioral skills, and HIV transmission risk behavior in a sample of 1,388 South Africans infected with HIV and receiving ART at 16 HIV primary care clinics in KwaZulu-Natal, South Africa. The aim of the study involved application of the IMB model to identify factors associated with HIV transmission risk behavior in this population of considerable significance for curtailing, or maintaining, South Africa's generalized HIV epidemic. The current study contributes to theory and application in HIV prevention in several significant ways. Notably, this research represents the first test of the IMB model of HIV transmission risk behavior in an HIV-infected South African (or any sub-Saharan) population on ART, and is designed to provide the first systematic information concerning the relationship, and importance, of HIV prevention information, HIV prevention motivation, and HIV prevention behavioral skills to HIV transmission risk in this population. The current research is also designed to contribute systematic information concerning the relationship and importance of HIV prevention information, HIV prevention

motivation, and HIV prevention behavioral skills to HIV transmission risk behavior in HIV-infected men as compared to HIV-infected women on ART, and in HIV transmission risk behavior with HIV-negative and HIV-status unknown as compared to HIV-positive partners. Moreover, the current research has direct implications for the design of HIV prevention interventions with HIV infected South Africans on ART. Specifically, the current study is designed to provide empirical evidence to guide intervention emphasis on HIV prevention information, and/or HIV prevention motivation, and/or HIV prevention behavioral skills, and evidence to guide the design of interventions that are targeted to the potentially differential importance of these factors for HIV-infected South African men and HIV-infected South African women on ART and for prevention of risky sexual contacts with HIV- and HIV-status unknown partners.

Methods

Procedures

Individuals infected with HIV and receiving ART attending 16 rural and urban public clinics in uMgungundlovu and uMkhanyakude Districts in KwaZulu-Natal, South Africa completed an audio computer-assisted self-interview (ACASI) employing touch screen technology between June 2008 and April 2010. The ACASI constituted the baseline assessment for a randomized controlled trial of an HIV transmission risk reduction intervention for South Africans infected with HIV and receiving ART. The current analysis focuses on baseline ACASI data collected before any exposure to intervention activities.

Staff clinicians informed patients about this research if they met basic eligibility criteria (at least 18 years of age, HIV-infected, on ART, and cognitively able to participate in research) and referred interested patients to an onsite research assistant who obtained written informed consent, screened potential participants for HIV transmission risk behavior, and enrolled individuals in the study according to HIV transmission risk behavior stratification requirements. To maximize statistical power to detect changes in HIV transmission risk behavior, the randomized trial structured the enrolled sample on the basis of whether or not participants reported unprotected sex within the past four weeks, with the objective of 60% of the sample being composed of “risky” individuals reporting one or more unprotected sex acts within the past four weeks and 40% of “non-risky” individuals who reported no unprotected sex acts within the past four weeks. At each site, patients were recruited and enrolled sequentially until “risky” and “non-risky” participant recruitment targets for the site were met. There were an estimated 11,278 HIV-infected patients on ART across all sites in the study; 3,445 HIV-infected patients on ART across all sites were screened for participation; and 1,890 were deemed eligible to participate, taking into account the need to fulfill enrollment quotas for “risky” and “non-risky” participants. (The enrollment quota for “non-risky” participants was filled earlier than the enrollment quota for “risky” participants).

The ACASI assessed participants’ demographic characteristics and their HIV prevention information, HIV prevention motivation, HIV prevention behavioral skills, and sexual behavior during the past four weeks. Data on participants’ CD4⁺ cell count and viral load at baseline were obtained from their medical records when available. Participants were compensated with 70 Rand (approximately \$10) for completing the ACASI assessment.

Research procedures were reviewed and approved by institutional review boards in the U.S., Canada, and South Africa.

Measures

HIV Prevention Information—A 10-item HIV prevention information scale was adapted from existing validated measures that have been used in studies in South Africa (Kalichman & Simbayi, 2003; Kalichman et al., 2006; Kiene, et al., 2006; Kiene et al., 2008; Simbayi et al., 2005) to assess HIV prevention knowledge in areas of specific relevance for people living with HIV and included assessment of knowledge about the potential infectiousness of HIV-infected persons on ART. These questions had a “Yes”—“No”—“Don’t know” format. The number of correct responses was summed to yield the score for the HIV prevention information scale. “Don’t know” was considered an incorrect response. In the present sample, scale reliability was $\alpha = 0.70$ and confirmatory factor analysis (CFA) evaluation showed that the scale was a good fit to the data, *RMSEA* 0.012, *CFI* 0.99, with all items loading significantly ($p < .01$) on the factor.

HIV Prevention Motivation—Motivation to engage in HIV preventive behavior was assessed using a 13-item scale that included four subscales: (1) personal motivation (attitudes towards personal performance of HIV preventive acts, 3 items), (2) social motivation (perceived social support for performing these preventive acts, 3 items), (3) intentions to practice safer sex (3 items), (4) perceptions of the vulnerability of others to HIV infection if they have unprotected sex with an HIV-infected individual, and one’s own vulnerability to sexually transmitted infections resulting from unsafe sexual behavior (4-items). These four constructs have been used in past research as indicators of motivation to practice safer sex (J. D. Fisher et al., 2006; J. D. Fisher, Fisher, Misovich, Kimble, & Malloy, 1996), including applications in South Africa (Cornman et al., 2008; Kalichman & Simbayi, 2003; Kalichman, et al., 2006; Kiene, et al., 2006; Kiene, et al., 2008; Simbayi, et al., 2005). With the exception of the perceived vulnerability scale, these items were formatted on 5-point Likert-type scales. The perceived vulnerability subscale was formatted on a 4-point scale which was later mathematically rescaled to approximate a 5-point scale. The data were averaged within subscales and then across subscales to form the composite motivation score. CFA supported the factor structure and relationships among the subscales and indicated that the scale structure was a good fit to the data, *RMSEA* 0.014, *CFI* 0.997. Scale reliability was $\alpha = 0.78$ with all items loading significantly on each of the 4 subscales ($p < .01$).

HIV Prevention Behavioral Skills—Behavioral skills for performing specific HIV-preventive acts were assessed with 3 items employing 5-point scales (1 = very difficult to 5 = very easy). Participants rated the extent to which they believed it would be difficult or easy to always use condoms during intercourse, convince a partner who does not want to use a condom to use one, and refuse to have sex with a partner who does not want to use a condom. Similar measures of behavioral skills have been used extensively in the U.S. (J. D. Fisher, et al., 2006; J. D. Fisher, et al., 1996; W. A. Fisher, Fisher, & Rye, 1995) and South Africa (Cornman, et al., 2008; Kalichman & Simbayi, 2003; Kalichman, et al., 2006; Kiene, et al., 2006; Simbayi, et al., 2005). The behavioral skills scale reliability was $\alpha = 0.71$. CFA

demonstrated that the scale structure was a good fit to the data, *RMSEA* 0.00, *CFI* 1.0, all items loading significantly on the factor ($p < .01$).

A confirmatory factor analysis supported the overall factor structure of the 3-factor IMB (Information, Motivation, Behavioral Skills) measurement model, $X^2 = 384.1$, $df = 96$, *RMSEA* 0.046, 90% CIs [0.041–0.051], *CFI* .942. The hypothesized 3-factor model fit the data significantly better than either a two-factor model combining motivation and behavioral skills into one factor $X^2 = 413.9$, $df = 97$ (X^2 diff = 29.8, $df = 1$, $p < .001$) or a single factor model $X^2 = 1328.9$, $df = 99$ (X^2 diff = 944.8, $df = 3$, $p < .001$).

HIV Transmission Risk Sexual Behavior—To assess risky sexual behavior, participants reported, for up to five sexual partners, the number of times they had vaginal or anal sex in the preceding 4 weeks, and how many of those times a condom was used. They also indicated their perception of the HIV status of each of their partners (HIV-negative, HIV-positive, HIV status unknown). The total number of sex acts and protected sex acts were summed across partners and used to calculate the proportion of vaginal or anal sex acts protected by a condom. The proportion of times that vaginal or anal sex involved condom use was categorized into four categories: (0%) never used condoms; (>0 to 49%) sometimes used condoms; (50 to <100%) often used condoms; and (100%) always used condoms. The rationale for this categorization is described in the results section that follows.

Statistical Analyses

Causal modeling using Amos 18.0[®] (Amos Development Corporation, Crawfordville, FL) with maximum likelihood estimation was employed to test the hypothesized structure of the IMB model and causal paths among the latent constructs of HIV prevention information, HIV prevention motivation, and HIV prevention behavioral skills and the outcome of HIV transmission risk behavior. Causal modeling analyses compared the hypothesized relationships of the IMB model with the actual data, assessing the closeness of fit between the hypothesized model and the data. Root Mean Square Error of Approximation (*RMSEA*) and the Comparative Fit Index (*CFI*) model fit indices are reported. The *RMSEA* specifies the magnitude of the residuals between the hypothesized model and the data. Values less than 0.05 for the *RMSEA* indicate a good fit (MacCallum, Browne, & Sugawara, 1996). 90% confidence intervals for the *RMSEA* are also provided. For a good fitting model, the lower limit should not exceed 0.05 and the upper limit 0.08. The *CFI* compares the hypothesized model to a null model and indicates the improvement in the fit from the null. Values of .90–.94 are acceptable and .95 and above indicate a good fit (Bollen & Long, 1993). To verify the factor structure and factor loadings confirmatory factor analysis of the IMB scales were conducted using AMOS 18.0[®] (reported above). For each scale (HIV prevention information, motivation, and behavioral skills), we verified that the loadings for each of the scale items were statistically significant ($p < .01$) and evaluated the fit of the specified factor structure using the model fit statistics described above.

Results

The full sample enrolled in the randomized trial consisted of 840 men and 1050 women from 16 rural and urban public clinics providing ART in uMgungundlovu and

uMkhanyakude districts in KwaZulu-Natal, South Africa. For the present analyses participants were excluded for the following reasons: (1) did not answer questions in the ACASI about their sexual behavior (15 men, 18 women), (2) entered potentially incorrect responses on the ACASI touch screen computers due to touching a button too long leading to double or triple entry of numbers (e.g., indicating 222 partners in the preceding month) (12 men, 17 women), and (3) did not report having sexual intercourse in the prior 4 weeks (190 men, 250 women). The sample size for the analyses reported herein is 1,388 (623 men, 765 women).

Sample Characteristics

The majority (96.4%) of respondents reported that they were Zulu, 1.4% indicated that they were Xhosa, and the remaining 2.2% reported being of another African, Indian, Colored, or other ethnicity. Participants' average age was 36.5 years (SD 8.57, range 18–78), most reported living in a rural area (65%), and 20% and 15%, respectively, reported living in a city or town, or near a city or town. Over half of the participants reported being unmarried but having a partner with whom they did not live (60%), 27% reported being married, engaged to be married, or cohabitating, 3% were widowed, 1% were separated or divorced, and 1% reported being abandoned by their partner. Fifty-four percent of participants reported living in informal housing (made of planks/stones or mud and wooden poles), and 46% reported living in formal housing (made from blocks, bricks, and cement). Average length of time on antiretroviral therapy was 21.24 months (SD 19.0, range 0–183) for men and 21.79 months (SD 16.33, range 0–114) for women. According to chart-based clinical data, 89% of the sample had CD4⁺ cell count data available (725 men and 917 women), and of those, the mean CD4⁺ cell count for women was 331.77 (SD 197.02, range 17–1259) and for men, 256.77 (SD 187.10, range 6–2911). Forty one percent of the sample (245 men and 321 women) had chart-based viral load data measured within 3 months of the ACASI baseline assessment. Of those with viral load data, 181 men (73.9%) and 242 women (75.4%) had undetectable viral loads (<50). Of those with detectable viral loads, mean viral load for men was 63,519.31 copies per ml (range 55–1,100,000) and for women was 16,121.71 copies per ml (range 51–373,563).

HIV Transmission Risk Behavior

Based on the risk stratification procedures used during eligibility screening (desired goal of 60% “risky” participants), 60% of men and 68% of women enrolled in the study were screened as “risky” (reported unprotected sex within the past four weeks) and were selected for enrollment in the current sample to represent HIV-positive individuals on ART who engage in HIV transmission risk behavior. Within this sample (N = 1,388), at baseline, participants reported a total of 1,987 protected vaginal and anal sex acts (M=1.43, SD=2.42) and 3,600 unprotected vaginal and anal sex acts (M=2.59, SD=4.28) during the preceding four weeks. Over half of the sample (n = 336 men and 449 women) reported engaging in sex with partners they believed to be HIV-negative or whose HIV status was unknown within the prior 4 weeks. Among those participants who reported recent sexual activity with partners they believed to be HIV-negative or whose HIV status was unknown, 74% reported at least one unprotected sexual act. These participants represented 42% of the overall sample (222/623 men, 359/765 women). The 581 HIV-infected respondents who had unprotected

sex with an HIV-negative or HIV status unknown partner reported a total of 2,222 unprotected sex acts with a total of 630 HIV-negative or HIV status unknown partners during the preceding four weeks. Of HIV-infected respondents who reported unprotected acts with HIV-negative or HIV status unknown partners during the preceding four weeks, for whom viral load data were available, 62/250 (24.8%) participants had detectable viral loads with a mean viral load of 65,544.68, (SD= 193,578.96, range 52–1100000). Note that participants' date of viral load testing was within the past three months, their reports of unprotected sex concerned the past four weeks, therefore, periods of viral detectability and the occurrence of unprotected sex may not have completely overlapped.

Reported consistency of condom use during the prior 4 weeks varied greatly. Approximately half of participants (44.3% of men, 57.8% of women) reported never using condoms during sexual intercourse in the preceding four weeks, and one-quarter of respondents (34.3% of men, 21.0% of women) reported always using condoms. The distribution of percentage of condom use was highly kurtotic (−1.53) indicating peaks at either tail of the distribution. Following the conventions of many sexual risk behavior researchers (as reviewed in Schroder, Carey, & Vanable, 2003) we derived Likert-type categories from the percentage of condom use variable by dividing the sample into 4 categories reflective of a 4-point Likert scale: (0%) never used condoms; (>0 to 49%) sometimes used condoms; (50 to <100%) often used condoms; and (100%) always used condoms. Both approaches, the raw percentage and a Likert-type scale, are relative frequency measures. An advantage of Likert-type ratings is that they more closely approximate a Gaussian distribution (Schroder et al., 2003) and thereby address skewness and kurtosis issues common with raw proportion scores. Descriptive statistics on the percentage of times condoms were used by gender and perceived partner HIV-status are given in Table 1. Within the current sample, which was selected in part to represent HIV positive individuals who engage in HIV transmission risk behavior, the majority of sex acts across all partner HIV statuses was “not usually protected” (<50% condom use) by condoms. We emphasize that 60%–68% of the sample was intentionally composed of “risky” participants and that this prevalence of risky sex does not represent the population of HIV positive individuals on ART in this area of South Africa.

Evaluation of the IMB Model

Prior to testing the IMB model, we conducted analyses to determine if there were differences between the 16 clinical care sites or between urban versus rural clinical care sites. These analyses revealed no differences between clinics on the categorized outcome variable of percentage of time condoms were used during the past 4 weeks by clinic $\chi^2 = 11.46$, $df=15$, $N=1,388$, $p = .72$ or by urban versus rural clinic location (urban vs. rural) $\chi^2 = .92$, $df=1$, $N=1,388$, $p = .34$.

Collapsing across sites, the IMB model was evaluated including the four IMB-related constructs: HIV prevention information, HIV prevention motivation, HIV prevention behavioral skills, and HIV transmission risk behavior, with risk behavior represented categorically as the outcome variable of using condoms during sex never (0%), sometimes (>0 to 49%), often (50 to <100%), and (100%) always. As shown in Figure 1, all hypothesized paths in the IMB model were statistically significant, and the model explained

16.6% of the variance in the proportion of sex acts protected by a condom. As specified, the IMB model is a saturated model which produces model fit statistics of $\chi^2 = 0$, $df = 0$, $CFI = 1.0$. To determine if the direct paths between information and behavior and between motivation and behavior were needed in the model, two additional models were assessed. The first model deleted the direct path from information to behavior which gave a model fit of $\chi^2 = 6.9$, $df = 1$, and the resulting difference in fit between the full model and the alternative model was $\chi^2 = 6.9$, $df = 1$, $p = .009$, demonstrating that removing the direct path from information to behavior resulted in a poorer fitting model. In the second alternative model, the direct path from motivation to behavior was deleted. The fit of this model was $\chi^2 = 78.6$, $df = 1$ and the resulting difference in fit was $\chi^2 = 78.6$, $df = 1$, $p < .001$, also demonstrating that removing the direct path from motivation to behavior resulted in a poorer fitting model. The full model including all paths as specified was the best fit to the data.

Multiple groups analysis comparing model path estimates between men and women (see Figure 2) by pairwise comparisons revealed significant gender differences in the paths between behavioral skills and behavior and between motivation and behavior. Specifically, the coefficient for the path between motivation and behavior was larger for men than for women ($z = 2.26$, $p < .05$), whereas the coefficient for the path between behavioral skills and behavior was larger for women than for men ($z = 1.97$, $p < .05$). This model in which the path estimates were allowed to vary between men and women was a good fit to the data: $\chi^2 = 10.67$, $df = 4$, $CFI = .988$, $RMSEA = .035$, 90% CIs: [0.0095–0.061]. The model explained 14.2% and 13.7% of the variance in the proportion of unprotected sex acts for men and women, respectively.

An additional evaluation of the IMB model was conducted including only sex acts with partners believed to be HIV-negative or HIV status unknown, since those sex acts may pose the greatest risk of HIV transmission to others. Participants who reported sex with both HIV-positive and HIV-negative or HIV-status unknown partners ($n=33$) were included but only the relevant sex acts were employed in calculating the percentage of sex acts protected by a condom. The results of this model are presented in Figure 3 showing path estimates separately for men and women. The model was a good fit to the data: $\chi^2 = 6.95$, $df = 5$, $p = .22$, $CFI = .996$, $RMSEA = .017$, 90% CIs: [0.00–0.044]. Overall, the model explained more of the variance in the proportion of sex acts that were protected among men than among women (14.7% for men vs. 11.4% for women). Interestingly, the path from behavioral skills to behavior was statistically significant for women but not for men.

Finally, in exploratory analyses, model path estimates were compared between participants reporting low (below the mean of 4) and high (1 SD above the mean, >8) levels of sexual activity for the prior 4 weeks. Correlates of risky sexual behavior among HIV-infected individuals on ART who have relatively high frequency of sexual activity may be of particular public health significance. As can be seen in Figure 4, the path estimates were stronger for those HIV-infected individuals engaging in high levels of sexual activity, and the model explains nearly twice as much variance in preventive behavior than for individuals engaging in low levels of sexual activity.

Discussion

The current research examined the IMB model's theorized correlates of HIV transmission risk behavior in a large sample of South African men and women infected with HIV and receiving ART. Findings indicate that HIV transmission risk behavior in the current sample of HIV-infected South Africans on ART was common, as would be expected in a sample that was recruited to represent such risk. Within this sample, which as we emphasize was selected to represent recent risky behavior in 60%–68% of participants, 581/1,388 sexually active HIV-infected individuals reported a total of 2,222 unprotected sex acts with some 630 HIV-negative or HIV-status unknown partners during the preceding four weeks. Given variable levels of potential infectiousness—approximately one out of four individuals in the current sample had a detectable viral load averaging 65,544.68 copies per ml—HIV transmission risk behavior among HIV-infected South Africans on ART appears to be of considerable individual and public health importance.

The IMB model analyses reported confirm the fundamental assumptions of the model and provide important information about the significance of particular constructs as correlates of HIV transmission risk for men compared to women, for unprotected contacts with HIV-negative and HIV-status unknown compared to HIV-positive partners, and for those with lower versus higher levels of sexual activity. Overall, analyses confirmed that HIV prevention information and HIV prevention motivation worked through HIV prevention behavioral skills to affect HIV transmission risk behavior. Direct links between HIV prevention information and HIV preventive behavior and between HIV prevention motivation and behavior were also seen, and eliminating these paths resulted in poorer fit of the model to the data.

Comparative IMB model testing analyses by participant gender indicated that the IMB model fit the data obtained for each gender. HIV prevention information and HIV prevention motivation worked through HIV prevention behavioral skills to affect HIV preventive behavior for both men and women. Importantly, the pattern of comparative results by gender also indicated that HIV prevention motivation was a more important correlate of transmission risk behavior for men (versus women), while HIV prevention behavioral skills were a more important correlate of transmission risk for women (compared to men). This pattern of findings is consistent with the past research concerning gender, power, and HIV risk in South Africa (e.g., Dunkle et al., 2004; Measham et al., 2004) and with the logic that motivated men may act to practice safer sex more or less unilaterally, with minimal involvement of their partners, and without reliance on complex behavioral skill performance. Women, in contrast, may require complex and sophisticated behavioral skills to negotiate safer sex with their partners and effectively ensure that safer sexual practices are initiated and maintained. The implications of this pattern of findings for correlates of HIV-infected men's and women's risky sexual behavior overall and with HIV-negative and HIV-status unknown partners are clear. Gender-targeted interventions for HIV-infected men on ART may emphasize strengthening their HIV prevention motivation, and gender-targeted interventions for HIV-infected women on ART may emphasize strengthening HIV prevention behavioral skills. We would add that clinical care settings such as those in which this research was conducted provide the most nearly universal and

ongoing access to HIV-infected persons on ART and can be utilized as an efficient intervention delivery channel to reach this population.

An overall test of the IMB model for HIV transmission risk behavior in sexual activity with partners perceived to be HIV-negative or HIV status unknown showed that the IMB model fit the data for such potentially high risk of infection acts. Moreover, the pattern of gender-specific relationships is seen once again in this analysis. For men, direct relationships between HIV prevention information and risk behavior and between HIV prevention motivation and risk behavior with HIV-negative and HIV-status unknown partners were observed. For women, HIV prevention information and HIV prevention motivation appear to be related to HIV transmission risk behavior with HIV-negative or HIV-status unknown partners though their relationship with HIV prevention behavioral skills. Convergent findings suggest that, for South African men infected with HIV and on ART, HIV prevention information and HIV prevention motivation may have a critical influence on preventive behavior, and for South African women infected with HIV and on ART, HIV prevention behavioral skills may be of paramount importance for enabling the practice of safer sexual behavior.

Further comparisons of IMB model evaluations for those with high (above mean levels) compared to lower (below mean levels) of sexual behavior were carried out to explore potential differences in correlates of risky sexual behavior among those who were particularly sexually active or less sexually active. Findings indicate that the fundamental relationships of the IMB model are significant in both groups, but the overall proportion of variance accounted for in the high sexual activity group was approximately twice as great as in the low sexual activity group. Quite speculatively—and hopefully, IMB model-based interventions targeting HIV prevention information, motivation, and behavioral skills may have especially strong impact in promoting safer sexual behavior among those who have a high level of sexual activity.

While the current research represents the first test of theorized correlates of HIV transmission risk behavior in a large sample of South African men and women who are HIV-infected and receiving ART, it has a number of limitations. First, it is noted that all findings are based upon self-reports, and there are potential biases in such self-reports. For example, the perception that a partner is HIV-infected and that condom use may therefore not be necessary may not be an accurate one. This would make our estimates of sexual behavior that poses the greatest risk of HIV transmission conservative ones. A second relative limitation of the current research involves the proportion of variance accounted for in IMB model tests. While the proportion of variance accounted for is not large, it is also not trivial. The IMB model repeatedly demonstrated fit with the data, and the patterns of results concerning the differential strength of correlates of HIV transmission risk for different groups (e.g., motivation is more important for men, behavioral skills are more important for women) has clear implications for the design of gender-sensitive HIV transmission risk reduction interventions. Finally, the current analyses are correlational in nature, and prospective tests of the IMB model in samples of HIV-infected South Africans are clearly desirable. The current research does, however, demonstrate the utility of applying a well-articulated theoretical model in efforts to understand HIV transmission risk behavior in a

population of individuals who may, in part, represent one of the leading edges of the South African HIV epidemic. While additional research is clearly needed to confirm and elaborate these findings, they suggest important factors to consider when developing HIV risk reduction interventions for men and women in South Africa who are living with HIV infection and taking ART.

Acknowledgments

The authors wish to acknowledge the assistance of Ntombenhle Ngcobo, Zandile Jojo, Lindsay Shepherd, Vernon Solomon, Ann Strode, Francois van Loggerenberg, Barry Kistnasamy, Lindiwe Xulu, Ross Greener, and Umesh Laloo for their efforts on measure development, data collection, and technical support. Acknowledgment is also made to the KwaZulu-Natal (KZN) Department of Health (DOH) and uMkhanyakude (DC 27) and uMgungundlovu (DC 22) health districts for their collaboration and support, and to the efforts of the on-site Options for Health Research Assistants. This research was supported by a grant from the National Institute of Mental Health (5R01MH077524-05), Jeffrey D. Fisher, PI and the first author is supported by a career development grant from NIMH (K01MH083536).

References

- Bollen, KA.; Long, JS. Testing structural equation models. Newbury Park, CA: Sage Publications; 1993.
- Chabikuli NO, Datonye DO, Nachega J, Ansong D. Adherence to antiretroviral therapy, virologic failure and workload at the Rustenburg Provincial Hospital. South Africa Family Practice. 2010; 52(4):350–355.
- Cornman DH, Kiene SM, Christie S, Fisher WA, Shuper PA, Pillay S, Fisher JD. Clinic-based intervention reduces unprotected sexual behavior among HIV-infected patients in KwaZulu-Natal, South Africa: Results of a pilot study. Journal of Acquired Immune Deficiency Syndromes. 2008; 48(5):553–560. [PubMed: 18645518]
- Dunkle KL, Jewkes RK, Brown HC, Gray GE, McIntyre JA, Harlow SD. Gender-based violence, relationship power, and risk of HIV infection in women attending antenatal clinics in South Africa. The Lancet. 2004; 363:1415–1421. (2004).
- Eisele TP, Mathews C, Chopra M, Lurie MN, Brown L, Dewing S, Kendall C. Changes in risk behavior among HIV-positive patients during their first year of antiretroviral therapy in Cape Town, South Africa. AIDS and Behavior. 2009; 13:1097–1105. [PubMed: 18846418]
- Fisher JD, Fisher WA. Changing AIDS risk behavior. Psychological Bulletin. 1992; 111:455–474. [PubMed: 1594721]
- Fisher JD, Fisher WA, Cornman DH, Amico KR, Bryan A, Friedland GH. Clinician-delivered intervention during routine clinical care reduces unprotected sexual behavior among HIV-infected patients. Journal of Acquired Immune Deficiency Syndrome. 2006; 41(1):44–52.
- Fisher JD, Fisher WA, Misovich SJ, Kimble DL, Malloy T. Changing AIDS risk behavior: Effects of a conceptually based AIDS risk reduction intervention in a university student population. Health Psychology. 1996; 15:114–123. [PubMed: 8681919]
- Fisher, JD.; Fisher, WA.; Shuper, PA. The Information-Motivation-Behavioral Skills model of HIV preventive behavior. In: DiClemente, RJ.; Crosby, RA.; Kegler, MC., editors. Emerging theories in health promotion practice and research. Second ed.. San Francisco: Jossey-Bass; 2009. p. 22–63.
- Fisher, WA.; Fisher, JD. A general social psychological model for changing AIDS risk behavior. In: Pryor, J.; Reeder, G., editors. The social psychology of HIV infection. Hillsdale, NJ: Erlbaum; 1993.
- Fisher WA, Fisher JD, Rye BJ. Understanding and promoting AIDS preventive behavior: Insights from the Theory of Reasoned Action. Health Psychology. 1995; 14:255–264. [PubMed: 7641667]
- Kalichman SC, Simbayi LC. HIV testing attitudes, AIDS stigma and voluntary HIV counseling and testing in a black township in Cape Town, South Africa. Sexually Transmitted Infections. 2003; 79:442–447. [PubMed: 14663117]

- Kalichman SC, Simbayi LC, Cain D, Jooste S, Skinner D, Cherry C. Generalizing the Information—Motivation—Behavioral Skills (IMB) model to sexually transmitted infection clinic patients in Cape Town, South Africa. *AIDS Care*. 2006; 18(3):178–182. [PubMed: 16546776]
- Kiene SM, Christie S, Cornman DH, Fisher WA, Shuper PA, Pillay S, Fisher JD. Sexual risk behavior among HIV-positive individuals in clinical care in KwaZulu-Natal, South Africa. *AIDS*. 2006; 20:1781–1784. [PubMed: 16931945]
- Kiene SM, Simbayi LC, Abrams A, Cloete A, Tennen H, Fisher JD. High rates of unprotected sex occurring among HIV-positive individuals in a daily diary study in South Africa: The role of alcohol use. *Journal of Acquired Immune Deficiency Syndromes*. 2008; 48:219–226. [PubMed: 18769345]
- MacCallum RC, Browne MW, Sugawara HM. Power analysis and determination of sample size for covariance structure modeling. *Psychological Methods*. 1996; 1:130–149.
- Marconi VC, Sunpath H, Zhigang L, Gordon M, Kofi K-A, Hampton J, Kuritzkers DR. Prevalence of HIV-1 drug resistance after failure of a first high active antiretroviral therapy regimen in KwaZulu Natal, South Africa. *Clinical Infectious Diseases*. 2008; 46:1589–1597. [PubMed: 18419495]
- Mee P, Fielding KL, Charalambous S, Churchyard GJ, Grant AD. Evaluation of the WHO criteria for antiretroviral treatment failure among adults in South Africa. *AIDS*. 2008; 22:1971–1977. [PubMed: 18784460]
- Peltzer K, Ramlagan S. Safer sexual behaviours after 1 year of antiretroviral treatment in KwaZulu-Natal, South Africa: a prospective cohort study. *Sexual Health*. 2010; 7(2):135–141. [PubMed: 20465976]
- Pettifor AE, Measham DM, Rees HV, Padian NS. Sexual power and HIV risk, South Africa. *Emerging Infectious Diseases*. 2004; 10(11):1996–2004. [PubMed: 15550214]
- Schroeder KE, Carey MP, Vanable PA. Methodological challenges in research on sexual risk behavior: I. Item content, scaling, and data analytical options. *Annals of Behavioral Medicine*. 2003; 26:76–103. [PubMed: 14534027]
- Shisana, O.; Rehle, T.; Simbayi, LC.; Zuma, K.; Jooste, S.; Pillay-van-Wyk, V. the SABSSM III Implementation Team. South African national HIV prevalence, incidence, behaviour and communication survey 2008: A turning tide among teenagers?. Cape Town: HSRC Press; 2009.
- Simbayi LC, Kalichman SC, Jooste S, Cherry C, Mfecane S, Cain D. Risk factors for HIV-AIDS among youth in Cape Town, South Africa. *AIDS and Behavior*. 2005; 9:53–61. [PubMed: 15812613]
- UNAIDS. [Retrieved September 1, 2011] Epidemiological Factsheet. 2009. from <http://www.unaids.org/en/regionscountries/countries/southafrica/>

Figure 1.

Overall evaluation of the Information—Motivation—Behavioral Skills Model of HIV-Preventive Behavior among South African men and women living with HIV and receiving ART. * $p < .01$, ** $p < .001$. Path estimates are standardized.

Figure 2.

Gender Differences in the Information—Motivation—Behavioral Skills Model of HIV-Preventive Behavior among South African men and women infected with HIV and receiving ART. Estimates for each path are listed as the estimate for men (n=623) and then the estimate for women (n=765).

* $p < .01$, ** $p < .001$. Path estimates are standardized. Measures of model fit: $\chi^2 10.67$ $df = 4$, $CFI = .988$, $RMSEA = .035$, 90% CIs: [0.0095–0.061]

Figure 3.

The Information—Motivation—Behavioral Skills Model of HIV-Preventive Behavior for sex acts involving HIV-negative or HIV status unknown partners by gender among South African men and women living with HIV and receiving ART. Estimates for each path are listed as the estimate for men (n=336) and then the estimate for women (n=449).

* $p < .01$, ** $p < .001$. Path estimates are standardized. Measures of model fit: $\chi^2 = 6.95$ $df = 5$, $p = .22$, $CFI = .996$, $RMSEA = .017$, 90% CIs: [0.00–0.044]

Figure 4.

Path-estimate differences in the Information—Motivation—Behavioral Skills Model of HIV-Preventive Behavior by levels of sexual activity among South African men and women living with HIV and receiving ART. Model coefficients appear in the following order: Low (n=1035) and High levels (n=189) of sexual activity.

* $p < .05$, ** $p < .01$. Path estimates are standardized. Measures of model fit: χ^2 10.09 df = 5, $p = .073$, CFI = .989, RMSEA = .035, 90% CIs: [0.016–0.055]. The model explained 10.7% of the variance in behavior for those reporting low-levels of sexual activity (1–4 events), 19.5% for those reporting high-levels of sexual activity (>8).

Table 1

Percentage of Vaginal or Anal Sexual Intercourse Protected with Condoms During the Preceding Four Weeks, by Gender and Partner HIV-Infection Status¹

	Men	Women	Overall
All partners			
Never (0%)	44.3%	57.8%	51.7%
Sometimes (>0 to 49%)	6.4%	6.9%	6.7%
Often (50 to-99%)	14.9%	14.2%	14.6%
Always (100%)	34.3%	21.0%	27.0%
HIV-negative or HIV status unknown partner			
Never (0%)	49.4%	61.5%	56.3%
Sometimes (>0 to 49%)	6.3%	6.7%	6.5%
Often (50 to-99%)	10.4%	11.8%	11.2%
Always (100%)	33.9%	20.0%	26.0%
HIV-positive partner			
Never (0%)	40.7%	53.7%	47.3%
Sometimes (>0 to 49%)	5.7%	5.5%	5.6%
Often (50 to-99%)	18.6%	16.9%	17.7%
Always (100%)	35.0%	23.9%	29.4%

¹ Since the recruitment procedures resulted in a greater percentage of women compared to men reporting unprotected sex during eligibility screening, direct comparisons between men and women on level of risk are not possible