International Journal of Community Medicine and Public Health
Hassan J et al. Int J Community Med Public Health. 2022 Nov;9(11):4213-4229
http://www.ijcmph.com
pISSN 2394-6032 | eISSN 2394-6040

DOI: https://dx.doi.org/10.18203/2394-6040.ijcmph20222921

Systematic Review

Sexual behaviours of HIV sero-discordant couples in the context of art: a systematic review of studies from Sub-Saharan Africa

Judith Hassan[1], Kate Mitchell[2], Uguge Basil[3], Babatunde Shuaib[4], Victor B. Oti[5]*

[1]Ministry of Health, Kaduna, Nigeria
[2]Imperial College, London-UK
[3]JHPEIGO, Sierra, Leone
[4]NFELTIP, Nigeria
[5]School of Pharmacy and Medical Sciences, Griffith University QLD, Australia

Received: 30 August 2022
Revised: 30 September 2022
Accepted: 01 October 2022

***Correspondence:**
Dr. Victor B. Oti,
E-mail: obabavictor1@gmail.com

ABSTRACT

The impact of the use of antiretroviral therapy (ART) on the sexual behaviours of serodiscordant couples (SDC) is not well documented. This systematic review attempts to examine the strength of evidence from primary studies on the impact of ART on the sexual behaviours of serodiscordant couples in SSA. In this study, 16 studies that fit the inclusion criteria were identified. Nine were cohort studies, six cross-sectional and one randomised controlled trial. Risky sexual behaviours generally declined on several indicators used to assess them. Five within individual studies reported a decrease in unprotected sex from baseline to follow-up, while of the four that said consistent condom use, they observed a significant increase in condom use from baseline to follow-up. For the between-individual studies, one study posited that ART is significantly associated with inconsistent condom use, whereas reporting multiple and concurrent partners and self-reported symptoms of sexually transmitted infections (STIs) were associated with not being on ART. Overall, there was evidence of lower-risk sexual behaviours with ART among SDC in sub-Saharan Africa. However, this relationship was not established to be causal. Further research is required to fully explore and validate the impact of ART on the sexual practices of these couples. Behavioural programmes should be strengthened and targeted towards couple-based counselling and testing with disclosure of status and continue encouraging consistent condom use among steady couples.

Keywords: Sero-discordant couple, Anti-retroviral therapy, Condom use, Sexually transmitted infections, Sub-Saharan Africa, HIV

INTRODUCTION

Human Immunodeficiency Virus (HIV) serodiscordant couples (SDC) have been a significantly high-risk group for ongoing HIV seroconversion due to the high sexual acts occurring within steady partnerships.[1] Studies from Sub-Saharan Africa (SSA) established a higher seroconversion rate within steady SDC than sero-concordant negative partners.[2,3] These rates have significantly decreased over the past decade, thanks to the efficacy of antiretroviral therapy (ART).[4] Researchers have identified that earlier initiation of highly active antiretroviral therapy (HAART) can considerably reduce and halt transmission.[5,6] The WHO has since recommended immediate initiation of ART in a positive partner of SDC irrespective of CD4 cell count, which is currently the standard in most settings.[7] As ART is becoming widely available and highly effective in reducing the spread of the virus, the chances of sexual partners engaging in risky sexual behaviours might be increased, which could undermine the effectiveness of ART and thus increase the risk of viral transmission.

Sexual disinhibiting has been reported among the general populations of HIV+ persons in different regions, including SSA.[8] Sexual behaviours generally include condom use, multiple and concurrent sexual partners, unprotected sex (UPS), risky sexual behaviours (RSB) and STI as a proxy for RSB. A meta-analysis study reported that although using ART and having a low viral load is not associated with increased sexual risk, the rate of unprotected sex was higher in those who believed that taking ART and having a low viral load is protective against HIV infection.[9] There have been mixed reports of sexual behaviours among PLHIV globally. In contrast, other studies reported that in the general population of people living with HIV (PLHIV), the use of ART has resulted in increasingly low-risk sexual behaviours.[10-14] Yet, others reported a rise in high-risk sexual behaviour among ART patients.[15] Although it is well known that serodiscordant couples contribute significantly, hiking the rate of new infections in different sub-saharan countries, the effect of ART on sexual behaviour among steady SDC, nor is the pattern of sexual activities among these couples on ART is apparent.[16]

This study shed light on this, by exploring the evidence from various primary research carried out in different SSA countries on sexual behaviours among this group of people in the context of ART. This research aims to identify primary studies within SSA and condense the strength of evidence reported by these studies on the effect of ART on the sexual behaviour of serodiscordant couples.

METHODS

This study was carried out in three parts; first, a thorough literature search to identify relevant works of literature was carried out. Secondly, screening of retrieved literature followed by a concise and intensive quality appraisal of conclusive studies was done and finally, data extraction, synthesis and analysis of results.

We carried out a thorough advanced literature search for three weeks in July 2015 on six relevant databases provided by the library of the London School of Hygiene and Tropical Medicine (LSHTM) from 2003 to the present. The databases searched included Pubmed, Embase, Medline, Web of Science, Global health, and Africa wide information.

Only primary studies, which include cohort, cross-sectional and randomised controlled trials, were included, with an identified unit of analysis being a dyad or individual member of the couple.

Secondary studies (Literature reviews, systematic literature reviews, meta-analysis, and mathematical models), medical books, guidelines for clinicians, case reports and conference abstracts were excluded. This involved screening identified studies, quality appraisal and assessing the risk of bias. It was carried out to decide whether studies meet the scope of the review.

RESULTS

Search Result

A total of 4584 studies were identified from the database search. In addition, 14 more were retrieved from bibliographies of other relevant literature, totalling 4598 articles. However, after removing duplicates, 2585 articles were left, further screened according to topics to 188 potential articles. Screening by abstracts yielded 65 pieces, and full-text screening was finally done to arrive at 16 papers included in the final analysis. The result of the screening strategy is represented in the adopted PRISMA flowchart in Figure 3.

General characteristics of sampled studies

Of the 16 final samples, 9 were cohort studies, six cross-sectional and one quantitative analysis nested within a randomised controlled trial. All studies were carried out in sub-Saharan Africa between 2006 to 2015, with the majority 7 in uganda, two each in south africa and kenya, and one each in Ethiopia, Cameroon, Ghana, Cote D'ivoire and Mozambique, as shown in Figure 2 and 3.

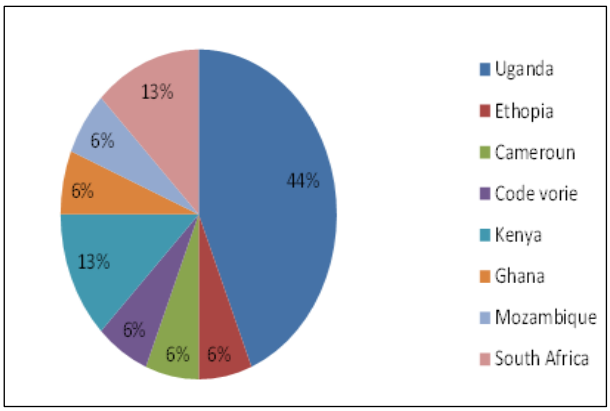

Figure 1: Sampled studies by study location.

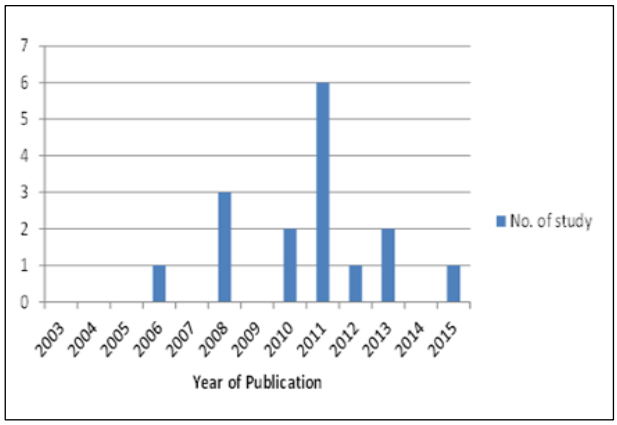

Figure 2: Sampled studies by study location.

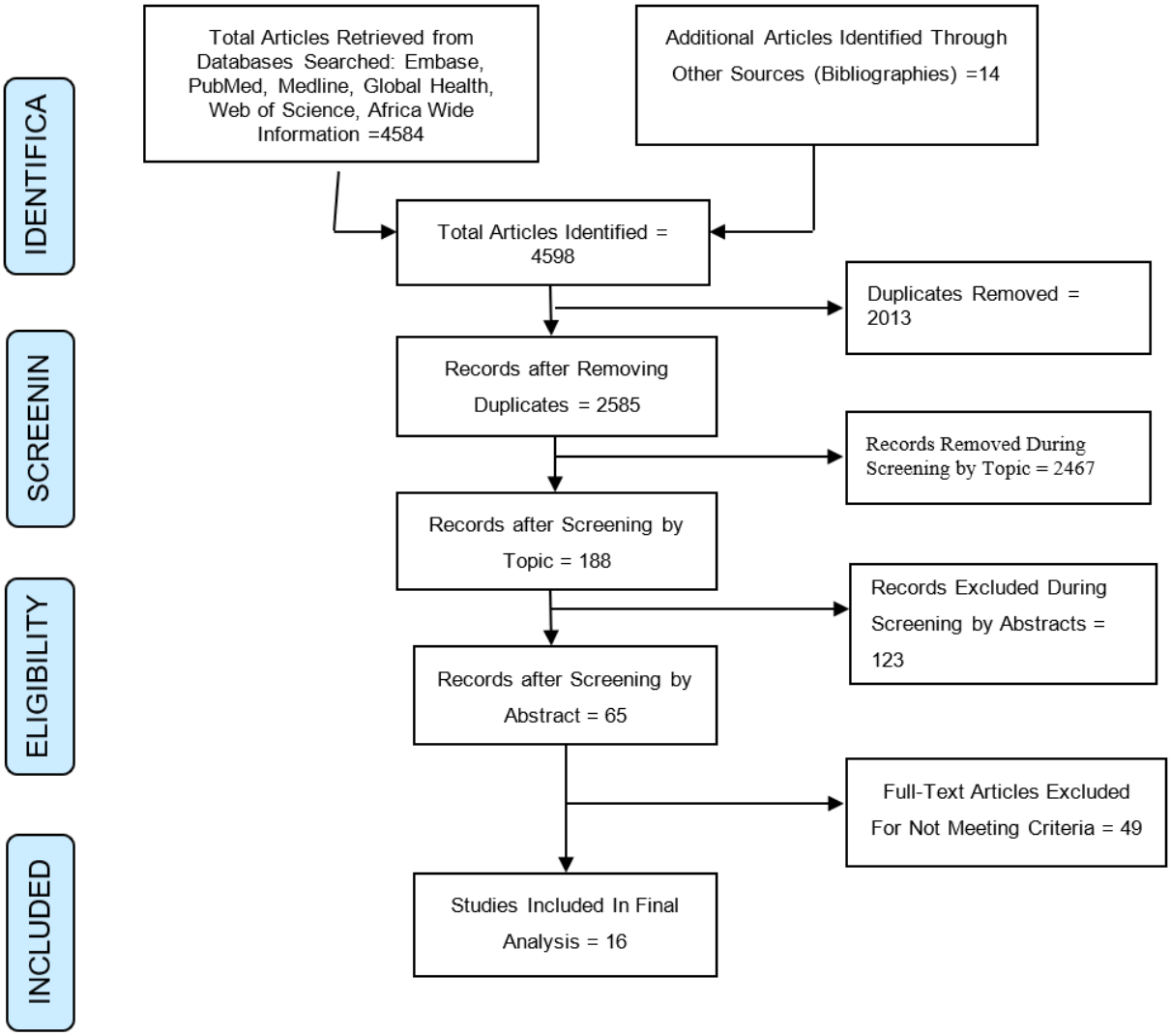

Figure 3: PRISMA flowchart.

Description of study design and methodology of sampled studies

Table 1 shows all but two studies that recruited participants through hospitals or HIV care facilities.[7,8] Sample sizes ranged from 205 to 1163, with a total sample size of 10,960.

Data were collected using structured questionnaire interviews, though a few employed other means of data collection, such as clinical records and data from national survey reports. STIs were self-reported symptoms in 5 of the studies, while one study was serology confirmed.[19]

Participants received interventions including ART, male condoms, preventive therapy, behavioural and adherence counselling, voluntary counselling, testing of partners, and cotrimoxazole and isoniazid prophylaxis. Within the cohort studies, follow-up periods ranged from 12 to 48 months; however, loss to follow-up was significant (up to 28%) in those with more extended follow-up periods, while there was no mention of loss to follow-up in two of the studies.[7,8,20,21] Statistical analysis included odds ratios, adjusted odds ratios, prevalence rates, Chi-squared tests and 95% confidence intervals.

Characteristics of study participants

Study participants included one member of a couple, primarily females. The age of participants varied among studies, but all participants were ≥18 years old and were within the sexually active age group (18-45 years). The percentage of participants in a steady sexual relationship, either married or co-habiting, partner HIV status and antiretroviral status of participants are represented in Table 2.

Summary characteristics of studies according to comparison group of analysis

Individual comparisons of ART-experienced versus ART-naïve participants were employed in the studies.[19,22-25] In

contrast, one study also compared HIV+ versus HIV- participants; three had no comparison group but reported the prevalence of UPS and condom use and the incidence of self-reported STI and new sexual partners.[20,26-28]

At the same time, the remainder were compared among individuals who followed up before and after ART initiation.[8,17-21,29,30] The randomised controlled trial employed an ART naïve comparison group, who were followed up when some participants were initiated on ART whenever eligible.[31] This analysis was based on the early ART group versus standard ART.

Study appraisal and assessment of risk of bias

Based on the NICE appraisal scoring tool, all the included studies had some limitations, although unlikely to invalidate their conclusions. In terms of the theoretical approach and study design, all had an appropriate, clear, and defensible rationale: meaning that a qualitative approach was the more appropriate study design to be applied since the outcome is measuring participants' behaviour, the aims and objectives of the study as well as research question were clear and the methodological approach justifiable. The data collection and management method where appropriate and clearly described: the relevant data for the outcome measure were collected using questionnaires, and record-keeping was systematic in all the studies except Reynolds et al which failed to describe how sexual behaviour data was obtained.[21]

Regarding trustworthiness, most studies failed to adequately express how the study was explained to participants nor considered context and selection bias. Also, the methodology was generally unreliable (as most studies applied only one data collection method except Birungi et al which carried out laboratory testing of STIs, as shown in Table 2).[19] Analysis was rigorous, rich, convincing, and relevant but unreliable as none of the studies reported how many researchers were involved in the research, whether there were any discrepancies, and how many were resolved.

All analyses presented adequate and precise discussions of their findings and identified and addressed study limitations. Fourteen of the sixteen studies reportedly obtained ethical approval to carry out the study. Still, they did not report on participants' confidentiality nor considered the consequences of the research on participants, whereas Dia et al and Eisele et al made no mention of ethics.[22,23]

Changes in sexual behaviours with ART

Unprotected sex and condom use

As shown in Table 5, unprotected sex decreases from baseline to follow-up in most of the seven individual studies.[8,17,21,29,30] Of these, three reported decreased unprotected sex among HIV+ persons with their HIV- partners.[17,20,29]

Bunnell et al reported a statistically significant reduction in unprotected sex with an HIV-/USP (6% at baseline versus 2% at follow-up, p=0.0001). In comparison, Apondi et al reported no difference in UPS with HIV-/USP at baseline to follow-up (6.2% versus 5.7%, p=0.2313).

Still, when the analysis was restricted to HIV- partners only, a statistically significant increase was observed (1.4 verses 2.0, p=0.0234). Luchters et al reported that unsafe sex (UPS with HIV-/USP) was 0.59 less likely (95% CI=0.37-0.94, p=0.026) in the 12 months after ART compared to baseline. Likewise, Wandera et al reported a decrease in UPS from 53% at baseline to 15% 12 months after ART initiation (p=0.0348). However, analysis was among sexually active participants irrespective of partner status, so also Eisele et al reported a significant decrease in UPS among the ART group from baseline to follow-up (43.7-23.2%, p<0.05) compared to the non-ART group. Also, they reported that persons on ART whose partner was HIV+ were twice as likely to have had unprotected sex the last time compared to those with HIV-/USP(AOR=2.18, 95% CI 1.29-3.68).

Kembabazi et al reported a gender prevalence of risky sexual behaviours (UPS with HIV-/USP) in men to be statistically significantly lower (16.3% to 4.3%, p≤0.01) from baseline to first post-ART follow-up as compared to in women. Meanwhile, the numbers reporting unprotected sex with HIV-/USPremained unchanged [n=45 (34%) versus n=45 (25%) t=1.71] from baseline to follow-up in the Pearson et al study.[30]

In terms of condom use, participants reported a significant increase in consistent condom use from baseline to follow-up in the Apondi et al, Bunnell et al, Pearson et al and Reynolds et al studies, as shown in Table 6.[17,18,21,30] Between individual studies, Sarna et al reported that persons receiving preventive therapy were more likely to have unprotected sex than those on HAART (78% versus 47%, p<0.001).[25]

Similarly, Venkatesh et al reported a decrease in UPS in the ART-experienced than in ART-naïve groUPS (11.5% versus 17.4%, p=0.049) but also showed that participants with HIV- partners were more likely than those with HIV+ partners to report unprotected sex in prior six months (18% versus 14%), whilst Jean et al reported no association between risky sex (unprotected sex with HIV-/USP) and ART in the standard group compared to early ART group (12.9% versus 10%, p=0.5).[24,31] In terms of condom use, Dia et al reported that receiving ART is significantly and strongly associated with reporting inconsistent condom use [p<0.0001 and OR (95% CI): 2.44 (1.78-3.33)]. While not the same can be said of Birungi et al couples in which HIV+ partners taking ART at enrolment were more likely to report condom use at last sex with HIV- a partner (77% versus 69%) and consistent condom use in the prior three

months than those not on ART (67% versus 58%, p=0.003).[19]

Although participants receiving HAART were more likely than those on PT to report consistent condom use with a regular partner (OR: 3.9, 95% CI 1.83-8.43), there was no difference observed between the HAART group and PT group in reporting consistent condom use with HIV- partners (30% versus 42%) as was observed with the HIV+ and USP (56% versus 14%, p=0.004 and 56% versus 16%, p=0.004) in the Sarna et al studies.[25]

Dessie et al reported that those with HIV- partners were less likely to practice unprotected sex (AOR=0.33, 95% CI=0.14-0.80) than those with HIV+ partners.[27] Ncube et al also reported that participants on ART were 80% less likely to have used condoms during their last sex (OR=0.2 95% CI, 0.04-0.6) and went on to conclude that condom use during last sex, being treated for STI and being on ART were all associated with serodiscordant.[28]

Similarly, in the Osinde et al studies, all the high indicators of risky sexual behaviours were reported.[32]

Multiple and concurrent sexual partnership

There were mixed reports of multiple and concurrent sexual partners in the studies. While Wandera et al and Luchters et al reported a decrease in reporting ≥2 sex partners from baseline to follow-up (18.3% to 9% and 10% to 6%, respectively), Reynolds et al found an increase in reporting ≥2 partners at baseline from 18.6% to 26.8% during follow-up and, Apondi et al also reported a rise in several new partners during follow-up (1.4% at baseline to 2.6%, p=0.027).[17,20,21,29] On the other hand, Venkatesh et al showed that ART-experienced participants were less likely than ART-naïve to report multiple partners in the last 6 months (0.6% versus 4.3%, p=0.014).[24]

Similarly, reports of ≥2 partners were more likely in the PT group than in the HAART group (13% versus 1%, P=0.006) as Sarna et al.[25] Birungi et al found no difference in polygynous relationships between the ART-experienced and ART-naïve group UPS (25% versus 24%, respectively, p=0.93).[19]

Jean et al also reported no significant difference in multiple partners in the early ART group compared to the standard ART group (9% versus 6.2%, p=0.11).[31] Pearson et al reported that about 96% of concurrent partnerships reported during follow-up were newly formed but with no difference in the mean number of concurrent partners from 2.17 at baseline to 2.11 at follow-up (t=0.68, p≥0.05).[30] Prevalence of multiple partnerships was high according to Osinde et al, 88.5% of participants had ≥1 sexual partner in the prior 3 months, with 35.8% acquiring new partners within this period.[32] In contrast, only 10% of those on ART reported multiple sexual partners (OR 2.47, p=0.001) in the Dessie et al studies.[27]

Other indicators of risky sexual behaviours (STI)

Sexually transmitted infections were reported in six of the 16 studies as a proxy for unprotected sex.[21,25-28,29,31] Of these, only Birungi et al carried out confirmatory serology. They found increased STI reports in the ART group than in non-ART (91% versus 84%, p=0.050), whereas STI symptoms were self-reported in the other studies. Sarna et al reported that the PT group were more likely to report STI than those on HAART [22% versus 13%, OR 1.7 (0.98-2.81), p=0.06], while Luchters et al and Reynolds et al found a higher prevalence of STI at baseline compared to during follow-up on ART [31% to 8% AOR 0.20 (0.09-0.43), p<0.001 and 2.6% to 2.4% respectively], and STI prevalence was 4.5-4.7% in the Ncube et al study.

DISCUSSION

Finding

Although few of the studies reported increased sexual risk behaviours such as inconsistent condom use among those on ART compared to non-ART, more unprotected sex in those with HIV- than HIV+ partners, and more STI report in those on ART than non-ART group, sexual risk behaviours among SDCs on ART generally decreased on several indicators in all the 16 studies included in this review.[1019,22]

These findings are consistent with the results of a systematic literature review of studies in SSA, which showed that access to ART was not associated with increased sexual behaviour risk. Likewise, a meta-analysis study did not show any statistically significant association between sexual activity with ART experience among people living with HIV on ART in this region.[13,14] Similarly, in developed countries, a meta-analysis of primary studies found no increase in risky sexual behaviours in patients on HAART.

However, it did prove a higher prevalence of unprotected sex among HIV+, HIV- or unknown-status individuals who believed that taking HAART guards against HIV transmission or are less concerned about engaging in unsafe sex due to the availability of HAART.[9]

Limitations

The main limitation of this review is that studies specific to sexual behaviours among SDC on ART were lacking despite an intensive literature search.

This shortage of information resulted in this review relying on behaviour data of SDCs extracted from secondary outcome measures and data from within sexual behaviour reports in the general population of PLHIV, including that of unknown status partners.

Table 1: Study characteristics according to the methodological approach.

Reference	Title	Study located on	Study design	Enrolment method	Data collection method	Intervention	Follow up period (months)	Loss to follow up	Outcome measure of interest	Statistical analysis
Apondi et al[17] 2011	Sexual behaviour and HIV transmission risk of Ugandan adults taking ART: 3-year follow-up	Uganda	Prospec-tive CS	Home-based enrolm-ent. Informed consent was obtained the in preferred language.	Private structured home interview of particip-ants	-ART -Free condoms on request -Group education. -Home-based VCT of co-habiting partners.	36M	28%	Frequency of condom use. Number of UPS act.	AOR, 95% CI, p value (trend)
Bunnell et al[18] 2006	Changes in sexual behaviour and risk of HIV transmission after ART and prevention interventions in rural Uganda	Uganda	Prospec-tive CS	TASO clients. Home enrolm-ent. Informed consent obtained.	Private home-based structur-ed intervie-ws.	Group education on ART. Home-based VCT of co-habiting partners. Free ART for eligible participants	18M	4.4%	Sexual behaviours. Partner specific sexual behaviour.	AOR, 95% CI, P-value
Birungi et al[19] 2015	Lack of effectiveness of ART in preventing HIV infection in sero-discordant couples in Uganda: An observational study	Uganda	Prospec-tive CS	Enrolment from TASO HAARP cohort study. Informed consent obtained.	Questionnaire interview. STI Serology.	Group1= ART Group 2= no ART. Both groUPS received couple-based HIV transmission risk reduction counselling and condoms.	Median duration= 17M	14%	Condom use	IRR, 95% CI, p value
Eisele et al[23] 2008	Changes in risk behaviour among HIV positive patients during their first year of antiretroviral therapy in cape town, south Africa	South Africa	CS	Hospital based enrolment. Verbal and written consent obtained.	Interview with self-administered and interviewer-assisted electronic questionnaires	ART	12M	19.9%	Prevalence of UPS at last sex. Sexual activity in last month	
Dia et al[22] 2010	Prevalence of unsafe sex with one's steady partner either HIV- or of	Camer-oon	CSS	Random sample of HIV+ individuals in 27 HIV treatment centres for the national cross-	Face-to-face interviews with participants. Clinical data obtained from	ART	**	**	Unsafe sexual behaviours	

Continued.

Reference	Title	Study located on	Study design	Enrolment method	Data collection method	Intervention	Follow up period (months)	Loss to follow up	Outcome measure of interest	Statistical analysis
	unknown HIV status and associated determinants in Cameroon (EVAL ANRS12-116 survey)			sectional survey EVAL	patients' medical records.					
Luchter et al[29] 2008	Safer sexual behaviours after 12 months of ART in Mombasa, Kenya: a prospective cohort	Kenya	CS	Hospital based. Random allocation to m-DOT or standard of care.	Structured questionnaire interviews by trained research assistants.	Group 1 = m-DOT HAART Group 2 = standard of care. Both groUPS received one-on-one counselling.	14M	18.4%	Unprotected sex with HIV- or USP	
Dessie et al[27] 2011	Risky sexual practices and related factors among art attendees in Addis Ababa public hospital, Ethiopia: A cross-sectional study	Ethiopia	CSS	Hospital based enrolment. Signed informed consent.	Interviews conducted by trained counsellors using structured behavioural questionnaires	ART	**	**	UPS with HIV-, HIV+ or USP)	
Pearson et al[30] 2011	Change in sexual activity 12 months after ART initiation among HIV-positive Mozambicans	Mozam bique	CS	Hospital based. Informed consent obtained.	Participants completed a 45mins interviewer-administered questionnaire	ART	19M	20.9%	Sexual behaviours.	OR, SE, 95% CI
Jean et al[31] 2013	Effect of early ART on sexual behaviours and HIV-1 transmission risk among adults with diverse heterosexual partnership statuses in Cote d'Ivoire	Cote d'Ivoire	Quantita tive study of an RCT	Facility based. Signed informed consent.	Face-to-face questionnaire interview.	ART only, ART plus isoniazid	30M	18.3%	Sexual activity and multiple partnerships	Percentage Difference, p value
Osinde et al[32] 2011	Sexual Behaviour and HIV sero-discordance	Uganda	CSS	Hospital based	Interviewer-administered questionnaire	ART, Behavioural counselling	**	**	Sexual Behaviour of HIV infected	COR, AOR, 95% CI, p value

Continued.

Reference	Title	Study located on	Study design	Enrolment method	Data collection method	Intervention	Follow up period (months)	Loss to follow up	Outcome measure of interest	Statistical analysis
	among HIV patients receiving HAART in rural Uganda								patients and characteristics associated with sero-discordance	
Reynolds et al[21] 2011	HIV-1 transmission among HIV-1 discordant couples before and after the introduction of ART	Uganda	CS	Enrolled through RCCS. Written informed consent.	RCCS data collected in four survey rounds 2004-2009.	ART Voluntary HIV-1 counselling and testing. Individual and couples behavioural counselling.	Median follow-up time before ART= 1.57y, after ART= 1.54y	**	Sexual risk behaviours	Fisher's exact test, p value
Ncube et al[28] 2012	Sexual risk behaviour among HIV-positive persons in Kumasi, Ghana	Ghana	CSS	Hospital based. Informed consent obtained.	Interviewer-administered questionnaire	ART	**	**	Sexual risk behaviours.	COR, AOR, 95% CI
Wandera et al[20] 2011	Sexual behaviours over a 3-year period among individuals with advanced HIV/AIDS receiving ART in an urban HIV clinic in Kampala, Uganda	Uganda	Prospective CS	Hospital based.	Trained counsellor conducted interviews using structured interviewer administered questionnaire.	ART. Free male condoms. Behavioural counselling.	36M	28%	Sexual Behaviour before and after ART	PR, 95% CI
Kembabazi et al[8] 2013	Disinhibition in risky sexual behaviours in men, but not women, during four years of ART in rural, South-Western Uganda	Uganda	CS	Participants enrolled in the UARTO study. Informed consent obtained.	Data collected through interviews by trained research assistants in private study rooms.	ART	48M	**	Unprotected sex with sero-discordant or unknown status partner and or casual partner	OR, 95% CI, p value
Venkatesh et al[24] 2012	Sexual risk behaviours among HIV infected South African men and women with their partners in a primary care program:	South Africa	CSS	Participants consent obtained.	Structured questionnaires delivered by study nurses.	ART	**	**	Patterns of sexual behaviours and whether these behaviours differed by	AOR, 95% CI, p value

Continued.

Reference	Title	Study located on	Study design	Enrolment method	Data collection method	Intervention	Follow up period (months)	Loss to follow up	Outcome measure of interest	Statistical analysis
	implications for couples-based prevention								partner HIV status	
Sarna et al[25] 2008	Sexual risk behaviour and HAART: A comparative study of HIV-infected persons on HAART and on preventive therapy Kenya	Kenya	CSS	Clinic based. Written informed consent.	Face-to-face interview conducted by trained interviewers using structured questionnaires.	HAART only group. CTX and or isoniazid group	**	**	RSB of HIV+ persons. Association of HAART with increased RSB.	OR, 95% CI, p value

Note: CS= cohort study, CSS= case-control study, RCT= randomised controlled trials, TASO= The AIDS Support Organisation, HAARP= highly active antiretroviral therapy as prevention, OR= Odd ratio, COR= Crude Odd ratio, AOR=adjusted Odd ratio, IRR= Incidence rate ratio, PR= prevalence rate, 95% CI= 95% Confidence interval, p value= significance Level, UPS= unprotected Sex, USP= unknown status partner, m-DOT=modified directly observed therapy, CTX= Cotrimoxazole, PT= preventive therapy, ART= antiretroviral therapy, VCT= voluntary counselling and testing, RCCS= Rakai Community cohort study, UARTO= Uganda AIDS Rural Treatment Outcomes, **=not applicable/not reported, RSB= risky sexual behaviour.

Table 2: Study characteristics according to the methodological approach.

Authors	Sample size	Eligibility criteria	Gender	Age (years)	Participants' ARV status	HIV- partners	Married or cohabiting /steady partner
Apondi et al	926	ART-naïve HIV infected adults with CD4 ≤250cells/µl or symptoms and living within a 100km catchment area	men and women	Mean age Men= 41 y Women= 37 y	ART initiated at enrolment	31%	35.4%
Birungi et al	586 couples	Co-habiting HIV SDC ≥18years, reported at least two episodes of sexual intercourse in last 3 months	Men=331 Women=255	≥18 years	249(42.5%) = ART at enrolment, 99(17%)= ART during study 238 (40.6%) = non-ART group	All partners HIV-	All in a steady couple
Bunnell et al	926	Clients with CD4 cell count ≤250 cells/µl or symptomatic AIDS, ART naïve, living within 100km catchment area	Men=235 Women=691	Median age Men= 41 y Women=37 y	ART initiated at enrolment	HIV- =49 HIV-/USP=143	35%
Eisele et al	913	≥18years, initiated ART in the last 3 months and another sample waiting to start ART	Men =311 women=605	Mean age ART group =34.1(0.2) Non-ART group =32.8(0.6)	512 initiated ART 401 comparison group not on ART	Partner HIV- or USP ART group =73.5% Non-ART group =72.4%	ART group =30% Non-ART group= 36.2%
Dessie et al	601	≥18years, sexually active in last 3 months, at least two clinic visits	Men=270 Women=331	Mean age= 33.4y±6.5 (SD)	All participants on ART	12.5%	82.1%

Continued.

Authors	Sample size	Eligibility criteria	Gender	Age (years)	Participants' ARV status	HIV- partners	Married or cohabiting /steady partner
Kembabazi et al	506	Adults PLHIV, living within 20km of the HIV clinic, and initiating ART	Men=155 Women=351	Median age 34 y (29-39)	All participants initiated ART	**	32%
Wandera et al	559	HIV infected, ART naïve adults aged ≥18years	Women= 68.9%	Median age= 38 y (33-44)	All initiated ART at enrolment	HIV- =6.1% USP = 63.4%	46.7%
Dia et al	907	ART attendees, at least 2 clinic visits, reported sexual activity during the 3 months prior to survey, with a steady HIV-/USP	Men=299 Women=608	Mean age 36 y SD (8)	691 receiving ART	All HIV- or USP	76.6%
Jean et al	957	HIV+, >18years, had HIV-1 or HIV-1/HIV-2 dual infection, no ongoing TB, pregnancy and breastfeeding, had CD4 cell count <800cells/mm and satisfied no criteria for starting ART.	Women =80.4%	Median age=35 y	Group 1= ART at baseline Group 2= ART during follow-up	Standard arm =55 Early arm=54	46.2%
Luchters et al	234	HIV+, ≥18years, ART naïve but ART eligible according to the Kenyan national treatment guidelines	Men=85 Women=149	Mean age= 37.2 y SD (7.9)	On ART=50% On standard care=50%	HIV- =11% USP=55%	48%
Ncube et al	267	HIV+, ≥19years, attending ARV clinic at the KSRH	Men=43 Women=224	Average age= 37y±9	Men =56% Women =74%	67% HIV-/USP	59%
Osinde et al	278	At least 3month clinic attendance, sexually active, available test result for participant and sexual partner	Men=22 Women=256	<24 y= 67.3% 25-≥45 y= 32.7%	78.1% on ART	38.7%	67.3%
Pearson et al	350	ART eligible adults ≥18years, living near the recruitment clinic, free from severe mental illness or dementia	Men and women	Median age Men= 39 y Women= 32 y	All participants-initiated ART at enrolment	45%	Living with partner =51% Concurrent relationship=17%
Venkatesh et al	1542	HIV+, ≥18years, sexually active in the preceding 6months, either already receiving HIV care, were self-referred or referred from PMTCT clinic	Men=21.1% Women=78.9%	Median age= 34.8 y	15.7%	HIV- =20.9% USP=39.8%	35.9%
Sarna et al	322	HIV+ at least 5months on HAART	HAART arm Men=112 Women=210	Mean age= 37 y SD(8)	179 initiated HAART	HAART Arm = 13% PT Arm= 22%	HAART Arm=97% PT Arm=88%
Reynolds et al	250 couples	Married participants among the RCCS from 50 villages in rural Rakai district	Men and women	Age group 15 y and above	32	HIV- men = 105 HIV- women = 145	All married

Note: SD= Standard deviation, PMTCT = Prevention of Mother to Child Transmission, KSRH= Kumasi South Regional Hospital, HIV- = HIV negative, HIV+ =HIV positive.

Table 3: Summary characteristics according to the comparison group.

Authors	Country	Type of study	Type of comparison	Sample size
Luchters et al[29]	Kenya	Prospective	Pre-ART versus post-ART	234
Wandera et al[20]	Uganda	Prospective	Pre-ART versus post-ART	559
Pearson et al[30]	Mozambique	Prospective	Pre-ART versus post-ART	350
Apondi et al[17]	Uganda	Prospective	Pre-ART versus post-ART	926
Reynolds et al[21]	Uganda	Prospective	Pre-ART versus post-ART	250 couples
Bunnell et al[18]	Uganda	Prospective	Pre-ART versus post-ART	926
Kembabazi et al[8]	Uganda	Prospective	Pre-ART versus post-ART	506
Jean et al[31]	Cote d'Ivoire	Prospective	Early ART versus standard ART	1172
Eisele et al[23]	South Africa	Prospective	ART-experienced versus ART naive	512
Birungi et al[19]	Uganda	Prospective	ART-experienced versus ART naive	586
Dia et al[22]	Cameroon	cross-sectional	ART-experienced versus ART naïve	907
Sarna et al[25]	Kenya	Cross-sectional	ART-experienced versus ART naive	322
Venkatesh et al[24]	South Africa	Cross-sectional	ART-experienced versus ART naïve	1542
Dessie et al[27]	Ethiopia	Cross-sectional	**	602
Ncube et al[28]	Ghana	Cross-sectional	**	267
Osinde et al[32]	Uganda	Cross-sectional	**	278

Note: **= not applicable.

Table 4: Study appraisal overall assessment summary.

AUTHORS	Overall assessment
Apondi et al	++
Birungi et al	++
Bunnell et al	++
Eisele et al	++
Dessie et al	++
Dia et al	++
Jean et al	++
Luchters et al	++
Ncube et al	+
Osinde et al	+
Pearson et al	++
Sarna et al	++
Reynolds et al	+
Kembabazi et al	++
Venkatesh et al	++
Wandera et al	++

Table 5: Results of sexual behaviours in within individual studies.

Author	Result			
Apondi et al		**Baseline**	**36M follow-up**	**P-value**
	Any UPS	12.5%	19.3%	<0.0001

Continued.

Author	Result				
	Any UPS with HIV- partner	1.4%	2.0%		0.0234
	Any UPS with USP	4.8%	3.8%		0.9937
	Any new partner in prior 3M	1.4%	2.6%		0.0272
	HIV- partnerships:				
	Always use condom in prior 3M	58.6%	73.7%		0.65571
	Number of UPS prior 3M, mean(SD)	4.8(8.7)	3.5(8.2)		0.0137
Bunnell et al		**Baseline**	**6M follow-up**	**AOR**	**P value**
	Sex with spouse	21%	23%	1.1(0.8-1.3)	0.6641
	Any UPS	12%	7%	0.5(0.3-0.8)	0.0035
	Any UPS with HIV-/Unknown status partner	6%	2%	0.4(0.2-0.6)	0.0001
	HIV- or USP:				
	Consistent condom uses in past 3M	59%	82%	3.1(1.7-5.8)	0.0003
	Number of UPS in past 3M, Mean (SD)	4.2(9.9)	1.4(4.3)	0.3(0.2-0.7)	0.0017
Eisele et al		**Baseline**	**Follow-up**	**X^2 test †**	**P value**
	ART patients:				
	At least 1 sex partner in past 1M	56.7%	70.2%	1.97	>0.05
	Most recent partner HIV-/USP	73.5%	63.7%	2.44	>0.05
	No condom at last sex with most recent partner	43.7%	23.2%	19.18	<0.05
	No condom at last sex with spouse	40.4%	23.7%	10.90	<0.05
	Non-ART patients:				
	At least 1 sex partner in past 1M	68.7%	70.6%	0.21	>0.05
	Most recent partner HIV-/USP	72.4%	61.7%	7.32	>0.05
	No condom at last sex with most recent partner	44.7%	40.1%	0.42	>0.05
		On ART	**Non-ART**	**Coefficient**	
	No condom at last sex with any partner during follow-up	23.7%	40.1%	-0.765	<0.05
Luchters et al		**Baseline**	**Follow-up**	**AOR (95% CI)**	**P value**
	UPS with HIV-/USP in past year	50%	28%	0.52(0.32-0.87)	0.012
	Self-reported STI	31%	8%	0.20(0.09-0.43)	<0.001
	Number of sex partners in last 12M:	**Men**	**Women**		
	1 partner	83%	94%		>0.05
	≥2 partners	17%	6%		0.068
Kembabazi et al		**Baseline**	**Follow-up**	**OR, AOR (95% CI)**	**P value**
	Men:				
	Risky sexual behaviour	16.2%	4.3%	**	0.002
	Association between years on ART and RSB	**	**	AOR=1.24 (0.92-1.67)	0.11
	Women:				
	Risky sexual behaviour	14.1%	13.4%	**	0.76
	Association between years on ART and RSB	**	**	OR=0.72(0.55-0.93)	0.01
Pearson et al		**Baseline**	**12M follow-up**	**Test statistics**	**P value**
	Sexual partner HIV-/USP	45%	80%	x^2=22.2	<0.001
	UPS with HIV-/USP	34%	25%	t=1.71	>0.05
	Correct and consistent condom score, Mean(SD)	0.36(0.41)	0.77(0.33)	t=8.21	<0.001
	Number of partners, Mean(SD)	1.20(0.05)	1.15(0.05)	t=0.39	>0.05

Continued.

Author	Result				
	Number of concurrent partners, Mean(SD)	2.17(0.52)	2.11(0.32)	t=0.68	>0.05
	UPS with HIV-/USP among those reporting vs those not reporting concurrent partners	70.6%vs29.2%	44% vs 22.5%	x^2=11.0 vs x^2=5.20	<0.001 vs <0.05
Reynolds et al		**Baseline**	**Follow-up**		**P-value**
	Sex partners in last 12M				
	1 partner	80.5%	70.7%		0.172
	≥2 partners	18.6%	26.8%		
	Condom use with married partner in last 12M:				
	No	57.7%	12.8%		<0.0001
	Inconsistent	29.8%	33.3%		>0.05
	Consistent	12.5%	53.9%		<0.0001
	Self-reported GUD:				
	No	97.4%	97.6%		1.000
	Yes	2.6%	2.4%		
Wandera et al		**Baseline**	**Follow-up**		**P-value**
	Sexually active	57.8%	51.1%		0.911
	UPS at last sex	54.5%	14.6%		0.348
	≥2 sex partners in last 12M	18.3%	9%		0.829

Note: Risky Sexual Behaviour: Any unprotected sex with HIV negative/status unknown partner and or unprotected sex with non-primary partner in last 3M; GUD: Genital ulcer disease; SD: Standard deviation.

Table 6: Results of sexual behaviours between individuals and other cross-sectional studies.

Author	Result				P value
Jean et al	Sexual behaviour in last 12 m	Standard art group	Early art group		
	Reported multiple partnership	6.2%	9%		0.11
	Last partners HIV status:				
	HIV-	26.6%	22.8%		0.47
	Unknown status	43.9%	47.7%		
	Sexual characteristics in the past month	21.4%	15.5%		0.06
	Ups at last sex	12.9%	10%		0.54
	Ups with HIV-/UPS at last sex				
Dia et al			Inconsistent condom use with HIV-/unknown status partner in last 3m	COR (95% CI)	P value
	Art-experienced		Yes		
			No	1.0	<0.0001
			65.3%		
	Art-naïve		82.1%	2.44 (1.78-3.33)	<0.0001
			34.7%		
			17.9%		

Continued.

Author	Result				P value
				OR (95% CI)	
		HAART	Preventive therapy		
Sarna et al	Number of partners:				
	1	99%	87%		>0.05
	≥2	1%	13%		0.006
	Sex with regular partner	97%	88%		0.044
		47%	78%		<0.001
	Reported ups			4.1 (1.37-12.28)	0.012
	Condom use with regular partner:	93%	77%	3.9 (1.83-8.43)	0.000
	At last sex	53%	22%	1.7 (0.98-2.81)	0.059
	Consistently	13%	22%		
	Reported STI				
	Used condom at last sex (HIV+ partner)	Not on ART	Art during study	ART at enrolment	P value
Birungi et al	Used condom at last sex (HIV- partner)	67%	69%	76%	0.095
	Consistent condom use in last 3m in males:	69%	70%	77%	0.101
	Polygynous partnership	58%	62%	67%	0.003
	Females reporting >1 sex partner	24%	26%	25%	0.928
	Hsv2+ in HIV- partners	2%	1%	1%	0.896
	Hsv2+ in HIV+ partners	77%	87%	83%	0.067
		84%	92%	91%	0.050
				AOR (95% CI)	
Venkatesh et al	Reported HIV-/UPS	Art-experience	Art-naïve	0.59 (0.41-0.85)	0.003
	>2 sex act in past 2 weeks	50.8%	62.5%	0.53 (0.30-0.93)	0.001
	UPS in past 6m	9.3%	19.1%		0.049
	>1 sex partner in last 6 m	11.5%	17.4%	0.64 (0.38-1.08)	0.014
		0.6%	4.3%	0.11 (0.01-0.88)	
	UPS among those on art and having:	Condom-ups	COR	AOR (95% CI)	
		No			
		yes	0.25		
	HIV- partner USP	85.5%	0.73	0.33 (0.14-0.80)	0.014
Dessie et al		14.5%			0.001
	Condom use pattern 3m prior to study	66.7%	$X^{2\ test}$	0.19 (0.09-0.39)	
		33.3%			
			9.95		0.007
	Consistent	Condom use before testing HIV+			
	Inconsistent		1.0		

Continued.

Author	Result				P value
	Non-users Number reporting single partner Number having multiple partners	Irregular users non-users 32.5% 67.5% 40.7% 59.3% 21.4% 78.6% 188/541 34/60	2.47		0.001
Osinde et al	Use of condom at last sex with partner	Yes 32.3%	No 67.6%	OR (95% CI) 0.52 (0.28-0.96)	0.037
	Average number of sex partners in last 3 m	1 partner 11.5%	≥2 partners 88.5%	1.87 (1.13-3.11)	0.015
	New sexual partners	Yes 35.8%	No 64.2%		
	STI treatment (yes versus no)	**	**	0.95 (0.57-1.54)	0.864
Ncube et al	Regular partner HIV- Condom use with regular partner: No Yes	M=(n=43) 14.8% 40.5% 33.3% 55.8%	F=(n=224) 20.5% 32.3% 32.3% 74.1%	OR, AOR (95% CI)	0.45
	Art use: Yes No	44.2%	25.9%		0.02
	Condom use at last sex among respondents on art	**	**	0.9, 0.2 (0.04-0.6)	<0.05
	Have had STI Never had STI	4.7% 95.4%	4.5% 95.5%		0.96

Secondly, all but two of the included studies utilised hospital-based enrolment of study participants.[17,18] Although guaranteed the certainty of the HIV and ARV status of participants, it is likely to have introduced bias in sample selection as participants must have been receiving risk reduction counselling and free condoms and might have developed the habit of using them. Therefore, participants cannot be generalisable to the population of SDC who do not have equal opportunities. Indeed, four studies enrolled only participants close to the study area, meaning that those left at a distance were automatically excluded.[8,17,18,30]

Thirdly, the risk of introducing information bias was high in all the studies because they all relied on self-reported sexual activities. Although studies on sexual behaviours and ART have always relied on interviewee's self-report of sexual activities, it still does not exclude the fact that they are prone to information bias. For example, individuals might be biased in recalling past episodes of sexual activities or lead to misreporting such activities due to social desirability. Moreover, most participants received behavioural and risk reduction counselling by counsellors cum interviewers; therefore, misreporting sexual activities to appear less promiscuous is not unlikely. This could have resulted in overestimating reports of condom use and underestimating episodes of unprotected sex. For example, Wandera et al reportedly informed clients of the need for condom use during sex and the provision of male condoms as part of the intervention received.[20] Thus, participants might tend to report that they used condoms even when they did not.

Indeed, nine cohorts and one RCT among the 16 studies strengthened the evidence obtained in this review because participants were followed up before and after they

initiated ART and sexual behaviour information obtained before the follow-up was compared to those obtained during the follow-up period on ART. Although more extended follow-up periods might have resulted in recall bias, loss of follow-up or behavioural fatigue of the risk reduction intervention, which could have underestimated the report of sexual activities, this does not suffice. Similarly, five studies utilised a non-ART comparison group and one compared sexual behaviours among those with HIV- partners to those with HIV+, thus further strengthening the reliability of these findings. Also, one RCT was included in this review, automatically excluding the risk of bias in that study as all the protocols of RCT were observed. Furthermore, four out of the six studies that reported on STI found higher prevalence at baseline compared to after ART initiation or lower prevalence in those on ART compared to the non-ART group, thus demonstrating consistency with a lower report of risky sexual behaviours, considering that STI is a proxy to risky behaviour.[21,225,28,29]

CONCLUSION

In conclusion, there was an observed association between being on ART and reporting lower risk sexual behaviour among SDCs on ART in SSA. However, this relationship cannot be causal due to the discussed limitations. Despite that, the findings of low reporting of unprotected sex, higher report of correct and consistent condom use, lower reporting of multiple sex partners and lower STI report strongly suggest worse sexual risk behaviour among this group. However, these findings should be interpreted cautiously since they cannot be conclusive. This study is essential in that it provides information about sexual behaviours among SDCs on ART in Africa; thus, it can serve to build on the growing weight of evidence and information on this topic and as a guide to policymakers and stakeholders on the current situation in this region. More extensive research is needed across SSA countries, which should be specific to SDCs to clearly define the association of ART on behaviours and formulate policies and appropriate measures to address this. Efforts in behavioural interventions and risk reduction among these core groUPS of ongoing seroconversions must not relent if HIV incidence remains.

ACKNOWLEDGEMENTS

We are grateful to the London School of Hygiene and Tropical Medicine, United Kingdom, for allowing us to use the library database for this study.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

REFERENCES

1. Lu W, Zeng G, Luo J, Duo S, Xing G, Guo-Wei D, et al. HIV transmission risk among serodiscordant couples: a retrospective study of former plasma donors in Henan, China. J Acquir Immune Defic Syndr. 2010;55(2):232-8.
2. Carpenter LM, Kamali A, Ruberantwari A, Malamba SS, Whitworth JA. Rates of HIV-1 transmission within marriage in rural Uganda in relation to the HIV sero-status of the partners. AIDS. 1999;13(9):1083-9.
3. Hugonnet S, Mosha F, Todd J, Mugeye K, Klokke A, Ndeki L, et al. Incidence of HIV infection in stable sexual partnerships: a retrospective cohort study of 1802 couples in Mwanza Region, Tanzania. J Acquir Immune Defic Syndr. 2002;30(1):73-80.
4. Donnell D, Baeten JM, Kiarie J, Thomas KK, Stevens W, Cohen CR, et al. Heterosexual HIV-1 transmission after initiation of antiretroviral therapy: a prospective cohort analysis. Lancet. 2010;375(9731):2092-8.
5. Cohen MS, Chen YQ, McCauley M, Gamble T, Hosseinipour MC, Kumarasamy N, et al. Prevention of HIV-1 infection with early antiretroviral therapy. N Engl J Med. 2011;365(6):493-505.
6. Cohen MS, McCauley M, Gamble TR. HIV treatment as prevention and HPTN 052. Curr Opin HIV AIDS. 2012;7(2):99-105.
7. Guidance on Couples HIV Testing and Counselling Including Antiretroviral Therapy for Treatment and Prevention in Serodiscordant Couples: Recommendations for a Public Health Approach. Geneva: World Health Organization; 2012.
8. Kembabazi A, Bajunirwe F, Hunt PW, Martin JN, Muzoora C, Haberer JE, et al. Disinhibition in risky sexual behavior in men, but not women, during four years of antiretroviral therapy in rural, southwestern Uganda. PLoS One. 2013;8(7):e69634.
9. Crepaz N, Hart TA, Marks G. Highly active antiretroviral therapy and sexual risk behavior: a meta-analytic review. JAMA. 2004 Jul 14;292(2):224-36.
10. Venkatesh KK, Srikrishnan AK, Safren SA, Triche EW, Thamburaj E, Prasad L, et al. Sexual risk behaviors among HIV-infected South Indian couples in the HAART era: implications for reproductive health and HIV care delivery. AIDS Care. 2011;23(6):722-33.
11. Moatti JP, Prudhomme J, Traore DC, Juillet-Amari A, Akribi HA, Msellati P, et al. Access to antiretroviral treatment and sexual behaviours of HIV-infected patients aware of their serostatus in Côte d'Ivoire. AIDS. 2003;17(3):S69-77.
12. Mugwanya KK, Donnell D, Celum C, Thomas KK, Ndase P, Mugo N, et al. Sexual behaviour of heterosexual men and women receiving antiretroviral pre-exposure prophylaxis for HIV prevention: a longitudinal analysis. Lancet Infect Dis. 2013;13(12):1021-8.
13. Kennedy C, O'Reilly K, Medley A, Sweat M. The impact of HIV treatment on risk behaviour in developing countries: a systematic review. AIDS Care. 2007;19(6):707-20.

14. Berhan A, Berhan Y. Is The Sexual Behaviour Of HIV Patients On Antiretroviral Therapy Safe Or Risky In Sub-Saharan Africa? Meta-Analysis And Meta-Regression. AIDS Res Ther. 2012;9(1):14
15. Diabaté S, Alary M, Koffi C. Short-Term Increase In Unsafe Sexual Behaviour After Initiation Of HAART In Cote D'ivoire. AIDS. 2008;22(1):154-6
16. oburn BJ, Gerberry DJ, Blower S. Quantification Of The Role Of Discordant Couples In Driving Incidence Of HIV In Sub-Saharan Africa. Lancet Infectious Dis. 2011;11(4):263-4
17. Apondi R, Bunnell R, Ekwaru JP, Moore D, Bechange S, Khana K, et al. Sexual behavior and HIV transmission risk of Ugandan adults taking antiretroviral therapy: 3 year follow-up. AIDS. 2011;25(10):1317-27.
18. Bunnell R, Ekwaru JP, Solberg P, Wamai N, Bikaako-Kajura W, Were W, et al. Changes In Sexual Behavior And Risk Of HIV Transmission After Antiretroviral Therapy And Prevention Interventions In Rural Uganda. AIDS. 2006;20(1):85-92
19. Birungi J, Min JE, Muldoon KA, Kaleebu P, King R, Khanakwa S, et al. Lack of Effectiveness of Antiretroviral Therapy in Preventing HIV Infection in Serodiscordant Couples in Uganda: An Observational Study. PLoS One. 2015;10(7):e0132182.
20. Wandera B, Kamya MR, Castelnuovo B, Kiragga A, Kambugu A, Wanyama JN, et al. Sexual behaviors over a 3-year period among individuals with advanced HIV/AIDS receiving antiretroviral therapy in an urban HIV clinic in Kampala, Uganda. J Acquir Immune Defic Syndr. 2011;57(1):62-8.
21. Reynolds SJ, Makumbi F, Nakigozi G, Kagaayi J, Gray RH, Wawer M, et al. HIV-1 transmission among HIV-1 discordant couples before and after the introduction of antiretroviral therapy. AIDS. 2011;25(4):473-7.
22. Dia A, Marcellin F, Bonono RC, Boyer S, Bouhnik AD, Protopopescu C, et al. Prevalence of unsafe sex with one's steady partner either HIV-negative or of unknown HIV status and associated determinants in Cameroon (EVAL ANRS12-116 survey). Sex Transm Infect. 2010;86(2):148-54.
23. Eisele TP, Mathews C, Chopra M, Lurie MN, Brown L, Dewing S, 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(6):1097-105.
24. Venkatesh KK, Bruyn G, Lurie MN, Modisenyane T, Triche EW, Gray GE, et al. Sexual risk behaviors among HIV-infected South African men and women with their partners in a primary care program: implications for couples-based prevention. AIDS Behav. 2012;16(1):139-50.
25. Sarna A, Luchters SM, Geibel S, Kaai S, Munyao P, Shikely KS, et al. Sexual risk behaviour and HAART: a comparative study of HIV-infected persons on HAART and on preventive therapy in Kenya. Int J STD AIDS. 2008;19(2):85-9.
26. Venkatesh KK, Srikrishnan AK, Safren SA, Triche EW, Thamburaj E, Prasad L, et al. Sexual risk behaviors among HIV-infected South Indian couples in the HAART era: implications for reproductive health and HIV care delivery. AIDS Care. 2011;23(6):722-33.
27. Dessie Y, Gerbaba M, Bedru A, Davey G. Risky sexual practices and related factors among ART attendees in Addis Ababa Public Hospitals, Ethiopia: a cross-sectional study. BMC Public Health. 2011;11:422.
28. Ncube NM, Akunna J, Babatunde F, Nyarko A, Yatich NJ, Ellis W, et al. Sexual risk behaviour among HIV-positive persons in Kumasi, Ghana. Ghana Med J. 2012;46(1):27-33.
29. Luchters S, Sarna A, Geibel S, Chersich MF, Munyao P, Kaai S, et al. Safer sexual behaviors after 12 months of antiretroviral treatment in Mombasa, Kenya: a prospective cohort. AIDS Patient Care STDS. 2008;22(7):587-94.
30. Pearson CR, Cassels S, Kurth AE, Montoya P, Micek MA, Gloyd SS. Change in sexual activity 12 months after ART initiation among HIV-positive Mozambicans. AIDS Behav. 2011;15(4):778-87.
31. Jean K, Gabillard D, Moh R, Danel C, Fassassi R, Desgrées-du-Loû A, et al. Effect of early antiretroviral therapy on sexual behaviors and HIV-1 transmission risk among adults with diverse heterosexual partnership statuses in Côte d'Ivoire. J Infect Dis. 2014;209(3):431-40.
32. Osinde MO, Kaye DK, Kakaire O. Sexual behaviour and HIV sero-discordance among HIV patients receiving HAART in rural Uganda. J Obstet Gynaecol. 2011;31(5):436-40.

Cite this article as: Hassan J, Mitchell K, Basil U, Shuaib B, Oti VB. Sexual behaviours of HIV sero-discordant couples in the context of art: a systematic review of studies from Sub-Saharan Africa. Int J Community Med Public Health 2022;9:4213-29.