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Changes in Condom Use During the First Year of HIV Treatment in Uganda and the Relationship to Depression

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Abstract

Purpose—We examined the effect of antiretroviral therapy (ART), and the predictive role of depression, on condom use with primary partners.

Methods—Data from three studies in Uganda were combined into a sample of 750 patients with a primary sex partner, with 502 starting ART and 248 entering HIV care, and followed for 12 months. Random-effects logistic regression models were used to examine the impact of ART, and the influence of baseline level and change in depression, on condom use with primary partners.

Results—At Month 12, 61% ART and 67% non-ART patients were consistent condom users, compared to 44% and 41% at baseline, respectively. Multivariate analysis revealed that consistent condom use increased similarly for ART and non-ART patients, and that Minor Depression at baseline and increased depression over time predicted inconsistent condom use.

Conclusions—Improved depression diagnosis and treatment could benefit HIV prevention.

Keywords

depression; HIV; antiretroviral therapy; condom use; primary partner; Uganda

Though once viewed as an exemplar of successful reduction in HIV prevalence, Uganda's HIV prevalence rate has remained largely stagnant at around 7% for nearly the past decade [1]. HIV transmission in Uganda and the larger region of sub-Saharan Africa often occurs within stable relationships [2,3], with about half of heterosexual couples living with HIV being serodiscordant [4,5], and 40–60% of new adult infections occurring in the context of such relationships [5,6]. The little research that has examined the prevalence of unprotected sex in heterosexual couples living with HIV in sub-Saharan Africa has found rates ranging from 20% to 40% [7,8], but research in the region involving couples has focused mainly on HIV disclosure and HIV testing [9,10], rather than identifying determinants of sexual risk

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behavior. Understanding the factors and context that influence sexual risk behavior in couples is critical for developing effective couples-based HIV prevention efforts.

Ongoing scale up of antiretroviral therapy (ART) continues across sub-Saharan Africa, and in 2011 nearly 300,000 Ugandans had accessed ART [1]. HIV treatment is thought to have a major influence on HIV prevention as highlighted by the current global emphasis on "treatment as prevention" approaches [11,12]. ART can prevent transmission by dramatically reducing viral load and infectiousness [13,14], but findings are mixed regarding the effect of ART on condom use. Most studies in sub-Saharan Africa have found unprotected sex to be reduced by 50–70% following initiation of ART [10,15–17], but at least one study found ART to be associated with increased unprotected sex [18], and still others have found no relationship [19]. Improved physical health from HIV treatment can increase libido and sexual activity [10,20], and reduced infectiousness and treatment optimism can contribute to complacency regarding condom use [21]. Methodological limitations may contribute to these mixed results, as most of the above studies were either cross-sectional [16,19] or were longitudinal but did not include a comparison group in their analysis [15,17].

While its physical health benefits are thought to be the primary mechanism by which ART influences sexual behavior, mental health may also play a role. Drawing on Social Cognitive Theory [22], we postulate that depression influences condom use through symptoms such as lack of motivation, hopelessness, and fatigue, which may diminish self-efficacy and motivation to negotiate safe sex and protect oneself and one's partner(s). Also, low libido can be a symptom of depression, and some may avoid using condoms in an attempt to improve sexual performance (e.g., erectile functioning) in the context of reduced interest [23]. The literature reveals an inconsistent link between depression and condom use [24,25]. Most studies have been cross-sectional, but one longitudinal study of people living with HIV in the U.S. found that both positive and negative mood states can be associated with condom use, and that depressive symptoms and sexual risk behavior tend to change in tandem [26]. Cross-cultural research in Uganda has supported the validity of the Western construction of depression [27], and with research showing that 10–20% of people living with HIV in sub-Saharan Africa have Major Depression, and another 20–30% have sub-clinical but elevated depressive symptoms [28–31], the role of depression in condom use behavior needs to be further explored. Understanding how depression may influence condom use has implications for policy and funding regarding integration of mental health services into HIV care programs that are largely void of such services in sub-Saharan Africa.

We have conducted three longitudinal studies of people living with HIV entering HIV care or starting ART in Uganda over the past five years, with the primary goal of examining social and economic benefits of HIV treatment. In the analysis reported here, we combined data from these studies to examine the effects of ART and HIV care on condom use among participants with a primary sex partner, and the role of depression as a determinant of condom use. More specifically, we assessed whether the influence of depression varied by depression severity (both globally, as well as diagnostically with regard to Minor vs. Major Depression), and whether change in depression was related to corresponding changes in condom use after accounting for the direct impact of ART.

METHODS

Study Design

Data from three longitudinal studies were merged for the analysis. Participants in Studies A and B enrolled in studies of ART impact on multiple health outcomes; both study samples were comprised solely of patients just entering HIV care and included both patients starting ART and those not yet eligible for ART. Enrolment for Study A was between January and September 2008, while Study B enrolled patients from July 2008 to August 2009. Participants in Study C had been in HIV care for different lengths of time but were about to start ART at study enrollment (between January 2010 and February 2011). Study C was designed specifically to examine the role of depression and antidepressant therapy on the socioeconomic outcomes of ART; in addition to depression being assessed at each time point, antidepressants were prescribed to those who were clinically depressed. Thus, all participants in Studies A and B could be included in the analysis for this paper, but only the participants in Study C who did not receive antidepressant therapy could be included. Depression diagnosis and treatment was not available as part of usual care at any of the participating clinics. In addition, only participants with a primary sex partner at a minimum of two survey assessments were included in the analysis for this paper so that we could examine potential change in condom use; however, the primary partner did not have to be the same individual at each assessment. In each of the three studies, participants completed assessments at baseline and months 6 and 12.

Setting

Study A was conducted at two HIV clinics operated by Joint Clinical Research Center in Kampala and Kakira. Study B was conducted at two HIV clinics in Kampala, one operated by Reach Out Mbuya and one by Mulago-Mbarara Teaching Hospitals Joint AIDS Program. Study C was conducted at four HIV clinics operated by Mildmay Uganda, in Kampala and the rural towns of Mityana, Naggalama and Mukono (each of which are within 100 km of Kampala). These clinics generally serve clients in the lower socioeconomic strata.

Sample

Eligibility criteria for Studies A and B included being age 18 years or older, just started receiving care at the clinic and completed evaluation for ART eligibility, and if ineligible for ART, then CD4 cell count < 400 cells/mm^3 (which signifies some immune suppression). In Study C, participants needed to be 18 years of age or older and just been prescribed ART. In all studies, the primary eligibility criteria for initiation of ART was having a CD4 cell count ≤ 250 cells/mm^3 or a WHO HIV disease stage III or IV (AIDS diagnosis). Eligible patients were enrolled consecutively in each study. Providers referred eligible patients who were interested in participating to the study coordinator for consent procedures, screening and scheduling of baseline interviews. All participants were required to provide written informed consent. Study coordinators in each study reported that very few (<5%) eligible patients refused to participate. The study protocol was approved by IRBs at RAND, Makerere University (Studies B and C), and Joint Clinical Research Center (Study A), as well as the Uganda National Council of Science and Technology.

Measures

All measures were interviewer-administered by trained interviewers in Luganda, the predominant language in this region of Uganda. The questionnaire was translated into Luganda using standard translation and back-translation methodology. All measures were administered at each of the three assessment time points.

Condom use—Condom use during sexual intercourse with one's primary partner over the past 6 months was measured using a 5-point rating scale from "never" to "always," which was converted to a binary variable representing whether or not condoms were always used (consistent condom use).

Depression—The 9-item Patient Health Questionnaire (PHQ-9) [32] was used to measure the presence of depressive symptoms over the past 2 weeks. Each of the 9 items corresponds to the symptoms used to diagnose depression according to DSM-IV (Diagnostic and Statistics Manual of Mental Disorders, 4th Edition) criteria [33]; responses to each item range from 0 'not at all' to 3 'nearly every day.' Items were summed with a possible range of 0–27, with scores < 5 representing no depression, 5–9 representing 'mild,' 10–14 'moderate,' 15–19 'moderately severe' and 20–27 'severe' depression. Scores > 9 correspond highly to Major Depression (88% specificity and sensitivity) when compared with a diagnostic clinical interview [32]. While the PHQ-9 is not a diagnostic tool per se, in this analysis scores of 5–9 are taken to represent the likelihood of having "Minor Depression" and scores greater than 9 represent the likelihood of having "Major Depression." The PHQ-9 has been used successfully with HIV-infected individuals in other studies within sub-Saharan Africa [34].

Relationship variables—Relationship status (single, married, in a committed relationship) and presence of a regular sex partner (among those not married or in a committed relationship) were assessed. HIV status (positive, negative, unknown) of the primary sex partner was assessed, as well as whether the respondent had disclosed their HIV status to this partner.

Demographic and medical characteristics included age, sex, education (classified as a binary indicator of having any secondary education), work status (engaged in food or income generating activity over the past 7 days), and CD4 cell count (abstracted from medical chart).

Data Analysis

Descriptive statistics were computed for the continuous and binary measures, followed by bivariate tests (two-tailed t-tests, chi square tests) to assess sample differences across the three studies and by treatment condition. Because participants included in the analysis reported having a primary partner for the first time either at study baseline or Month 6, the "baseline" for analyses involving the primary sex partner represented the first study assessment in which the respondent reported having a primary partner.

Multivariate random-effects logistic regression models were used to examine the effects of ART and HIV care on consistent condom use with primary partner measured across three assessments, assuming a linear trend in the outcome between baseline and Month 12. We assumed a hierarchical data structure with multiple assessments nested within participants, and with participants nested within their study site. The model specification included a random intercept for each study site and participant to allow for baseline differences in the outcome across sites and participants. This approach also produced adjusted standard errors that accounted for correlations among multiple assessments conducted with each person, and participants at the same study site.

With the potential for systematic differences in baseline characteristics between the ART and non-ART groups as a result of the lack of randomization, we adjusted for such biases using propensity score weights. Specifically, we included 18 baseline variables in the propensity score model to predict the likelihood of each study participant being in the ART or non-ART groups. The inverse of this predicted likelihood was used to generate a propensity score weight to equalize the distribution of baseline variables among members of the two groups in order to represent the characteristics of the underlying population from which they were drawn.

The propensity score weights were computed using generalized boosted models (GBM), a flexible, nonparametric estimation technique that can regress the treatment indicator (ART versus non-ART) onto a large number of baseline covariates [35,36]. These procedures were implemented using the twang (Toolkit for Weighting and Analysis of Nonequivalent Groups) package in R, and balance between the ART and non-ART groups was assessed across a number of twang diagnostic criteria [37]. To assess for significant differences between the two groups, we calculated the standardized mean difference (SMD) for all 18 variables before and after propensity-score weighting. SMD values of 0 represent no difference in means, and SMD differences greater than 0.25 (or less than −0.25) are considered to be "moderate effect size differences" [38]. The majority of variables showed good balance, and the few that did not were either included as covariates (e.g., CD4 count) or highly correlated with other variables in the model and thus excluded.

The random effects models with propensity score weights were fit using a maximum likelihood approach in XTMELOGIT in Stata [39]. Note that we did not use attrition weights because our sample included only participants with a primary partner at no less than two of the three assessments, and condom use data at those time points, resulting in all participants having at least partial follow-up data.

Model Specification—Three models were estimated to examine the effect of ART on change in consistent condom use over 12 months of treatment, and the potential role of depression in explaining these changes. The dependent variable in the models was change in consistent condom use across the three study assessments. All three models included the following core set of independent variables: 1) ART status (representing whether or not the ART and non-ART groups differ on condom use at baseline), 2) time [ordinal variable representing the change in condom use for each additional unit of time (i.e., 6 months) over the three time periods, and which is attributed to the comparison or non-ART group], 3) the

interaction of ART status by time (representing the change in consistent condom use with each unit of time among ART patients relative to the non-ART group), and 4) covariates including age, male sex, HIV status of primary partner, any secondary education, work status and baseline CD4 count.

What differed across the 3 models were the depression-related independent variables to compare the influence of global depressive symptoms to categorical depression severity. The regression effects for each measure of depression over time were decomposed into two parts: (i) a baseline value of the measure, and (ii) change from baseline in the measure. The main effect of the baseline value estimated the cross-sectional association between baseline depression and consistent condom use, while the main effect of the change score estimated whether change in depression is prospectively associated with change in consistent condom use. The first model included baseline depressive symptoms (measured by the continuous PHQ-9 total score) and the interaction of time and change in depressive symptoms from baseline to Month 12. A positive change score indicates a reduction in depressive symptoms, while a negative change score indicates increased symptoms. The second model included separate baseline indicators of having Major Depression (PHQ-9 score > 9) and Minor Depression (PHQ-9 score between 5–9), and the interaction of time and change in depression symptoms (as measured by PHQ-9 total score and coded as in the first model). The third model was similar to model 2 as it also included baseline indicators of Major and Minor Depression, but its two interaction terms were for time by categorical improvement in depression severity (with the three categories being none, Minor or Major Depression), and time by worsening of depressive severity category; this served to separately estimate change in consistent condom use among those who improved vs. those who got worse with respect to depression. The indicators of categorical change in depression severity were binary: “1” for improving severity indicated that someone went from Major to Minor or no depression, or Minor Depression to none, while “0” represented either no change or worsening of severity category; with regard to the indicator of worsening severity, “1” indicated that someone went from no depression to Minor or Major Depression, or from Minor to Major Depression, while “0” represented no change or an improvement in severity category.

Sensitivity analysis—The primary analysis used an intention-to-treat (ITT) approach, which included all participants in the ART and non-ART groups classified by their ART status at baseline, regardless of change in ART status after baseline. This produced a conservative estimate of the effects of ART given that 72 non-ART patients started ART during the study period (34 at Month 6 and 38 by Month 12); also 4 ART patients stopped taking ART during the study (1 by Month 6 and 3 by Month 12). We tested the robustness of the ITT analysis with a sensitivity analysis that excluded the 76 participants who switched treatment assignments during the course of the study. We conducted a second sensitivity analysis in which non-ART patients who started ART at Month 6 were allowed to switch over to the ART arm starting at Month 6. In the second sensitivity analysis, we used a time-lag effect model to assess the effect of baseline treatment assignment on change between baseline and Month 6, and the “actual” rather than baseline treatment assignment on the change between Month 6 and Month 12 to allow for the time between receiving treatment

and seeing an effect of treatment. We chose not to present the data from the sensitivity analyses, because the findings remained unchanged from the original ITT models.

RESULTS

Sample Characteristics

Of the 1,731 participants in the merged dataset, 750 reported having a primary sex partner in at least two of the three assessments, thus comprising the sample included in this analysis. (Note that 68% of the 750 had a primary partner at all three assessments). Of the 750, 299 were from Study A, 188 from Study B, and 263 from Study C; 502 (69%) were starting ART and 248 were in the non-ART group. The baseline characteristics of the complete sample, as well as by study and ART status, are presented in Table 1. The subgroups drawn from the three studies differed significantly on several variables. Mean age was higher in Study C compared to Study B [35.4 years vs. 33.0; $t(449) = 3.2$, $p = .007$]. Study C had a greater proportion of participants with an HIV-negative partner compared to those in Study B [22% vs. 11%; $t(449) = 3.1$, $p = .009$], and fewer with a partner of unknown HIV status compared to Study A [24% vs. 40%; $t(560) = 3.7$, $p = .001$]. Mean CD4 count varied significantly across studies, with the lowest average CD4 count (sickest patients) in Study C, which was expected given that all participants in Study C were ART eligible [$F(2,717) = 41.7$, $p < .0001$]. There were between-study differences on all depression measures, with the highest level of depression observed among participants of Study A, followed by Study B, and the lowest level of depression being in Study C because we excluded its clinically depressed participants as they were receiving antidepressants [Depression symptoms: $F(2,747) = 30.2$, $p < .0001$; Major Depression: $F(2,747) = 4.00$, $p = 0.02$; Minor Depression: $F(2,747) = 16.8$, $p < .0001$]. In baseline comparisons with the non-ART group, the ART group had a higher mean age [35.0 years vs. 33.4; $t(747) = 2.5$, $p = .01$], a greater proportion of males [45% vs. 37%; $t(748) = 2.2$, $p = .03$], and (as expected) a lower CD4 count [158 vs. 354; $t(303) = 17.1$, $p < .0001$] (see Table 1); the two groups also differed significantly with regard to measures of depression, but not consistent condom use, as described below.

For the vast majority of participants, their primary sex partner was a spouse or someone that they were in a committed relationship with (88%), while the remaining 12% were single and not in a committed relationship and their primary partner was someone they had regular sex with. Almost half (49%) of the sample had a primary partner who was also HIV-positive, while 17% reported that their partner was HIV-negative, and the other 34% did not know the HIV status of their partner. Most (81%) of the participants reported having disclosed their HIV status to their primary partner. However, while rates of disclosure were very high among those who knew the HIV status of their partner, whether their partner was HIV-positive (98%) or HIV-negative (89%), just over half (53%) of the participants who did not know the HIV status of their partner had disclosed [$\chi^2(2, N = 676) = 189.5$, $p < .0001$].

Condom use—The distribution of condom use was bimodal with 43% reporting that they ‘always’ used a condom during sexual intercourse with their primary partner in the 6 months prior to baseline, and 35% reporting that they ‘never’ used condoms; only 22% reported using condoms ‘rarely’, ‘sometimes’ or ‘often’. The ART (44%) and non-ART (41%)

groups did not differ significantly in the proportion of participants reporting always used condoms with their primary partner during the 6 months prior to baseline [$\chi^2(1, N = 678) = 0.7$, $p = .42$]. Condom use differed significantly by partner's HIV status. Those with an HIV-negative partner had the highest rate of consistent condom use at 59%, compared to 43% among those whose partner was also HIV-positive, but respondents who did not know the HIV status of their partner had the lowest rate of 32% [$\chi^2(2, N = 666) = 22.3$, $p < .0001$].

Depression—The mean PHQ-9 at baseline was 3.60 (SD = 3.3), while 6% likely had Major Depression (scored > 9 on PHQ-9) and 28% likely had Minor Depression (scored between 5–9 on PHQ-9). The ART group had a higher rate of Major Depression [8% vs. 3%; $\chi^2(1, N = 750) = 7.1$, $p = .002$] and higher PHQ-9 total score [mean = 3.79 vs. 3.22; $t(748) = 2.4$, $p = .02$] (see Table 1).

Change in Consistent Condom Use Over Time

In bivariate analyses, rates of consistent condom use in the ART group increased significantly from baseline (43%) to Month 6 [55%; McNemar Test: $p = .001$, n = 395), and further increased to 61% by Month 12 (McNemar Test: $p = .012$, n = 347). In the non-ART group, consistent condom use also increased significantly from baseline (38%) to Month 6 (52%; McNemar Test: $p = .003$, n = 209), and then had a further marginal increase to 63% by Month 12 (McNemar Test: $p = .08$, n = 176). Rates of consistent condom use were not significantly different between the ART and non-ART groups at any assessment.

In the multivariate analyses, each of the three models revealed no baseline difference between the ART and non-ART groups on condom use, and the interaction of time and ART status was not associated with condom use; however, the coefficient of time was significant in each model, indicating that consistent condom use increased significantly over time for the sample as a whole, and similarly in both the ART and non-ART groups (see Table 2). For each 6-month interval in the study period, the odds of consistent condom use improved by 48% to 60%, depending on the model. Each of the 3 models examined different aspects of how baseline depression and change in depression may relate to change in consistent condom use.

In model 1, greater baseline depressive symptoms (PHQ-9 total score) was marginally associated with lower odds of using condoms consistently over the 12-month study, while greater reduction in depressive symptoms from baseline to Month 12 was significantly associated with increased odds of always using condoms; each unit of positive or negative change in depressive symptoms was associated with a corresponding 4% change in the odds of consistent condom use.

Models 2 and 3 both showed that having Minor Depression at baseline was significantly associated with having 35% and 36% lower odds of consistent condom use, respectively, while having Major Depression was not associated with condom use. Similar to Model 1, each unit of positive or negative change in depressive symptoms was significantly associated with a corresponding 4% change in the odds of consistent condom use, while a worsening of categorical depression status was significantly associated with 44% lower odds of using condoms consistently over time in model 3 (see Table 2).

Covariates that significantly predicted consistent condom use over time were baseline measures of sex and partner HIV status; in all 3 models, men and those who had an HIV-negative partner were more likely to report consistent condom use, while participants who did not know the HIV status of their partner were less likely to use condoms (see Table 2). Both sensitivity analyses produced similar results with regard to variables that were significantly related to consistent condom use; therefore, we chose not to present the data from these models.

DISCUSSION

The results of this longitudinal analysis reveal that consistent condom use with primary sex partners dramatically increases among both ART and non-ART patients in the first year of HIV care or ART in Uganda. Our results also suggest that mental health may play a key role in consistent condom use, as depression level at treatment outset is significantly associated with condom use, and change in depression is a significant predictor of change in consistent condom use during the year of treatment.

The restored health and improved physical functioning that is associated with HIV treatment may result in increased sexual activity [10,20], which could present heightened opportunities for HIV transmission. However, our data indicate that the longer clients are receiving HIV treatment, the more likely they are to always use condoms with the primary partner, at least during the first year of HIV care or ART. On average, consistent condom use increased by over 50% during the 12 month period of receiving treatment. Several other studies in Uganda [15,16] and the larger region [10,17] have found that ART is associated with increased condom use, but this is among the few longitudinal studies, and one of the first to demonstrate that HIV care in general, not only ART, is associated with reduced sexual risk behavior. HIV care exposes patients to prevention education, and to a community of peers and providers that emphasize healthy behavior and prevention—all of which may help patients practice safer sex. With the emergence of evidence that viral suppression from ART results in greatly reduced infectiousness [12–14], these findings add further credence to the prevention benefits of ART and HIV care in general.

Depression appears to play a significant role in condom use behavior with primary partners among people living with HIV in Uganda. Severity of depressive symptoms at the onset of treatment was marginally predictive of condom use, but when examining categorical levels of depression it was Minor Depression, not Major Depression, that was associated with a one-third lower likelihood of consistent condom use. This may seem counterintuitive, as one might expect that Major Depression would have a stronger negative relationship to condom use. Possible explanations include the low number of participants with Major Depression, which hampered our power to detect an association, and that more severe forms of depression may impede sexual activity in general, preventing even the opportunity to use a condom [40]. More mild forms of depression may not be severe enough to limit sexual activity, but may influence motivation and decision making related to condom use [41].

Other prior research has found unprotected sex to be associated with depression among people living with HIV in Uganda [26], but this is one of the first longitudinal studies to

show that change in depressive symptoms correspond to like changes in the likelihood of consistent condom use over time. Our data suggest that a 5-point change in the PHQ-9 total score (which is the amount that distinguishes the severity levels of depression as measured by the scale) alters the odds of consistent condom use by 20%, while a categorical representation of worsening depression (e.g., from none to Minor Depression, or Minor to Major Depression) reduced the odds of consistent condom use by 44%. Changes in mood may affect condom use through its effects on physical and sexual functioning, motivation and self-efficacy to negotiate condom use with their partner, as suggested by Social Cognitive Theory [22]. However, it is also possible that condom use and risk behavior influence mood states and depression; engaging in risk behavior may lead to anxiety and depression, while successfully negotiating condom use may result in improved psychological well-being. We are not able to establish causality with our data given the non-randomized assignment of treatment, and the relationship between condom use and depression may be bidirectional. It is also worth noting that depressive symptoms may impede HIV prevention by contributing to ART nonadherence [42], which can result in higher viral load and increased infectiousness. These findings suggest that integration of depression diagnosis and treatment into HIV care programs could represent an important avenue by which HIV care in Uganda and other parts of sub-Saharan Africa can further contribute to HIV prevention.

Despite the improvement observed in consistent condom use, high rates of unprotected sex were maintained in this sample. At Month 12, about 30–40% of the sample continued to report unprotected sex with their primary partner, many of whom were at risk for transmission. In our study, participants in serodiscordant couples were most likely to be using condoms consistently with their primary partner, where as respondents who did not know the HIV status of their primary partner were least likely to be using condoms. Not knowing the HIV status of one's partner may indicate either that the partner has not tested, and/or the respondent has not disclosed or discussed HIV status with their partner. Non-disclosure of HIV status has been found to be associated with unprotected sex with a stable sex partner in South Africa [43], and without disclosure, requests to use condoms are thought to suggest infidelity or lack of trust [44,45], making it difficult to use condoms if a partner's HIV status is unknown [46]. The sex of the respondent was an independent predictor of condom use, with women being less likely to report consistent condom use; this may speak to the relative lack of control that women have over the use of male condoms, and the potential benefits to making the female condom more available in this setting. Taken together, these findings highlight the need for prevention efforts among people living with HIV to go beyond HIV medical care and "treatment as prevention" paradigms [11].

The study has a number of limitations. With widespread access to ART in Uganda at the time of study enrollment, we could not ethically randomly assign ART to matching groups in Studies A and B. This resulted in a non-randomized comparison group with clear differences, as there were indications that the non-ART group had better health at baseline than the ART group; however, the non-ART group did have evidence of immune suppression (CD4<400) and a strength of our analysis is the inclusion of propensity weights which enabled us to adjust for the baseline differences between the ART and non-ART groups. While having a non-ART group enabled us to control for other time trends in the

context of receipt of HIV care, we could not account for natural changes in the outcomes in the complete absence of HIV care. Also, our ability to detect a difference between ART and non-ART patients may have been undercut by some non-ART patients who started ART during the study period; however, our sensitivity analysis, in which participants who switched treatment status during the study were excluded, resulted in the same multivariate findings, suggesting that our results are robust. Additionally, our evaluation is limited by our reliance on a self-report rather than diagnostic interview to assess depressive disorders and to distinguish between Minor and Major Depression. As a result, our rates of these depressive conditions are likely to be over-estimated, although the PHQ-9 has been shown to have good criterion validity [32]. Also, self-report measures of condom use are vulnerable to social desirability [47], so this is a potential confounder of the observed increase in condom use over time. Lastly, studies with a longer follow-up are needed to examine the possibility that as treatment continues, complacency sets in and condom use begins to decline.

In this study of condom use among HIV clients in Uganda with primary sex partners, consistent condom use increased significantly during the first year of HIV care or ART, providing further evidence of the prevention benefits of HIV treatment. Our data shows that these effects on condom use are strongly influenced by depression and its remediation. Unfortunately, mental health services are largely absent in HIV care programs across Uganda and SSA—potentially undercutting the prevention benefits of HIV treatment. Research that examines the effects of depression treatment on sexual risk behavior will inform policy decisions regarding the integration of depression treatment into HIV care and strategies for optimizing ART as an agent for HIV prevention.

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REFERENCES

1. UNAIDS. Global Report: UNAIDS report on the global AIDS epidemic. 2012
2. Chomba E, Allen S, Kanweka W, et al. Evolution of couples' voluntary counseling and testing for HIV in Lusaka, Zambia. J Acquir Immune Defic Syndr. 2008; 47:108–115. [PubMed: 17984761]
3. Malamba SS, Mermin JH, Bunnell R, et al. Couples at risk: HIV-1 concordance and discordance among sexual partners receiving voluntary counseling and testing in Uganda. J Acquir Immune Defic Syndr. 2005; 39:576–580. [PubMed: 16044010]
4. de Walque D. Sero-discordant couples in five African countries: Implications for prevention strategies. Popul & Devlop Rev. 2007; 33:501–523.
5. Uganda AIDS Commission (UAC). The Uganda HIV Modes of Transmission and Prevention Response Analysis: UAC Kampala Uganda April 2009. 2009
6. Dunkle KL, Stephenson R, Karita E, et al. New heterosexually transmitted HIV infections in married or cohabiting couples in urban Zambia and Rwanda: an analysis of survey and clinical data. Lancet. 2008; 371:2183–2191. [PubMed: 18586173]
7. Eisele TP, Mathews C, Chopra M, et al. High levels of risk behavior among people living with HIV Initiating and waiting to start antiretroviral therapy in Cape Town South Africa. AIDS Behav. 2008; 12:570–577. [PubMed: 17636372]

8. Kamenga M, Ryder RW, Jingu M, et al. Evidence of marked sexual behavior change associated with low HIV-1 seroconversion in 149 married couples with discordant HIV-1 serostatus: experience at an HIV counselling center in Zaire. AIDS. 1991; 5:61–67. [PubMed: 2059362]
9. Desgrees-du-Lou A, Orne-Gliemann J. Couple-centered testing and counselling for HIV serodiscordant heterosexual couples in sub-Saharan Africa. Reprod Health Matters. 2008; 16:151–161. [PubMed: 19027631]
10. Eisele TP, Mathews C, Chopra M, et al. Changes in risk behavior among HIV-positive patients during their first year of antiretroviral therapy in Cape Town South Africa. AIDS Behav. 2009; 13:1097–1105. [PubMed: 18846418]
11. The Lancet. HIV treatment as prevention—it works. Lancet. 2011; 377:1719. [PubMed: 21601691]
12. Cohen MS, Chen YQ, McCauley M, et al. Prevention of HIV-1 infection with early antiretroviral therapy. NEJM. 2011; 365:493–505. [PubMed: 21767103]
13. Quinn TC, Wawer MJ, Sewankambo N, et al. Viral load and heterosexual transmission of human immunodeficiency virus type 1. Rakai Project Study Group. N Engl J Med. 2000; 342:921–929. [PubMed: 10738050]
14. Donnell, D.; Kiarie, J.; Thomas, K., et al. ART and risk of heterosexual HIV-1 transmission in HIV-1 serodiscordant African couples: a multinational prospective study. Seventeenth Conference on Retroviruses and Opportunistic Infections; San Francisco, CA. 2010. Abstract 136.
15. Bunnell R, Ekwaru JP, Solberg P, et al. Changes in sexual behavior and risk of HIV transmission after antiretroviral therapy and prevention interventions in rural Uganda. AIDS Behav. 2006; 20:85–92.
16. Bateganya M, Colfax G, Shafer LA, et al. Antiretroviral therapy and sexual behavior: a comparative study between antiretroviral- naive and –experienced patients at an urban HIV/AIDS care and research center in Kampala, Uganda. AIDS Patient Care STDS. 2005; 19:760–768. [PubMed: 16283836]
17. Luchters S, Sarna A, Geibel S, et al. Safer sexual behaviors after 12 months of antiretroviral treatment in Mombasa, Kenya: a prospective cohort. AIDS Patient Care STDS. 2008; 22:587–594. [PubMed: 18601582]
18. Cohen L. ARV users taking risks. Johannesburg Sunday Times. 2007 Oct 7.
19. Bunnell R, Opio A, Musinguzi J, et al. HIV transmission risk behavior among HIV-infected adults in Uganda: results of a nationally representative survey. AIDS. 2008; 22:617–624. [PubMed: 18317003]
20. Seeley J, Russell S, Khana K, Ezati E, King R, Bunnell R. Sex after ART: sexual partnerships established by HIV-infected persons taking anti-retroviral therapy in Eastern Uganda. Cult Health Sex. 2009; 11:703–716. [PubMed: 19544115]
21. Pickett J. 'HAART optimism': is it really the problem with HIV prevention in developed countries? AIDS. 2003; 17:S20–S22. [PubMed: 15080175]
22. Bandura A. Self-efficacy: Toward a unifying theory of behavioral change. Psych Rev. 1977; 84:191–215.
23. Cove J, Petrak J. Factors associated with sexual problems in HIV-positive gay men. Int J STD AIDS. 2004; 15:732–736. [PubMed: 15537458]
24. Crepaz N, Marks G. Towards an understanding of sexual risk behavior in people living with HIV: a review of social, psychological, and medical findings. AIDS. 2002; 16:135–149. [PubMed: 11807297]
25. Kalichman SC. HIV Transmission Risk Behaviors of Men and Women Living With HIV-AIDS: Prevalence, Predictors, and Emerging Clinical Interventions. Clin Psychol: Sci & Pract. 2000; 7:32–47.
26. Comulada WS, Rotheram-Borus MJ, Pequegnat W, et al. Relationships over time between mental health symptoms and transmission risk among persons living with HIV. Psychol Addict Behav. 2010; 24:109–118. [PubMed: 20307117]
27. Wilk CM, Bolton P. Local perceptions of the mental health effects of the Uganda acquired immunodeficiency syndrome epidemic. J Nerv Ment Dis. 2002; 190:394–397. [PubMed: 12080210]

28. Brandt R. The mental health of people living with HIV/AIDS in Africa: a systematic review. Af J AIDS Res. 2009; 8:123–133.
29. Collins PY, Homan AR, Freeman MC, Patel V. What is the relevance of mental health to HIV/AIDS care and treatment programs in developing countries? A systematic review. AIDS. 2006; 20:1571–1582. [PubMed: 16868437]
30. Myer L, Smit J, Le Roux LL, Parker S, Stein DJ, Seedat S. Common mental disorders among HIV-infected individuals in South Africa: prevalence, predictors, and validation of brief psychiatric rating scales. AIDS Patient Care STDs. 2008; 22:147–157. [PubMed: 18260806]
31. Nakimuli-Mpungu E, Bass JK, Alexandre P, et al. Depression, alcohol use and adherence to antiretroviral therapy in sub-Saharan Africa: a systematic review. AIDS Behav. 2012; 16:2101–2118. [PubMed: 22116638]
32. Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. J Gen Intern Med. 2001; 16:606–613. [PubMed: 11556941]
33. American Psychiatric Association. American Psychiatric Association, Diagnostic statistical manual of mental disorders. 4th edition. Washington, D.C.: American Psychiatric Association; 1994.
34. Monahan PO, Shacham E, Reece M, et al. Validity/reliability of PHQ-9 and PHQ-2 depression scales among adults living with HIV/AIDS in western Kenya. J Gen Intern Med. 2009; 24:189–197. [PubMed: 19031037]
35. Lee BK, Lessler J, Stuart EA. Improving propensity score weighting using machine learning. Statist Med. 2010; 29:337–346.
36. McCaffrey D, Ridgeway G, Morral AR. Propensity score estimation with boosted regression for evaluating causal effects in observational studies. Psychol Methods. 2004; 9:403–425. [PubMed: 15598095]
37. Ridgeway G, McCaffrey DF, Morral AR. Twang: Toolkit for weighting and analysis of nonequivalent groups. (Version 1.0–2). (Software and reference manual). 2010 Available at: http://cran.r-project.org/web/packages/twang/index.html.
38. Cochran WG. The effectiveness of adjustment by subclassification in removing bias in observational studies. Biometrics. 1968; 24:295–313. [PubMed: 5683871]
39. StataCorp. Stata Statistical Software: Release 12. College Station, TX: StataCorp LP; 2011.
40. Koblin BA, Husnik MJ, Colfax G, Huang Y, Madison M, Mayer K, et al. Risk factors for HIV infection among men who have sex with men. AIDS. 2006; 20:731–739. [PubMed: 16514304]
41. O'Cleirigh C, Newcomb ME, Mayer KH, Skeer M, Traeger L, Safren SA. Moderate levels of depression predict sexual transmission risk in HIV-infected MSM: a longitudinal analysis of data from six sites involved in a "prevention for positives" study. AIDS Behav. 2013; 17:1764–1769. [PubMed: 23605154]
42. Vranceanu AM, Safren SA, Lu M, Coady WM, Skolnik PR, Rogers WH, Wilson IB. The relationship of post-traumatic stress disorder and depression to antiretroviral medication adherence in persons with HIV. AIDS Patient Care STDs. 2007; 22:313–321. [PubMed: 18338960]
43. Lurie M, Pronyk P, DeMoor E, et al. Sexual behaviour and reproductive health among HIV-infected patients in urban and rural South Africa. J Acquir Immune Defic Syndr. 2008; 47:484–493. [PubMed: 18209685]
44. Bauni E, Jarabi BO. The low acceptability and use of condoms within marriage: Evidence from Nakuru District, Kenya. Afr Popul Studies. 2003; 18:51–65.
45. Maharaj P, Cleland J. Risk perception and condom use among married or cohabiting couples. Int Fam Plan Perspect. 2005; 31:24–29. [PubMed: 15888406]
46. Nebie Y, Meda N, Leroy V, et al. Sexual and reproductive life of women informed of their HIV seropositivity: a prospective cohort study in Burkina Faso. J Acquir Immune Defic Syndr. 2001; 28:367–372. [PubMed: 11707674]
47. Lau JT, Yeung NC, Mui LW, Tsui HY, Gu J. A simple new method to triangulate self-reported risk behavior data—the bean method. Sex Transm Dis. 2011; 38:788–792. [PubMed: 21844730]

Table 1

Baseline Characteristics by Study, ART Status and in Combined Sample

	Study			Baseline ART Status		Combined (N=750)
	A (N=299)	B (N=188)	C (N=263)	Non-ART (N=248)	ART (N=502)	
Age (mean years)	34.5**	33.0**	35.4**	33.4*	35.0*	34.5
Male	40%	46%	43%	37%*	45%*	42%
Secondary education or more	15%	13%	19%	15%	16%	16%
Worked in the past 7 days	67%*	76%*	75%*	76%	70%	72%
CD4 count (mean cells/mm^3)	223***	298***	169***	354***	158***	222
Disclosed HIV status to partner	80%***	73%***	89%***	77%	83%	81%
Partner HIV status:						
Positive	45%	56%	53%	50%	51%	51%
Negative	15%**	11%**	22%**	14%	18%	17%
Unknown	40%**	34%**	24%**	36%	31%	33%
Consistent condom use with primary partner	38%	40%	47%	40%	43%	42%
Major Depression	9%*	5%*	3%*	3%**	8%**	6%
Minor Depression	37%***	29%***	16%***	27%	28%	28%
Depression symptoms (mean PHQ-9)	4.57***	3.62***	2.49***	3.22*	3.79*	3.60

* $p < .05$,

** $p < .01$,

*** $p < .001$

Table 2

Multivariate Analysis of Impact of ART and Change in Depression on Consistent Condom Use with Primary Partner over 12 Months of HIV Treatment

	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
ART status	1.23 (0.75, 2.01)	1.24 (0.76, 2.01)	1.22 (0.75, 1.99)
Time	1.48 (1.14, 1.91)**	1.49 (1.15, 1.93)**	1.60 (1.22, 2.09)***
Time × ART status	0.89 (0.66, 1.21)	0.9 (0.66, 1.22)	0.89 (0.65, 1.21)
Cross-Sectional			
Baseline depressive symptoms	0.95 (0.90, 1.01)+		
Baseline Major Depression		1.00 (0.51, 1.94)	1.09 (0.57, 2.12)
Baseline Minor Depression		0.65 (0.47, 0.92)*	0.64 (0.43, 0.96)*
Prospective (change over time)			
Time × reduced depressive symptoms	1.04 (1.01, 1.08)**	1.04 (1.004, 1.073)*	
Time × improved depression status			1.20 (0.90, 1.60)
Time × worsened depression status			0.56 (0.33, 0.97)*
Covariates			
Age	1.00 (0.99, 1.02)	1.00 (0.99, 1.02)	1.00 (0.99, 1.02)
Male sex	1.66 (1.24, 2.24)***	1.64 (1.22, 2.20)***	1.64 (1.22, 2.20)***
Any secondary education	0.97 (0.67, 1.42)	0.94 (0.65, 1.37)	0.93 (0.64, 1.36)
Partner is HIV-negative[a]	1.63 (1.14, 2.33)**	1.62 (1.14, 2.31)**	1.62 (1.14, 2.32)*
Partner's HIV status is unknown[a]	0.58 (0.42, 0.79)***	0.58 (0.42, 0.80)***	0.58 (0.42, 0.79)***
Working over past 7 days	1.07 (0.78, 1.48)	1.10 (0.79, 1.51)*	1.09 (0.79, 1.50)
Baseline CD4 count	1.001 (1.000, 1.002)	1.001 (1.000, 1.002)	1.001 (1.000, 1.002)

[a] Reference group is participants with HIV-positive primary partner

+ $p < .10$,

* $p < .05$,

** $p < .01$,

*** $p < .001$