The impact of HIV treatment on risk behaviour in developing countries: A systematic review

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Abstract
In developing countries, access to antiretroviral therapy (ART) is improving as HIV treatment becomes a greater priority in the global fight against AIDS. While ART has clearly beneficial clinical effects, increased access to treatment may also affect sexual behaviour. To examine the strength of evidence for the impact of medical treatment for HIV-positive individuals on behavioural outcomes in developing countries, we conducted a comprehensive search of the peer-reviewed literature. Studies were included if they provided clinical treatment to HIV-positive individuals in a developing country, compared behavioural, psychological, social, care, or biological outcomes related to HIV-prevention using a pre/post or multi-arm study design, and were published between January 1990 and January 2006. Only three studies were identified that met the inclusion criteria. All were conducted in Africa, utilized before/after or multi-arm study designs, and relied on self-reported behaviour. In all three studies, a majority of HIV-infected individuals reported being sexually abstinent, and access to ART was not associated with an increase in HIV-related risky sexual behaviours. However, one cross-sectional study found that ART patients were more likely to report STD treatment. The available evidence indicates a significant reduction in risk behaviour associated with ART in developing countries. However, there are few existing studies and the rigor of these studies is weak. More studies are needed to build an evidence base on which to make programmatic and policy decisions.

Introduction
In developing countries, access to antiretroviral therapy (ART) is improving as HIV treatment becomes a greater priority in the global fight against AIDS. ART has clearly beneficial clinical effects, and the incidence of AIDS and AIDS-related mortality have declined considerably in countries where ART has been made widely available (Mocroft et al., 1998; Palella et al., 1998).

However, increased access to treatment may also affect sexual behaviour. Improvements in health and life expectancy of HIV-infected people may lead to a belief that HIV is no longer a serious and deadly disease. ART significantly reduces patients’ viral loads, often to undetectable levels, which may lead to the perception that they are no longer infectious. People may experience ‘safer sex burnout’ as they have difficulty sustaining safer sexual behaviour over a lifetime. In addition, ART significantly improves physical health and quality of life, which may enable or encourage individuals to resume sexual activity, including unsafe sex. These issues have commonly been referred to as treatment optimism or behavioural disinhibition. Conversely, increased contact with health systems to receive ART may actually encourage positive changes in sexual risk behaviour.

A 2004 meta-analysis of the relationship between ART and sexual risk behaviour showed that HIV-positive patients receiving ART did not exhibit increased sexual risk behaviour (Crepaz et al., 2004). That analysis found 16 studies with 21 independent effect sizes reflecting the association between receiving ART (vs. not receiving ART) and risky sexual behaviour. However, all of the studies included in that meta-analysis were conducted in developed countries.

As HIV treatment becomes more widely available in developing countries, the relationship between treatment and sexual risk behaviour in these countries has also become more important. To date, there have been no systematic reviews of the literature on this topic for developing countries. There are many reasons to believe that the effect of HIV treatment on behaviour might be different in developing countries. These include reduced access to care, different cultural norms regarding HIV, and the fact that few people have seen ART work in these settings. The purpose of this paper is to assess the evidence for the relationship between HIV treatment and sexual risk
behaviour in developing countries by conducting a
systematic review of the literature.

Methods
This research was conducted as part of a larger series
of systematic reviews on behavioural interventions
for HIV in developing countries conducted jointly by
the Johns Hopkins Bloomberg School of Public
Health and the World Health Organization
(WHO). Other interventions being systematically
reviewed under this project include: mass media,
condom social marketing, voluntary counselling and
testing (VCT), family planning for HIV-infected
women, psychosocial support, partner notification,
peer education, abstinence-based interventions, need-
le exchange, comprehensive sex education in
schools, and free condom distribution programmes.
The methods reported here are standardized across
all systematic reviews with minor changes for each
specific intervention.

Search strategy
We searched electronic databases including the U.S.
National Library of Medicine’s (NLM) Gateway
system, PsycINFO, Sociological Abstracts, EM-
BASE, and the Cumulative Index to Nursing &
Allied Health Literature (CINAHL) for articles
published from January 1990 through January
2006. A complete list of search terms can be found
in the Appendix.

To identify articles not obtained from electronic
database searching, study staff hand-searched the
table of contents of the following journals: AIDS,
AIDS and Behavior, AIDS Care, and AIDS Educa-
tion and Prevention. Finally, we examined the refer-
ence lists of articles selected to further identify
potential articles for inclusion. This process was
iterated until no new articles were found.

Study selection
Initial inclusion/exclusion of studies was done by a
member of the study staff, who excluded clearly non-
relevant articles based on the titles and abstracts.
The remaining articles were then reviewed by the
principal investigator and the study coordinator, who
independently read the abstracts of these articles and
classified the citations as either: (1) primary citations
qualifying for inclusion in the synthesis; (2) back-
ground citations not qualifying for inclusion but
providing useful information; (3) citations to be
acquired for further inquiry; or (4) not relevant.
The separate screened files were then merged
for comparison, and citations with discordant
screening were discussed to establish consensus.

Final inclusion/exclusion of studies was based on a
thorough reading of the full-text article.

Studies were included as primary citations if they
met the following criteria: (1) data were presented
from a developing country, defined by combining
the World Bank categories of low-income, lower-
middle income, or upper-middle income economies
(World Bank); (2) participants received a diagnosis
of HIV or were presumed to be HIV-infected based
on clinical signs and symptoms; (3) clinical
treatment was provided, including treatment for
opportunistic infections and anti-retroviral therapy;
(4) an evaluation design was employed that com-
pared post-intervention outcomes using either a pre/
post or multi-arm study design (including post-only
exposure analysis); (5) behavioural, psychological,
social, care, or biological outcome(s) related to
HIV-prevention were presented; and (6) the article
appeared in a peer-reviewed journal from January
1990 through January 2006. No language restric-
tions were used. When an article in a language other
than English was found, it was translated into
English, and then coded.

Data extraction
Each citation meeting the inclusion criteria under-
went data extraction by two independent reviewers
working separately. Data were entered into a
systematic, detailed coding form that included
questions on study design, study location, gender
and age distribution, sample population, sample
size, sampling strategy, comparison groups, descrip-
tion of the intervention received, loss to follow up,
steps taken to control for confounders, outcome
measures, statistical tests used and findings. The
coding forms from the two reviewers were compared
for discrepancies. Any discrepancies found were
resolved by a third reviewer, who was a member of
the senior study staff.

Rigor score
The rigor of the study design of all primary citations
was assessed using an eight-point scale developed for
the larger series of systematic reviews. The scale was
additive, with one point awarded for each item. The
items were: (1) prospective cohort; (2) control
or comparison group; (3) pre/post intervention
data; (4) random assignment of participants to the
intervention; (5) random selection of subjects for
assessment; (6) follow-up rate of 80% or more;
(7) comparison groups equivalent on socio-
demographic measures; and (8) comparison groups
equivalent at baseline on outcome measures.
Results

Initial screening of the articles from computer database searching yielded 166 potentially relevant articles (Figure 1). The abstracts of these articles were screened by the principal investigator and the project coordinator. At this stage, 101 articles were excluded for not meeting inclusion criteria, and the full-text versions of 65 articles were pulled for further screening. Of these, 3 articles met the criteria for inclusion in this review as a primary article (Moatti et al., 2003; Bateganya et al., 2005; Bunnell et al., 2006), and 59 were included as background articles (Mussico et al., 1994; Kelly et al., 1998a; Kelly et al., 1998b; Remien et al., 1998; van der Straten, 1998; DeNoon, 1999; Misovich et al., 1999; Colebunders et al., 2000; Erbelding et al., 2000; Miller et al., 2000; Vanable et al., 2000; van der Straten et al., 2000; Wood et al., 2000; Catz et al., 2001; Dukers et al., 2001; Vlahov et al., 2001; Bouhnik et al., 2002; Chen et al., 2002; Crepaz et al., 2002; Demmer, 2002; DiClemente et al., 2002; Hosseinipour et al., 2002; Katz et al., 2002; Laporte, 2002; Nollen et al., 2002; Ostrow et al., 2002; Gray et al., 2003; International Collaboration on HIV Optimism, 2003; Rietmeijer et al., 2003; Rothenberg et al., 2003; Stephenson et al., 2003; Xiridou et al., 2003; Boily et al., 2004; Crepaz et al., 2004; Fang et al., 2004; Stolte et al., 2004; Texeira et al., 2004; Tun et al., 2004; Williamson et al., 2004; Abadia-Barrero et al., 2005; Akileswaran et al., 2005; Bachmann et al., 2005; Baez-Feliciano et al., 2005; Baggaley et al., 2005; Batterham et al., 2005; Blower et al., 2005; Boily et al., 2005; Castilla et al., 2005; Chulamokha et al., 2005; Diamond et al., 2005; Elford et al., 2005; Halkitis et al., 2005; Hogan et al., 2005; Jelsma et al., 2005; Lightfoot et al., 2005; Munoz-Laboy et al., 2005; Remien et al., 2005; van der Snoek et al., 2005; Van de Ven et al., 2005).

Table I presents a description of the three primary articles included in this review. All three were conducted in Africa – one in Côte d’Ivoire (Moatti et al., 2003) and two in Uganda (Bateganya et al., 2005; Bunnell et al., 2006) – with HIV-positive adults. Two were cross-sectional studies comparing patients who had received ART to those who had not (Moatti et al., 2003; Bateganya et al., 2005); one was a before/after study following a cohort of

![Flow chart showing selection of articles for inclusion.](image-url)
<table>
<thead>
<tr>
<th>Author, year</th>
<th>Setting &amp; Target Group</th>
<th>Intervention</th>
<th>Study Design</th>
<th>Sample Size</th>
<th>Age Range</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moatti, 2003</td>
<td>Abidjan and Bouake, Côte d’Ivoire</td>
<td>Patients in the intervention group received ART in addition to standard HIV care.</td>
<td>A cross-sectional study design comparing the sexual risk behaviour of patients receiving ART to the risk behaviour of patients not receiving ART. Authors used non-probability convenience sampling to select participants from one of eight HIV care centres. Individual unit of analysis.</td>
<td>Overall sample size: 711 patients</td>
<td>53.9% of participants were less than 35 years old</td>
<td>51.1% males; 48.9% females</td>
</tr>
<tr>
<td>Bunnell, 2006</td>
<td>Tororo, Uganda</td>
<td>Participants received weekly home-based ART delivery and monitoring by lay field officers and referral as needed for free medical and psychological care at the study clinic. In addition, participants received a behavioural intervention that included group education on ART at enrolment and testing of cohabitating partners through home-based family VCT.</td>
<td>A before-after study with no comparison or control arm. Authors used non-probability convenience sampling to select participants from one HIV treatment clinic. Individual, couple, and clinic-level data were all used as the unit of analysis.</td>
<td>Baseline: 926 participants</td>
<td>Median Age: 41 yrs.</td>
<td>25.4% males; 74.6% females</td>
</tr>
<tr>
<td>Bateganya, 2005</td>
<td>Kampala, Uganda</td>
<td>Patients in the intervention group were provided with monthly ART. The therapy provided was the standard WHO recommended first-line drugs. All patients in this group had been on ART for at least one year.</td>
<td>A cross-sectional study design comparing different levels of sexual risk behaviour, socio-economic status, and general health among HIV-positive patients who were ART-experienced versus ART-naïve. Authors used non-probability convenience sampling to select participants from one HIV treatment clinic. Individual unit of analysis.</td>
<td>Overall sample size: 723 patients</td>
<td>Mean Age: 37 years</td>
<td>41% males; 59% females</td>
</tr>
</tbody>
</table>

Note: Authors do not define what they mean by standard HIV care.
patients initiating ART and examining behavioural outcomes six months later (Bunnell et al., 2006).

The overall rigor of these studies was low (Table II). The two cross-sectional studies received a rigor score of 1 (out of a possible 8), receiving credit only for having treatment and comparison groups. Bunnell et al. (2006) received the highest rigor score of 3 for their before/after study. This study presented the only available longitudinal data; however, the lack of a control group limited the rigor of the study. Moatti et al. (2003) did not report the socio-demographic characteristics of the ART and non-ART groups for comparison purposes, although they did control for these measures in multiple logistic regression. Bateganya et al. (2005) did compare ART and non-ART groups on socio-demographic characteristics and found that ART patients were significantly more likely to be male and employed and less likely to be under 37 years of age, reside in an urban area, have lower education, and earn less than US$50 per month. They controlled for some of these variables in multivariate logistic regression. However, they did not adjust for gender or employment status despite the fact that these were statistically significantly different between the ART and non-ART groups. In addition, multivariate models were presented only for some outcomes; other outcomes were reported using only bivariate comparisons.

Further limitations of these studies included reliance on self-report of sexual behaviours, convenience sampling, and short duration of ART among the participants. All three studies used self-report of behaviour, which may be subject to both recall and social desirability bias. Social desirability bias may have been exacerbated in the study by Bunnell et al., as counsellors who provided on-going risk reduction counselling also administered interviews. Bateganya et al. note that their interviewers were not the same people who provided the clinical services, while Moatti et al. do not report whether their interviewers were also involved in intervention implementation. All three studies used convenience sampling from clinics to recruit their study populations. This may have introduced a bias regarding the representativeness of the samples to the broader populations. Finally, the duration of ART among the participants in all three studies was relatively short (Bunnell et al.: six months; Bateganya et al.: mean 1.6 years, min. 12 months; Moatti et al.: max. 18 months). Thus, these studies are unable to examine the long-term impact of ART on social experiences and sexual behaviours.

Table III summarizes the study findings using a standardized format to allow comparisons across studies, and across intervention topics covered in the larger synthesis project. Results from all three studies showed that access to ART was generally not associated with an increase in HIV-related risky sexual behaviours. Results for selected outcome behaviours are presented below.

### Sexual abstinence

In all three studies, approximately half of the participants reported practicing sexual abstinence. In the two cross-sectional studies, these high rates of sexual abstinence were reported for all HIV-positive patients in the previous six months regardless of ART status. In the before/after study, the percentage of ART patients who were sexually abstinent in the previous three months did not change from baseline to follow-up.

### Frequency of sexual intercourse

Frequency of sexual intercourse was not different between ART and non-ART patients in the one cross-sectional study that measured it. It also did not change from baseline to follow-up in the before/after study.

### Condom use

Condom use was significantly higher among ART patients compared to non-ART patients in both cross-sectional studies. Moatti et al. found that condom use

**Table II. Rigor score.**

<table>
<thead>
<tr>
<th>Study</th>
<th>Cohort</th>
<th>Control or comparison group</th>
<th>Pre/post intervention data</th>
<th>Random assignment of participants to the intervention</th>
<th>Random selection of participants for assessment</th>
<th>Follow-up rate of 80% or more</th>
<th>Comparison groups equivalent on socio-demographics</th>
<th>Comparison groups equivalent at baseline on outcome measure</th>
<th>Final score out of 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moatti, 2003</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>N/A*</td>
<td>Not reported</td>
<td>N/A</td>
<td>N/A</td>
<td>1</td>
</tr>
<tr>
<td>Bunnell, 2006</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>N/A</td>
<td>N/A</td>
<td>3</td>
</tr>
<tr>
<td>Bateganya, 2005</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>1</td>
</tr>
</tbody>
</table>

*N/A = Not applicable.*
### Table III. Study results.

<table>
<thead>
<tr>
<th>Citation</th>
<th>Results (I = Intervention; C = Comparison; NS = Non-significant p &gt; 0.05; Sig = Significant p &lt; 0.05; NR = Not reported)</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moatti, 2003</td>
<td><strong>OVERALL SAMPLE:</strong>&lt;br&gt;a) Used condoms at last sexual intercourse&lt;br&gt;I (80.2%), C (58.8%)&lt;br&gt;[I vs. C, p-value &lt; 0.001, <strong>SIG</strong>]&lt;br&gt;b) Participated in unprotected sex in prior 6 months&lt;br&gt;OR = 0.52 (95% CI: 0.29, 0.93)&lt;br&gt;c) Length of time since last sexual intercourse&lt;br&gt;Less than one month I (58.2%), C (55.6%)&lt;br&gt;One month or more I (41.8%), C (44.4%)&lt;br&gt;d) Last sexual encounter with&lt;br&gt;Main partner I (95.6%), C (86.8%)&lt;br&gt;Occasional partner I (4.4%), C (13.2%)&lt;br&gt;<strong>MALES:</strong>&lt;br&gt;a) Reported sexual abstinence in prior 6 months&lt;br&gt;OR = 0.60 (95% CI: 0.30, 1.19)&lt;br&gt;[I vs. C, p-value = 0.002, <strong>SIG</strong>]&lt;br&gt;b) Used condoms at last sexual intercourse&lt;br&gt;I (78.2%), C (64.3%)&lt;br&gt;[I vs. C, p-value = NR]&lt;br&gt;c) Length of time since last sexual intercourse&lt;br&gt;Less than one month I (67.3%), C (59.2%)&lt;br&gt;One month or more I (32.7%), C (40.8%)&lt;br&gt;d) Last sexual encounter with&lt;br&gt;Main partner I (96.4%), C (82.4%)&lt;br&gt;Occasional partner I (3.6%), C (17.6%)&lt;br&gt;<strong>FEMALES:</strong>&lt;br&gt;a) Reported sexual abstinence in prior 6 months&lt;br&gt;OR = 1.53 (95% CI: 0.72, 3.22)&lt;br&gt;[I vs. C, p-value = 0.015, NS]&lt;br&gt;b) Used condoms at last sexual intercourse&lt;br&gt;I (83.3%), C (53.0%)&lt;br&gt;[I vs. C, p-value = NR]&lt;br&gt;c) Length of time since last sexual intercourse&lt;br&gt;Less than one month I (44.4%), C (50.5%)&lt;br&gt;One month or more I (55.6%), C (49.5%)&lt;br&gt;d) Last sexual encounter with&lt;br&gt;Main partner I (94.4%), C (93.1%)&lt;br&gt;Occasional partner I (5.6%), C (6.9%)&lt;br&gt;<strong>Sexual behaviour</strong>&lt;br&gt;(i) Sex in the last 3 months&lt;br&gt;Men:&lt;br&gt;Baseline: 47% (110/233) Follow-up: 53% (109/205) OR: 1.3 [0.9–1.9] [B vs. Follow-up NS]&lt;br&gt;Among sexually active patients, those undergoing ART were significantly more likely to use condoms at their last sexual intercourse and significantly less likely to declare unprotected sex in the previous 6 months than non ART patients. Moreover, ART patients were more likely to report that the last sexual encounter was with a main partner compared to non ART patients.&lt;br&gt;Receiving ART had no significant effect on being sexually abstinent in the past 6-months for either males or females even after adjustment for potential confounders.&lt;br&gt;There were no significant differences between those receiving ART and those not receiving treatment for the frequency of sexual intercourse.&lt;br&gt;The sexual behaviour model was adjusted for sex, age, marital status, and intra-client clustering.</td>
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</table>
### Table III (Continued)

<table>
<thead>
<tr>
<th>Citation</th>
<th>Results (I = Intervention; C = Comparison; NS = Non-significant $p &gt; 0.05$; Sig = Significant $p &lt; 0.05$; NR = Not reported)</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIV positive adults, living within 100 km² of the Tororo branch of the AIDS support organization, who are provided with ART.</td>
<td><strong>(1) Sexual Activity at baseline</strong>&lt;br&gt;Men: Baseline: 21% (145/689) OR: 1.2 [0.9 – 1.5] Follow-up: 24% (134/608) OR: 1.4 [1.0 – 1.9] [B vs. Follow-up NS]<strong>&lt;br&gt;Women: Baseline: 28% (255/922) OR: 1.5 [1.2 – 1.9] Follow-up: 31% (252/812) OR: 1.2 [1.0 – 1.5] [B vs. Follow-up NS]</strong></td>
<td>The proportion of participants who had had sexual intercourse in the prior three months did not change between baseline and follow-up for either men or women. Consistent condom use significantly increased while unprotected sex with partners of negative or unknown status significantly decreased comparing baseline to follow-up. Model looking at sexual behaviour within partnerships was adjusted for sex; age; religion; whether sex was with spouse, steady, or casual partner; and intra-index client clustering. Overall, there was a 70% reduction in the number of unprotected sex acts with a partner of known negative or unknown status: among men there was a 75% reduction (5.4 acts vs. 1.3 acts, $p = 0.02$) and among women a 58% reduction (3.5 acts vs. 1.5 acts, $p = 0.03$). Over 85% of unprotected sex acts with negative/unknown partner occurred within married couples.</td>
</tr>
<tr>
<td>Before and After study comparing the effect of a home-based ART programme that included prevention counselling, VCT for cohabitating partners, and condom provision on self-reported sexual risk behaviours, use of condoms, changes in desire and frequency of sexual behaviour, and changes in the risk of HIV transmission based on viral load, risky sex, and established condom failure rates.</td>
<td><strong>(2) Sex with a Spouse</strong>&lt;br&gt;Men: Baseline: 44% (1040/235) OR: 1.0 [0.7 – 1.5] Follow-up: 45% (94/207) OR: 1.0 [0.7 – 1.5] [B vs. Follow-up NS]<strong>&lt;br&gt;Women: Baseline: 13% (93/691) OR: 1.1 [0.9 – 1.3] Follow-up: 15% (93/609) OR: 1.1 [0.9 – 1.3] [B vs. Follow-up NS]</strong></td>
<td>The intervention led to a significant increase in sexual desire. At follow-up participants were also more likely to expect sexual activity in the future. Finally, more respondents reported increased opportunities to meet potential partners at the six month follow-up (it is possible people met during the ART instruction sessions).</td>
</tr>
<tr>
<td>HIV positive adults, living within 100 km² of the Tororo branch of the AIDS support organization, who are provided with ART.</td>
<td><strong>(3) Any unprotected sex in past 3 months</strong>&lt;br&gt;Men: Baseline: 21% (49/235) OR: 0.5 [0.3 – 0.8] Follow-up: 11% (23/207) OR: 0.5 [0.3 – 0.8] [B vs. Follow-up Sig]<strong>&lt;br&gt;Women: Baseline: 9% (65/691) OR: 0.6 [0.4 – 0.9] Follow-up: 6% (37/609) OR: 0.6 [0.4 – 0.9] [B vs. Follow-up Sig]</strong></td>
<td><strong>(4) Any unprotected sex with negative/unknown partner</strong>&lt;br&gt;Men: Baseline: 9% (21/235) OR: 0.4 [0.2 – 0.9] Follow-up: 4% (8/207) OR: 0.4 [0.2 – 0.9] [B vs. Follow-up Sig]<strong>&lt;br&gt;Women: Baseline: 5% (35/691) OR: 0.4 [0.2 – 0.7] Follow-up: 2% (12/609) OR: 0.4 [0.2 – 0.7] [B vs. Follow-up Sig]</strong></td>
</tr>
<tr>
<td>HIV positive adults, living within 100 km² of the Tororo branch of the AIDS support organization, who are provided with ART.</td>
<td><strong>(5) Increased sexual desire in past 3 months</strong>&lt;br&gt;Men: Baseline: 2% (4/232) OR: 0.6 [0.2 – 1.6] Follow-up: 38% (61/161) OR: 69.8 [16.5 – 295.9] [B vs. Follow-up Sig]<strong>&lt;br&gt;Women: Baseline: 1% (9/691) OR: 0.6 [0.2 – 1.6] Follow-up: 14% (70/512) OR: 12.8 [6.3 – 25.9] [B vs. Follow-up Sig]</strong></td>
<td><strong>(6) Expects sexual activity to increase in future</strong>&lt;br&gt;Men: Baseline: 32% (72/225) OR: 2.1 [1.5 – 2.9] Follow-up: 49% (99/203) OR: 2.1 [1.5 – 2.9] [B vs. Follow-up Sig]<strong>&lt;br&gt;Women: Baseline: 19% (128/662) OR: 1.6 [1.3 – 2.0] Follow-up: 27% (166/606) OR: 1.6 [1.3 – 2.0] [B vs. Follow-up Sig]</strong></td>
</tr>
<tr>
<td>HIV positive adults, living within 100 km² of the Tororo branch of the AIDS support organization, who are provided with ART.</td>
<td><strong>(2) Sex with a Spouse</strong>&lt;br&gt;Men: Baseline: 21% (197/926) OR: 1.2 [1.0 – 1.5] Follow-up: 23% (166/606) OR: 1.2 [1.0 – 1.5] [B vs. Follow-up NS]**</td>
<td></td>
</tr>
<tr>
<td>HIV positive adults, living within 100 km² of the Tororo branch of the AIDS support organization, who are provided with ART.</td>
<td><strong>(3) Any unprotected sex in past 3 months</strong>&lt;br&gt;Men: Baseline: 5% (35/691) OR: 0.6 [0.4 – 0.9] Follow-up: 2% (37/609) OR: 0.6 [0.4 – 0.9] [B vs. Follow-up NS]<strong>&lt;br&gt;Women: Baseline: 9% (65/691) OR: 0.6 [0.4 – 0.9] Follow-up: 6% (37/609) OR: 0.6 [0.4 – 0.9] [B vs. Follow-up NS]</strong></td>
<td><strong>(4) Any unprotected sex with negative/unknown partner</strong>&lt;br&gt;Men: Baseline: 9% (21/235) OR: 0.4 [0.2 – 0.9] Follow-up: 4% (8/207) OR: 0.4 [0.2 – 0.9] [B vs. Follow-up NS]<strong>&lt;br&gt;Women: Baseline: 5% (35/691) OR: 0.4 [0.2 – 0.7] Follow-up: 2% (12/609) OR: 0.4 [0.2 – 0.7] [B vs. Follow-up NS]</strong></td>
</tr>
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### Table III (Continued)

<table>
<thead>
<tr>
<th>Citation</th>
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<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>(7)</td>
<td>Opportunities to meet potential sexual partner increased in last three months</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Men:</strong></td>
<td>Condom use increased within concordant positive partnerships although the decline in mean number of unprotected sexual contacts was not significant.</td>
</tr>
<tr>
<td></td>
<td>Baseline: 3% (7/234) Follow-up: 30% OR: 15.6 [6.6–36.6] [B vs. Follow-up Sig]</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Women:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Baseline: 4% (29/689) Follow-up: 25% OR: 8.9 [6.0–13.2] [B vs. Follow-up Sig]</td>
<td></td>
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<tr>
<td></td>
<td><strong>All</strong></td>
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<tr>
<td></td>
<td>Baseline: 4% (36/923) Follow-up: 27% OR: 9.8 [6.8–14.0] [B vs. Follow-up Sig]</td>
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<tr>
<td>(6)</td>
<td>Sexual behaviour within partnerships of persons at baseline and after six months of ART</td>
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<tr>
<td></td>
<td><strong>Always use a condom in last three months</strong></td>
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<tr>
<td></td>
<td>HIV-negative or unknown partnerships:</td>
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<tr>
<td></td>
<td>Baseline: 59% (82/140) Follow-up: 82% OR: 3.1[1.7–5.8] [B vs. Follow-up Sig]</td>
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<tr>
<td></td>
<td>HIV positive partnerships:</td>
<td></td>
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<tr>
<td></td>
<td>Baseline: 58% (79/137) Follow-up: 74% OR: 2.2 [1.4–3.7] [B vs. Follow-up Sig]</td>
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</tr>
<tr>
<td>(2)</td>
<td><strong>Used a condom the last time</strong></td>
<td>Estimated risk of HIV transmission to partners of negative and unknown status reduced from 45.7 per 1000 person years at baseline to 0.9 per 1000 person years at follow-up representing a 98% decrease.</td>
</tr>
<tr>
<td></td>
<td>HIV-negative or unknown partnerships:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Baseline: 63% (90/143) Follow-up: 85% OR: 3.3[1.7–6.4] [B vs. Follow-up Sig]</td>
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<td></td>
<td>HIV positive partnerships:</td>
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<tr>
<td></td>
<td>Baseline: 70% (96/138) Follow-up: 82% OR: 2.2 [1.3–3.8] [B vs. Follow-up Sig]</td>
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<tr>
<td>(3)</td>
<td><strong>Number of sex contacts in last three months</strong></td>
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<td></td>
<td>HIV-negative or unknown partnerships, mean (SD)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Baseline: 13.7 (14.5) Follow-up: 13.5 OR:1.0 [1.7–1.3] [B vs. Follow-up NS]</td>
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<tr>
<td></td>
<td>HIV positive partnerships:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Baseline: 13.7(12.3) Follow-up: 15.4 (17.0) OR: 1.1 [1.9–1.3] [B vs. Follow-up NS]</td>
<td>The model was supported by clinical findings. When VCT was repeated at 1 year for HIV-negative spouses, one male spouse of a female index participant had sero-converted. Both spouses self-reported inconsistent condom use with each other.</td>
</tr>
<tr>
<td>(4)</td>
<td><strong>Number of unprotected sex contacts in last three months, mean (SD)</strong></td>
<td></td>
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<tr>
<td></td>
<td>HIV-negative or unknown partnerships, mean (SD)</td>
<td></td>
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<tr>
<td></td>
<td>Baseline: 4.2 (9.9) Follow-up: 1.4( 4.3) OR: .3 [2.2–.7] [B vs. Follow-up Sig]</td>
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<td></td>
<td>HIV positive partnerships:</td>
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<td></td>
<td>Baseline: 3.6(9.0) Follow-up: 2.3(5.5) OR: .6 [3–1.1] [B vs. Follow-up NS]</td>
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<tr>
<td>(5)</td>
<td><strong>HIV transmission risk within partnerships (HIV negative/unknown status partner) at baseline and six months after ART</strong></td>
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<td></td>
<td><strong>Expected number of sero-conversions in three months</strong></td>
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<td></td>
<td>Viral load &lt;1700:</td>
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<tr>
<td></td>
<td>Baseline: 0.0000 After six months on ART: 0.018</td>
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<td></td>
<td>Viral load 1700–12499                                    After six months on ART: 0.028</td>
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<td></td>
<td>Viral load 12500–38500                                    After six months on ART: 0.006</td>
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<tr>
<td></td>
<td>Viral load &gt;38500                                       After six months on ART: 1.445</td>
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</tbody>
</table>
Table III (Continued)

<table>
<thead>
<tr>
<th>Citation</th>
<th>Results (I = Intervention; C = Comparison; NS = Non-significant p &gt; 0.05; Sig = Significant p &lt; 0.05; NR = Not reported) Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bateganya, M. 2005</td>
<td>Condom use by sexual partner type comparing ART-experienced and ART-naive HIV positive individuals: 1) Overall total: Baseline: 1.566 After six months on ART: 0.024 2) Expected number of sero-conversions per 1000-person-years Viral load &lt;1700: Baseline: 0.5 After six months on ART: 0.7 Viral load 1700–12499 Baseline: 14.0 After six months on ART: 12.0 Viral load 12500–38500 Baseline: 19.5 After six months on ART: 0 Viral load &gt;38500 Baseline: 53.0 After six months on ART: 0 Overall total: Baseline: 45.7 After six months on ART: 0.9</td>
</tr>
</tbody>
</table>

A cross-sectional study comparing different levels of sexual risk behaviour, socio-economic status, and general health among HIV positives who were ART-experienced versus ART-naive individuals: 1) Reported sexual intercourse in the past six months (n = 723) ART experienced: 55% ART naive: 45% | Overall, 57%, 65%, 85%, and 85% of the sexually active respondents reported consistent condom use with their spouse, regular, casual, and commercial partners, respectively. The ART-experienced respondents were significantly more likely to report consistent condom use with their spouses than ART-naive respondents and significantly more likely to report condom use at last sexual act with their regular partners. All other outcomes measuring condom use were non-significant. |

I: HIV positive individuals who have been on ART for at least a year | Sexual behaviour in the past six months comparing ART-experienced and ART-naive HIV-positive individuals: 1) 1) Reported sexual intercourse in the past six months (n = 723) Yes: ART experienced: 55% ART naive: 45% |

C: HIV positive individuals who have known their HIV status for at least a year but who have never undergone ART | Receipt of ART was not associated with a significantly higher likelihood of being sexually active. There were also no significant association between having multiple sex partners and receiving ART. |
<table>
<thead>
<tr>
<th>Citation</th>
<th>Results (I = Intervention; C = Comparison; NS = Non-significant ( p &gt; 0.05 ); Sig = Significant ( p &lt; 0.05 ); NR = Not reported)</th>
<th>Summary</th>
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<tbody>
<tr>
<td></td>
<td><strong>Summary</strong></td>
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<tr>
<td></td>
<td>No: ART experienced: 47% ART naïve: 53% UOR: 1.35 95% CI: 0.77–1.83 [I vs C NS] AOR: 2.0 95% CI: 0.3–0.99 [I vs C NS]</td>
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<td></td>
<td><strong>2) Percentage of respondents reporting multiple sex partners in the past six months (n = 348)</strong></td>
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<td></td>
<td>Yes: ART experienced: 34% ART naïve: 35% No: ART experienced: 66% ART naïve: 65% UOR: 0.96 95% CI: 0.60–1.52 [I vs C NS]</td>
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<td></td>
<td><strong>3) Of those participants reporting having sex with a non-spousal partner during the past six months, the number of non-spousal sexual partners (n = 120)</strong></td>
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<tr>
<td></td>
<td>One: ART experienced: 46% ART naïve: 43% Two or more: ART experienced: 54% ART Naïve: 57% UOR: 1.67 95% CI: 0.48–5.92 [I vs C NS]</td>
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<td><strong>4) Of those participants reporting having sex with a non-spousal partner during the past six months, the type of non-spousal partner the participant had sex with (n = 120):</strong></td>
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<tr>
<td></td>
<td>Regular: ARV experienced: 82% ART naïve: 78% Non-regular: ART experienced: 18% ART naïve: 22% UOR: 0.82 95% CI: 0.33–2.04 [I vs C NS]</td>
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<td><strong>STD treatment in prior six months comparing ART-experienced and ART-naïve HIV-positive individuals:</strong></td>
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<tr>
<td></td>
<td><strong>1) Percentage of respondents reporting treatment for a sexually transmitted disease in the past six months (n = 713)</strong></td>
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<td></td>
<td>Yes: ART experienced: 16% ART naïve: 38% No: ART experienced: 84% ART naïve: 62% UOR: 0.31 95% CI: 0.21–0.44 [I vs. C Sig] AOR: 2.62 95% CI: 1.77–3.83 [I vs. C Sig]</td>
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<td></td>
<td><strong>HIV serostatus disclosure comparing ART-experienced and ART-naïve HIV-positive individuals:</strong></td>
<td></td>
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<tr>
<td></td>
<td><strong>1) Ever disclosed HIV status to spouse (n = 545):</strong></td>
<td></td>
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<tr>
<td></td>
<td>Yes: ART experienced: 73% ART naïve: 63% No: ART experienced 27% ART naïve: 37% UOR: 1.57 95% CI: 1.07–2.30 [I vs C Sig]</td>
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<td></td>
<td><strong>2) Disclosed HIV status to other sexual partners (n = 120):</strong></td>
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<tr>
<td></td>
<td>Yes: ART experienced: 49% ART naïve: 51% No: ART experienced: 51% ART naïve: 49% UOR: 1.56 95% CI: 0.88–2.76 [I vs C NS]</td>
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<td></td>
<td><strong>3) Know HIV status of spouse or other sexual partner (n = 627):</strong></td>
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</tr>
<tr>
<td></td>
<td>Yes: ART experienced 54% ART naïve: 52% No: ART experienced: 46% ART naïve: 48% UOR: 1.12 95% CI: 0.82–1.55 [C vs. I NS]</td>
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</tbody>
</table>

The ART-experienced group was significantly more likely to report STD treatment in the past six months than the ART-naïve group. ART-experienced respondents were more likely than ART-naïve respondents to have disclosed their HIV status to their spouses. There was no significant difference between the two groups in disclosure to ‘other’ sexual partners nor in the knowledge of partner’s serostatus.
patients (95% CI: 1.7 – 4.6). In the before/after study, condom use at last sexual intercourse with a spouse was 71% for ART patients vs. 47% for non-ART patients (95% CI: 1.7 – 4.6). In the before/after study, condom use at last sexual intercourse increased significantly from baseline to follow-up among participants with HIV-negative or unknown partners (59% to 82%, 95% CI: 1.7 – 5.8) and with HIV-positive partners (58% to 74%, 95% CI: 1.4 – 3.7).

Type of partner

Moatti et al. found that ART patients were more likely to report that the last sexual encounter was with a main partner compared to non-ART patients (95.6% vs. 86.8%, p = 0.02). However, Bateganya et al. reported no difference in the unadjusted percent of ART and non-ART patients reporting multiple sexual partners in the last 6 months (34% vs. 35%, UOR: 0.96, 95% CI: 0.60 – 1.52).

Longitudinal risk and HIV transmission

In the before/after study, Bunnell et al. found that six months after initiating ART, the number of unprotected sex acts with a partner of known negative or unknown HIV status declined by 70%. Men experienced a 75% reduction (5.4 acts vs. 1.3 acts, p = 0.02) and women experienced a 58% reduction (3.5 acts vs. 1.5 acts, p = 0.03). Over 85% of unprotected sex acts with a negative or unknown partner occurred within married couples. The estimated risk of HIV transmission to partners of negative or unknown status reduced from 45.7 per 1000 person years at baseline to 0.9 per 1000 person years at follow-up, representing a 98% decrease.

STD treatment

One potentially contradictory finding was also reported. After controlling for possible confounders, Bateganya et al. found that ART patients were more than twice as likely as non-ART patients to report sexually transmitted disease (STD) treatment in the past six months (AOR, 2.6; 95% CI, 1.77 – 3.82). This finding was inconsistent with all other measures of risk behaviour in this study, which found that ART patients were less likely to engage in risky behaviour.

Discussion

The three articles included in this systematic review all concluded that ART is not associated with risky sexual behaviour among HIV-positive individuals in these developing country settings. In many cases, ART was actually associated with reduced sexual risk behaviour. These findings are consistent with the results of a meta-analysis of literature from developed countries which found that the likelihood of engaging in unprotected sexual behaviour was not higher among persons receiving ART compared to those not receiving ART, although they did report a wide heterogeneity of results (Crepez et al., 2004).

From this review, the one discrepant outcome of increased reporting of STD treatment among ART patients deserves further investigation. Importantly, this is self-reported STD treatment, not self-reported STD. Bateganya et al. speculate that this finding may have been the result of better diagnoses and treatment of STDs among individuals with more regular access to health care. However, this finding may also reflect the weakness of self-reported data and the potential for socially desirable response bias.

This is the first systematic review to examine the impact of medical treatment on HIV risk behaviour in developing countries. Despite considerable research on this topic in developed countries, and despite calls for this type of research in developing countries (Valdiserri, 2004), we were able to identify only three studies that met broad inclusion criteria for this review. The lack of studies is a key finding of this review, as there is currently great speculation but limited data about the phenomenon of treatment optimism.

The dearth of articles found in this review likely reflects the relatively recent emergence of this issue in developing countries. In developed countries, concern about HIV treatment optimism corresponded with the widespread availability of highly active antiretroviral therapy in the 1990s. As the availability of these treatments in developed countries has expanded only recently, there has been little time to document resulting changes in behaviour.

Although the inclusion criteria for this review were quite broad and encompassed all forms of HIV treatment, the three studies that met the inclusion criteria all examined the link between antiretroviral therapy and risky sexual behaviour. No studies were found that looked at other forms of HIV treatment, including treatment of opportunistic infections, prevention of opportunistic infections (e.g. isoniazid therapy or cotrimoxazole prophylaxis), STI treatment, tuberculosis treatment, or palliative care/pain management. Bateganya et al. provided cotrimoxazole and other care to individuals who were eligible for ART but unable to pay for the drugs while their families arranged to contribute for ART. However, in general, the relationship between non-ART forms of treatment and behaviour remains unknown.

This review only examined the impact of HIV treatment on HIV-positive individuals. However,
treatment optimism may also manifest itself at the population level among individuals of positive, negative, or unknown serostatus. In the 2004 meta-analysis in developed countries, the prevalence of unprotected sex was higher in individuals, regardless of serostatus, who believed that receiving ART or having an undetectable viral load protects against HIV transmission, or who were less concerned about engaging in unsafe sex given treatment availability (Crepaz et al., 2004). This was the only statistically significant finding to come out of that meta-analysis, and it indicates that treatment optimism at a population level may be more important than treatment optimism among HIV-positive individuals.

The conclusion of this review – that ART is not associated with increases in sexual risk behaviour among HIV-positive individuals in developing country settings – must be interpreted with caution. It is based on the results of just three studies, a small evidence base from which to draw conclusions. In addition, all of these studies were before/after or cross-sectional in nature and of low methodological rigor according to our eight point scale. These studies are important, however, in that they provide the first information on ART and sexual risk behaviour in developing country settings. Taken together, though, they do not allow us to draw strong conclusions about the effect of ART on sexual risk behaviour in these settings.

The low rigor of studies in this area partly reflects ethical issues in HIV treatment research. As ART is known as the standard of care, it would be unethical to randomize participants to intervention and control groups receiving ART. It therefore would be difficult to design a study that could score a full eight points on our rigor scale given these ethical concerns. As this scale is designed to compare study rigor across interventions within the larger series of systematic reviews, we did not change it to reflect ethical limitations on study design for this topic.

The methodological limitations of these studies limit their generalizability to other populations. Given the limited access to treatment in these settings, it is likely that those receiving treatment are not a representative population of those in need. By using clinic-based sampling, the participants in these studies had already self-selected to attend clinic services and to seek treatment. They may, therefore, have been more aware of risk factors than the population at large, and thus less likely to engage in risky sexual behaviour. These clinic-based populations may have been different in other unanticipated ways as well. In addition, the context of HIV treatment varies widely across programmes and countries in the developing world. With differences in populations served, clinical guidelines for initiating therapy, payment procedures, and auxiliary services, different HIV treatment programs may not be comparable or generalizable to other settings.

In addition, the reduction in risk observed among ART patients may not be solely attributable to ART per se, but rather to the global improvement of care, support, and counselling associated with prescription of ART. Bunnell et al. highlighted the fact that their treatment programme included a large risk-reduction counselling component in which clients developed personal sexual behaviour plans and discussed risk reduction options. In addition, cohabiting partners were offered home-based VCT, and free condoms were provided to clients who requested them. Given their study design, Bunnell et al. acknowledge that it is impossible to disaggregate the relative effects of the prevention activities (counselling, partner VCT, and condom provision) and ART on changes in risk behaviour over time. This is likely to be a problem in most studies on this topic, as ART is rarely given without some degree of counselling or other forms of social support.

Clearly, more evidence is needed to assess the relationship between HIV treatment and risky sexual behaviour. This evidence should be reported as rigorously as possible, following guidelines for reporting non-RCTs such as the recently issued TREND statement (Des Jarlais et al., 2004). This will ensure a stronger evidence base for important policy decisions, including such issues as the nature and content of prevention counselling that may need to accompany ART.

Acknowledgements
The authors wish to thank Sarah Mauch, Devaki Nambar, Jennifer Gonyea, Andrea Ippel, Morgan Philbin, Andrea Wirtz, Alicen Spaulding, Kiesha McCurtis, and Allison Zerbe for their coding work on this project.

References


**Appendix**

The following search terms were used when searching the electronic databases: ARV treatment and risk behaviour; opportunistic infection treatment and risk behaviour; ARV; medical treatment and risk behaviour; HAART, risk behaviours, and HIV; medical care, risk behaviours and HIV; medical treatment, HIV, and risk behaviour; treatment, HIV, and risk behaviour; ARV, HIV, and risk behaviour; opportunistic infection, risk behaviour, and HIV; HAART and risk behaviours; medical care, HIV, and risk behaviour; medical intervention, HIV, and risk behaviour; clinical care, HIV, and risk behaviour.
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