

UCSF

UC San Francisco Previously Published Works

Title

Supportive couple relationships buffer against the harms of HIV stigma on HIV treatment adherence

Permalink

<https://escholarship.org/uc/item/6f61x6g4>

Journal

BMC Public Health, 23(1)

ISSN

1472-698X

Authors

Gutin, Sarah A

Ruark, Allison

Darbes, Lynae A

et al.

Publication Date

2023

DOI

10.1186/s12889-023-16762-w

Peer reviewed

RESEARCH

Open Access



Supportive couple relationships buffer against the harms of HIV stigma on HIV treatment adherence

Sarah A. Gutin^{1*}, Allison Ruark², Lynae A. Darbes³, Torsten B. Neilands⁴, James Mkandawire⁵ and Amy A. Conroy⁴

Abstract

Introduction HIV stigma can impact couple relationships through stress or bring partners closer through shared experiences. Conversely, couple relationships may protect against the harms of stigma, including anticipated stigma on negative health outcomes. Yet few studies have assessed the potential link between HIV stigma, relationship dynamics, and antiretroviral therapy (ART) adherence. Using dyadic data from a cross-sectional study of Malawian couples living with HIV, we tested associations between anticipated stigma and: 1) relationship dynamics (e.g., trust, sexual satisfaction, communication) and partner support; and 2) self-reported ART adherence.

Methods Heterosexual couples (211 couples, 422 individuals) with at least one partner on ART were recruited from clinics in Zomba, Malawi. Partners completed separate surveys on anticipated stigma, relationship dynamics, and ART adherence. Linear mixed models evaluated associations between anticipated stigma and relationship dynamics, and whether associations varied by gender. Generalized estimating equation models tested for associations between anticipated stigma and high ART adherence (90–100% vs. < 90%) at the individual level, and whether they were moderated by relationship dynamics at the couple level.

Results Couples' relationship length averaged 12.5 years, 66.8% were HIV sero-concordant, and 95.6% reported high ART adherence. In multivariable models, sexual satisfaction ($\beta = -0.22$, 95%CI = -0.41;-0.03, $p = 0.020$) and partner social support ($\beta = -0.02$, 95%CI = -0.04;-0.01, $p < 0.01$) were negatively associated with anticipated stigma. Significant interaction effects showed that adherence is moderated in couples with higher partner support and sexual satisfaction such that adherence is lowest when anticipated stigma is high and social support is low, and that adherence is lowest when anticipated stigma is high and sexual satisfaction is low.

Conclusions Increased anticipated stigma is most associated with lower ART non-adherence at lower levels of social support and sexual satisfaction. Conversely, supportive and fulfilling relationships may buffer the negative association between stigma and ART adherence. Couples' interventions that focus on improving communication and support systems within couples could reduce the negative impacts of anticipated stigma on couples living with HIV.

Keywords Anticipated HIV stigma, Heterosexual couples, Antiretroviral therapy, Relationship dynamics, Sub-Saharan Africa

*Correspondence:

Sarah A. Gutin
sarah.gutin@ucsf.edu

Full list of author information is available at the end of the article



© The Author(s) 2023. **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>. The Creative Commons Public Domain Dedication waiver (<http://creativecommons.org/publicdomain/zero/1.0/>) applies to the data made available in this article, unless otherwise stated in a credit line to the data.

Introduction

Despite global efforts to fight HIV stigma and increase access to care and treatment, HIV stigma remains a major obstacle to ending the AIDS epidemic by 2030 [1]. HIV stigma limits access to healthcare, economic, and social resources that are needed to live a healthy life with HIV [1–3]. Stigma refers to a social process that can lead to the exclusion of individuals or groups based on real or perceived characteristics [4]. Globally, HIV stigma remains a significant barrier to HIV testing [5–7], linkage to care and treatment, and adherence to antiretroviral therapy (ART) [1, 8–10]. Experiences of HIV stigma are also linked to non-disclosure of HIV status [11, 12], condomless sex [13], and unsuppressed viral load [14–16], which can result in transmission of HIV to sexual partners [17].

Stigma occurs at multiple levels, from internalized stigma to stigma experienced in interpersonal relationships, at the couple level, and through institutions and social structures. HIV stigma has been grouped into four main domains in which people internalize real or perceived stigma onto themselves (internalized stigma), experience overt acts of discrimination (enacted stigma), anticipate or fear enacted stigma (anticipated stigma), and perceive how others view and treat people living with HIV (perceived stigma) [1]. Research suggests that when a partner first tests positive, there is more intra-dyadic stigma and concerns about rejection, discrimination, abandonment, and violence [18–21], but this may decline over time, with the primary source of HIV stigma coming from outside the couple relationship [5, 22–25]. According to couple interdependence theory [26], both partners' beliefs, experiences, and behaviors impact the other partner's beliefs, experiences, and behaviors regardless of which partner lives with HIV. This may be particularly relevant in settings such as Malawi where married individuals are viewed as a single marital body with shared characteristics [27, 28]. In South Africa, a clinical trial of an HIV-stigma intervention with pregnant women living with HIV and their partners found that women's reports of HIV stigma in the control arm were correlated with male partners' stigma scores among men living with HIV, suggesting that stigma can act interdependently in couples and is not an isolated issue for only one partner [29]. Therefore, interventions are needed that go beyond the individual level to focus on interpersonal and other levels where stigma occurs and can negatively impact health.

HIV-related social support from primary partners may reduce or buffer the harms of anticipated stigma. Studies have highlighted the positive role of partner support on health-enhancing behaviors, such as HIV testing, HIV status disclosure, and ART adherence [27, 30–33]. However, little research has been conducted on how

anticipated stigma impacts couple relationships, and how relationship dynamics (e.g., intimacy, partner support) in turn affect stigma. Previous research has focused on the negative effects of HIV stigma on non-disclosure to partners [34–37] rather than examining how stigma impacts couples who have already disclosed and should be engaged in HIV care and treatment. Few, if any studies, in sub-Saharan Africa have examined whether relationship dynamics can buffer the negative impacts of stigma on ART adherence.

While supportive relationships may help offset negative HIV stigma effects, it is also possible that HIV stigma could worsen relationship dynamics and damage the couple relationship. Qualitative research found that HIV stigma could damage couple communication regarding HIV and negatively impact sexuality and sexual satisfaction [38, 39]. Stigma from a partner could also increase self-stigmatization and lead to the experience of more HIV stigma [18]. Couple characteristics such as relationship duration and couple HIV serostatus could moderate the association between experiences of HIV stigma and relationship functioning and partner support [40]: if both partners are living with HIV and report experiencing stigma, they may offer greater mutual support and be united by negative experiences as compared to couples in which only one partner is living with HIV. Based on this research [18, 38–40], we hypothesize that the strength and direction of the association between stigma and relationship dynamics may vary by couple serostatus.

Few studies have considered the role of relationship dynamics and social support in studies of HIV stigma in couples. A review paper found that only one quantitative study that examined HIV stigma with couple-level outcomes [41]. Among Chinese sero-discordant couples, individuals with a more couple-centric versus individual-centric orientation reported fewer depressive symptoms, but the protective effect of being in a couple diminished when HIV stigma levels were high [42]. We are not aware of studies that have tested for associations between HIV stigma and relationship dynamics in couples in which one or both partners are living with HIV.

To fill this research gap, we investigated the association between HIV stigma, relationships dynamics, and ART adherence among heterosexual sero-concordant and discordant couples in Malawi. Specifically, we tested for associations between anticipated stigma and relationship dynamics, including social support and couple communication, and whether these associations differed by couple serostatus. Next, we tested for associations between anticipated stigma and ART adherence and whether these associations differed by the same relationship dynamics (e.g., intimacy, partner support, couple communication). This allowed us to test the hypothesis

that supportive couple relationships may offset the negative impacts of anticipated stigma on engagement in HIV care. If shown to be associated, this study would provide critical evidence to support interventions that strengthen partner support for couples affected by HIV and build sources of resiliency within couples to fight stigma, improve treatment outcomes, and end AIDS by 2030 [1].

Methods

Study context

This study took place in the Zomba district of Southern Malawi, which has an HIV prevalence of approximately 15% [43]. With a well-established ART program, Malawi has over 850,000 individuals on ART [44]. Since the start of a universal test-and-treat approach in 2016 which offers free HIV care and treatment, almost 90% of people living with HIV (PLHIV) in Malawi have started ART [45]. Most adults in Malawi are married or in cohabitating unions [43].

Study procedures

Data are from the *Umodzi M'Banja* (Unity in the Family) study, a mixed-methods dyadic investigation of PLHIV and their primary partners in Zomba, Malawi [46–48]. We conducted a cross-sectional survey with 211 couples (422 individuals) from August to November 2017. Couples were eligible to participate if they were: (1) age 18+; (2) in non-polygamous married or cohabitating unions for at least six months; and (3) had at least one partner (referred to as the “index patient”) on ART for two months or more, who had disclosed their HIV status to their primary partner.

Participants were recruited at two high-volume HIV clinics, a private clinic at a rural community hospital and an urban clinic at a large district hospital acting as a regional referral center. Research staff announced the study in waiting rooms during daily health talks and interested index patients could approach the staff for more information. If the index patient was eligible, they were given an information card to share with their primary partner who could contact study staff for screening. Partner eligibility was assessed over the phone and confirmed in-person at an interview appointment with the couple.

Partners were consented separately in private locations at the HIV clinics and were both provided with a small incentive (around \$2 USD) for their time. Gender-matched research assistants administered surveys using tablet devices that housed a secure, web-based data collection platform. Surveys were translated into the local language, back-translated into English by an independent person, and then administered in Chichewa. Partners were interviewed separately, but simultaneously, in

private spaces at the HIV clinics, and were asked questions on relationship dynamics, partner support, and if they were living with HIV, and about anticipated stigma and ART adherence.

Measures

We examined two dependent variables (anticipated HIV stigma and self-reported ART adherence) and several independent variables of interest. In the first set of models, anticipated HIV stigma was treated as a dependent variable (continuous) and we examined associations with various relationship dynamics (including continuous variables for sexual satisfaction, relationship intimacy, trust, equality, unity/ “we-ness”, and commitment), with partner support (continuous variables for general partner support and HIV treatment-specific partner support), and with couple communication patterns (including continuous variables for withdrawal, demanding, and avoidant communication styles). In a second set of models, self-reported ART adherence was the dependent variable (binary, adherent vs. non-adherent) and the independent variables of interest included anticipated HIV stigma (continuous) with two potential moderators, general partner social support (continuous), and sexual satisfaction (continuous). All study measures are summarized in Table 1.

Anticipated HIV stigma

Anticipated HIV stigma was measured with the anticipated HIV stigma scale [49]. This scale captures future expectations of stereotyping, discrimination, and/or prejudice from family members and providers because of one’s HIV status. Only participants who were living with HIV were asked these questions. Therefore, if both members of the couple were living with HIV, they both reported on their own anticipation of stigma. However, if the couple was sero-discordant, then only the PLHIV reported on anticipated stigma. This scale has been previously validated in sub-Saharan Africa with PLHIV [50–52]. Response options ranged from 1 (highly unlikely) to 5 (highly likely) (Table 1 for details). A mean of stigma items was calculated with higher scores across a range from 1 to 5 indicating higher anticipated stigma. In all analyses, the scale was used as a continuous variable.

Relationship dynamics

We assessed relationship dynamics by measuring sexual satisfaction, relationship intimacy, trust, equality, unity/ “we-ness”, and commitment (Table 1). Row means or row totals were created for each scale based on the original scoring procedures (see Table 1 for the ranges for each variable). Couple-level variables were created such that

Table 1 Measures used in the Umodzi M'Banja Study in Malawi

Category	Construct	Scale	Sample question	Number of items	Response options	Cronbach's alpha (α)	Scale range	Male Mean score (SD)	Female Mean score (SD)
Stigma	Anticipated HIV stigma	Anticipated stigma scale	"Family members will use my HIV status against me"	8 items	1 = Highly unlikely 2 = Unlikely 3 = Neutral 4 = Likely 5 = Highly likely	0.89	1–5	1.70 (0.79)	1.58 (0.70)
Relationship dynamics	Sexual satisfaction	General Couple Sexual Satisfaction Scale (CSSS-Gen)	"I am satisfied with the frequency with which I have sexual intercourse"	13 items	1 (strongly disagree) to 5 (strongly agree)	0.90	1–5	4.28 (0.61)	4.50 (0.58)
	Relationship intimacy	Triangular Scale of Love	"I have a relationship of mutual understanding with my partner"	5 items	1 (strongly disagree) to 5 (strongly agree)	0.90	1–5	4.54 (0.62)	4.51 (0.65)
Partner support	Trust	Dyadic trust scale	"My partner is honest with me"	8 items	1 (strongly disagree) to 5 (strongly agree)	0.82	8–40	32.92 (4.85)	32.20 (6.65)
	Relationship equality	intimacy subscale of the Relationship Values Scale	"My partner and I have equal power in the relationship"	8 items	1 (strongly disagree) to 5 (strongly agree)	0.87	8–40	35.34 (4.87)	33.19 (5.73)
Relationship commitment	Unity/"we-ness"	inclusion-of-other-in-self diagram	Visual scale	1 item	1 (no overlap) to 7 (complete overlap)	–	1–7	6.61 (0.92)	6.01 (1.25)
Couple communication	General partner support	Subscales from the Social Provisions Scale (partner version)	"I am committed to maintaining my relationship with my partner"	8 items	1 (strongly disagree) to 5 (strongly agree)	0.82	1–5	4.52 (0.55)	4.64 (0.40)
	HIV treatment-specific partner support	SPS scale	"I can depend on my partner to help me with my antiretrovirals if I really need it"	12 items	1 (strongly disagree) to 5 (strongly agree)	0.88	12–60	52.16 (6.89)	51.80 (8.62)
Demanding communication	Avoidant communication	Communications Pattern Questionnaire	"When an issue or problem arises both of us avoid discussing the problem"	2 items	1 (very unlikely) to 5 (very likely)	0.75	1–5	1.8 (0.87)	2.40 (1.08)
Withdrawal communication	Demanding communication	Communications Pattern Questionnaire	"When an issue or problem arises both of us avoid discussing the problem"	3 items	1 (strongly disagree) to 5 (strongly agree)	0.84	1–5	2.32 (1.01)	2.46 (1.06)
Withdrawal communication	Demanding communication	Communications Pattern Questionnaire	"When an issue or problem arises both of us avoid discussing the problem"	3 items	1 (strongly disagree) to 5 (strongly agree)	0.84	1–5	2.38 (1.02)	2.61 (1.08)

each represented the couple-level mean score from both partners.

Sexual satisfaction was measured using the General Couple Sexual Satisfaction Scale (CSSS-Gen) [53], which was validated in Malawi. Relationship intimacy was measured using a subscale from the Triangular Scale of Love [54]. We used the shortened version of this scale validated in Malawi [55]. Trust was measured with the Dyadic Trust Scale [56] which has been validated in various sub-Saharan African countries [57–59]. Relationship equality was measured with the intimacy subscale of the Relationship Values Scale [60] which was previously validated in another Malawian study [53]. Unity or “we-ness” was measured with a single item using the inclusion-of-other-in-self diagram [61]. The diagram asks respondents to pick from a set of overlapping circles that best describes their relationship with their partner. Response options included seven sets of circles that ranged from 1 (no overlap) to 7 (complete overlap) with higher scores indicating greater relationship unity. This scale was previously validated in Malawi [53]. Relationship commitment was measured with a subscale from the Triangular Scale of Love [54], which was previously validated in Malawi [55].

Partner support

Partner support was measured in two ways (Table 1). We assessed general partner support with three subscales from the Social Provisions Scale (partner version) representing guidance, attachment, and reliable assistance [62]. These items were selected because they capture aspects of emotional, instrumental, and informational support that were salient in previous studies in Malawi and South Africa [27, 33]. We also developed a measure of HIV treatment-specific partner support that was adapted from the SPS scale [63] and validated in Malawi [53]. Both partner support variables were treated as continuous variables in all models.

Couple communication patterns

Couple communication patterns (i.e., engaging in withdrawal, demanding, or avoidant communication styles) were measured with an adapted version of the Communications Pattern Questionnaire [64]. This scale has been previously validated in Malawi [55]. Variables for withdrawal, demanding, and avoidant communication styles were all treated as continuous variables in models.

Self-reported adherence to ART

To account for low educational attainment, adherence was assessed using the “bean method” for low literacy populations [46] based on the 30-day Visual Analog Scale [65]. The interviewer gave the participant two bowls, one

with beans and one empty, and explained that the beans represent the ART that they take each month. Participants were instructed to select the number of beans corresponding to the pills they did not take in the last month and put them in the second bowl. A binary variable was created based on treatment regimen (once or twice per day) and the number of beans selected. We considered taking 90% or more of pills to be adherent and less than 90% to be non-adherent [65]. The 90% cutoff was chosen because while $\geq 95\%$ adherence is considered perfect or near perfect adherence, prior research has shown that with newer ART regimens, HIV viral suppression for persons with 90–94% adherence did not differ from those with $\geq 95\%$ adherence [66, 67]. The 90% adherence cutoff is also a validated cutoff used in other studies in SSA [68]

Covariates

Based on the previous literature on couples and HIV [46, 69], multivariable models controlled for age (continuous), gender, years of education (continuous), couple HIV status (concordant or discordant), relationship duration (continuous), and household wealth score (continuous), which is a proxy for socio-economic status [70].

Data analysis

One-way frequency tables and measures of central tendency were generated to characterize the sample. Linear mixed models [71] tested for associations between relationship dynamics (independent variables) and anticipated stigma (dependent variable) and whether this association varied by couple serostatus, after controlling for socio-demographics (gender, age, education, household wealth score) and relationship characteristics (relationship duration, couple sero-status), in accordance with literature on HIV risk behaviors and relationship dynamics [72]. Models also adjusted for clustering at the couple-level by including a random intercept for the couple to control for non-independence of responses from individuals within the same couple who both reported on the outcome of anticipated stigma. In addition, models included the cluster-robust standard error option [73–75] to protect inferences against normality and homoskedasticity assumption violations.

In addition, using generalized estimating equation (GEE) models clustering at the couple-level with the robust standard error option [73–75], a binary distribution, and a logit link function to yield odds ratios [76], we tested for associations between anticipated stigma and ART adherence after controlling for socio-demographics and relationship duration. Using ad hoc analyses, we also examined whether this association was moderated by relationship dynamics (e.g., intimacy, trust) and partner support by including interaction terms in the models. To

evaluate whether associations differed by couple sero-status and gender, we included respective interaction terms in the models. Initial models were specified to contain main effects. Models were then extended by adding relevant interaction terms one by one to test the moderation hypotheses described previously. If interactions were significant, results from the models with interaction terms included are reported. We considered an alpha of $p < 0.05$ to be statistically significant. Overall, missing data were negligible (less than 5% on any given variable). All analyses were performed using Stata 16 (College Station, TX).

Ethical approval

The study was approved by the National Health Science Research Committee in Malawi (IRB # 15/12/1512) and the Human Research Protection Program at the University of California, San Francisco (IRB # 15–17394). Informed consent was obtained for all individual participants included in the study. All procedures followed were in accordance with the Helsinki Declaration of 1975, as revised in 2000.

Results

Sample characteristics

Of 422 participants, the mean age was 40.5 years and the majority (80.8%) had a primary education or less (Table 2). All couples were married/cohabitating and had

been together on average for 12.5 years. Two-thirds of couples were sero-concordant positive (66.8%). Of participants who were living with HIV ($N = 352$), the majority were on ART (82.5%) and 95.6% reported 90–100% ART adherence in the past 30 days. The mean anticipated stigma score was 1.6 (scale range 1–5).

We tested whether anticipated stigma scores were higher for sero-discordant versus sero-concordant couples. We found higher levels for sero-discordant couples, but the difference was not statistically significant ($p = 0.345$). In addition, we tested to see if stigma scores within couples were correlated for sero-concordant couples. However, we only found a small correlation between partners' stigma scores ($r = 0.28$).

Associations between relationship factors and anticipated stigma

In multivariable models, sexual satisfaction was significantly associated with anticipated stigma such that HIV-positive individuals in a relationship with higher sexual satisfaction reported lower levels of anticipated stigma ($\beta = -0.22$, 95%CI = -0.41; -0.03, $p = 0.020$) (Table 3). Associations did not vary by couple serostatus or gender. Other relationship dynamics such as intimacy, trust, equality, “we-ness”/unity, and commitment did not show significant associations with stigma.

Table 2 Sample characteristics of couples living with HIV in the Umodzi M'Banja Study, Malawi (211 couples; 422 individuals)

Variable	Total sample %, Mean (SD)	Men %, Mean (SD)	Women %, Mean (SD)	t / Pearson χ^2	DF	p-value for gender differences
Individual characteristics						
Age (years)	40.5 (10.2)	43.5 (10.6)	37.4 (8.8)	-6.4388	419	<0.001
Education level						
Primary school or less	80.8	73.5	88.2	15.4638	2	<0.001
Secondary school	18.7	25.6	11.8			
Tertiary school or higher	0.5	1.0	0.0			
Household wealth index (range: 0–8)	2.8 (1.6)	3.0 (1.6)	2.7 (1.6)	-2.0337	413	0.04
Religion						
Muslim	10.2	10.0	10.4	0.0209	1	0.89
Christian	89.8	90.0	89.6			
Living with HIV	83.4	81.0	85.8	2.4580	2	0.29
Currently on ART	82.5	79.6	85.3	2.3597	1	0.13
Length of time on ART (years)	4.8 (3.1)	4.6 (3.1)	5.1 (3.1)	1.6023	346	0.11
90–100% adherence reported ^a	95.6	96.4	94.8	0.4725	1	0.49
Anticipated stigma score (range 1–5)	1.6 (0.74)	1.70 (0.1)	1.58 (0.1)	-1.4280	349	0.15
Relationship characteristics						
Relationship duration (years)	12.5 (9.0)	12.9 (9.2)	12.1 (8.8)	-0.9673	418	0.33
Number of dependent children (range: 0–11)	3.3 (1.8)	3.5 (1.9)	3.2 (1.7)	-1.3595	420	0.17
Sero-concordant positive	66.8	–	–			

^a ART adherence is presented as a binary variable where taking 90% or more of pills was considered to be adherent and less than 90% to be non-adherent

Table 3 Associations between relationship dynamics and HIV stigma among persons living with HIV in Malawi ($N=345$)

Variable	Unadjusted Beta coefficient (β)	95% CI	P-value	Adjusted Beta coefficient (β)	95% CI	P-value
Intimacy	-0.10	-0.26, 0.07	0.257	-0.13	-0.31, 0.55	0.172
Trust	-0.01	-0.03, 0.01	0.425	-0.01	-0.03, 0.01	0.209
Equality	-0.01	-0.03, 0.01	0.244	-0.02	-0.04, 0.01	0.164
"We-ness"/unity	-0.04	-0.16, 0.08	0.520	-0.06	-0.18, 0.07	0.374
Sexual satisfaction	-0.19	-0.36, -0.01	0.042	-0.22	-0.41, -0.03	0.020
Commitment	-0.08	-0.32, 0.17	0.537	-0.11	-0.37, 0.15	0.414
Partner support (general)	-0.02	-0.03,-0.004	0.014	-0.02	-0.04, -0.01	0.006
Partner support (HIV treatment-specific)	-0.01	-0.03, 0.003	0.102	-0.02	-0.04, -0.0003	0.046
Communication style						
Withdrawal	0.12	0.04, 0.20	0.004	0.13	0.04, 0.21	0.003
Demanding	0.15	0.08, 0.23	<0.001	0.17	0.09, 0.24	<0.001
Avoidant	0.26	0.13, 0.38	<0.001	0.26	0.13, 0.39	<0.001

Multivariable models controlled for gender, age, years of education, relationship duration, household wealth, and couple HIV status. All relationship dynamics variables listed are continuous variables

In the multivariable models on partner support, both general partner support ($\beta = -0.02$, 95%CI = -0.04; -0.01, $p = 0.006$) and HIV treatment-specific partner support ($\beta = -0.02$, 95%CI = -0.04; -0.0003, $p = 0.046$) were associated with less anticipated stigma. In the multivariable models on communication, negative communication styles such as withdrawal ($\beta = 0.13$, 95%CI = 0.04; 0.21, $p = 0.003$), demanding ($\beta = 0.17$, 95%CI = 0.09; 0.24, $p < 0.001$), and avoidant communication ($\beta = 0.26$, 95%CI = 0.13; 0.39, $p < 0.001$) were associated with higher stigma (Table 3). Associations did not vary by couple serostatus or by gender.

Associations between anticipated stigma and ART adherence

In multivariable models on ART adherence, the odds of having high adherence were 45% lower for each

one-unit increase in anticipated stigma (aOR = 0.55, 95%CI = 0.34; 0.89, $p = 0.014$) (Table 4). A one-unit increase corresponds to a participant saying stigma is "likely" vs. "highly likely". Given the significant associations described above, we also tested whether there were any interactions between partner social support and anticipated stigma and between sexual satisfaction and anticipated stigma and associations with ART adherence. The models showed significant positive interactions between partner social support and anticipated stigma (aOR = 1.10, 95%CI = 1.01; 1.20, $p = 0.032$) and sexual satisfaction and anticipated stigma (aOR = 3.25, 95%CI = 1.06; 9.93, $p = 0.039$) such that the association between higher stigma and non-adherence was moderated in couples with higher levels of partner social support and sexual satisfaction (Table 4). Associations did not vary by couple serostatus or gender.

Table 4 Adjusted odds ratios (aORs) for associations between HIV stigma and ART adherence among couples living with HIV in Malawi ($n = 337$)

Variable	Model 1: Association of Stigma on ART adherence		Model 2: Association of social support x stigma on ART adherence		Model 3: Association of sexual satisfaction x stigma on ART adherence	
	aOR (95% CI)	p	aOR (95% CI)	p	aOR (95% CI)	p
HIV stigma	0.55 (0.34; 0.89)	0.014	0.01 (0.00; 0.45)	0.020	0.003 (0.00; 0.48)	0.025
Couple HIV status	0.31 (0.11; 0.89)	0.029				
Social support			0.93 (0.76; 1.13)	0.451		
Social support x stigma interaction			1.10 (1.01; 1.20)	0.032		
Sexual satisfaction					0.29 (0.03; 2.96)	0.294
Sexual satisfaction x stigma interaction					3.25 (1.06; 9.93)	0.039

Multivariable models controlled for gender, age, years of education, relationship duration, and couple HIV status. HIV stigma, social support, and sexual satisfaction variables were all continuous

To aid in understanding these interaction terms, we developed two contour plots [77, 78] that examine 1) the predicted probability of optimal ART adherence at different levels of anticipated stigma and social support (Fig. 1), and 2) the predicted probability of optimal ART adherence at different levels of anticipated stigma and sexual satisfaction (Fig. 2). In Fig. 1, adherence is lowest when anticipated stigma is high and social support is low (dark orange region, lower right corner)

whereas adherence is highest when social support is high or anticipated stigma is low (or both are true) as represented by the blue region (upper left corner). In Fig. 2, we see that adherence is lowest when anticipated stigma is moderate to high and sexual satisfaction is low to moderate (dark orange region, lower right corner) whereas adherence is highest when sexual satisfaction is high or anticipated stigma is low (or both are true) as represented by the dark blue region (upper left corner).

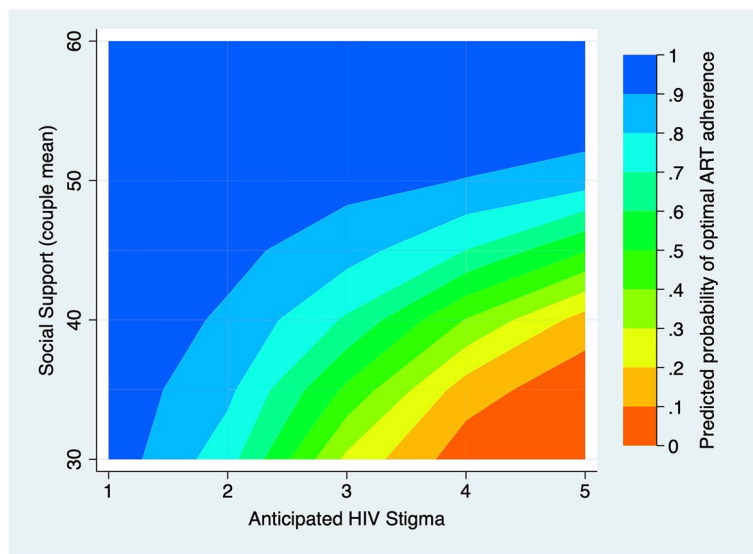


Fig. 1 The predicted probability of optimal ART adherence at different levels of anticipated HIV stigma and social support

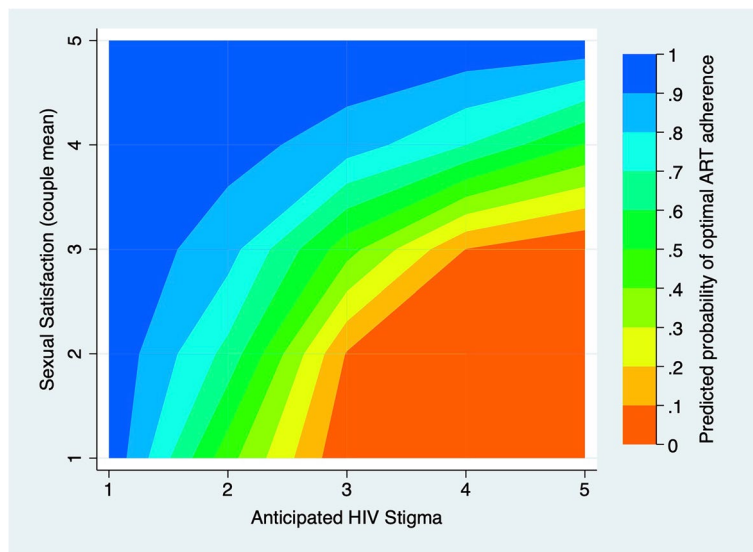


Fig. 2 The predicted probability of optimal ART adherence at different levels of anticipated stigma and sexual satisfaction

Discussion

Among couples in Malawi, we examined associations between relationship dynamics (relationship quality, partner support, and communication) and anticipated HIV stigma, as well as the association of anticipated stigma with ART adherence. We found that higher sexual satisfaction and partner social support were associated with less anticipated stigma, and that negative communication styles were associated with higher anticipated stigma. In addition, significant interaction effects showed that the association between higher stigma and suboptimal adherence was moderated in couples with higher partner support and sexual satisfaction. This is one of the first studies to examine the role that relationship dynamics and social support may play in mitigating anticipated stigma in couples and whether relationship dynamics can buffer the negative impacts of stigma on ART adherence. Insights from this study can help researchers develop couple-based interventions to improve important aspects of relationships and build couple resiliency that may lessen the negative impact of anticipated stigma on HIV treatment outcomes.

In our study, individuals with higher levels of sexual satisfaction reported lower levels of anticipated stigma, whereas other relationship quality constructs such as intimacy, trust, unity, and equality did not show this association. Previous research has highlighted the importance of sexual satisfaction in relationship quality [79] and relationship satisfaction [80, 81] and its impact on sexual and reproductive health [55, 82, 83]. It may be that couples who have a fulfilling sex life anticipate less stigma from outside their relationships. Some PLHIV have reported that HIV limits or reduces sexual intimacy [84–86]. Thus, couples who report high sexual satisfaction despite living with HIV may have particularly healthy and resilient relationships, which also provide a buffer against stigma. Couple-based interventions that promote a healthy sex life, and normalize sex and HIV, may help protect couples from the experience of stigma.

In addition, our findings highlight the importance of partner support and communication for anticipated stigma. Couples with more supportive relationships experienced lower anticipated stigma. Also, the association between higher stigma and lower adherence was moderated in couples with higher social support and sexual satisfaction. It may be that people who are in strong, healthy relationships may feel more secure and comfortable with HIV as well as anticipate less stigmatization and discrimination. Finally, negative communication styles were associated with higher anticipated stigma. Partner support and positive couple communication have been linked to positive HIV-related health behaviors such as uptake of couple HIV counselling and testing [87, 88],

HIV status disclosure [30], encouraging partner ART use [89], and adherence to ART more broadly [33, 46, 89]. Thus, couples' interventions focused on helping couples develop skills such as healthy couple communication and providing partner support may be optimal for reducing stigma and helping overcome barriers to ART adherence that arise from stigma and discrimination outside the relationship [18, 25, 90].

We also found that being in a sero-discordant relationship did not weaken the potential protective effect of relationship factors on anticipated stigma, meaning that the association does not depend on couple serostatus. This could suggest that HIV is becoming more normalized with widespread access to ART and “undetectable equals untransmittable” messaging, and that sero-discordant couples who have disclosed are as resistant to stigma as those who are sero-concordant. Recent studies have found that partners are providing an elevated role in offering HIV-related support [89] and there are also signs of growing resistance to stigma from outside the couple, which may be levelling the playing field for discordant and concordant couples [3].

A study strength was that we could report on perspectives of both partners and analyze the dyad as a unit, thus adding to previous research that has examined anticipated stigma at the individual level. By incorporating both partners' perspectives of relationship dynamics, we can overcome potential biases that might be present if just one partner was reporting on their relationship. A possible limitation is that study couples may have more positive relationship dynamics and less anticipated stigma than the general population, given that both partners decided to enroll in a couples' study. Thus, these findings may not be fully generalizable to other populations that may have higher levels of stigma and poorer relationship dynamics. Other characteristics of study participants may also reduce the generalizability of our findings. For example, the mean age in our sample was 40 years, couples had been together for many years (approximately 14 years), and almost 96% reported optimal adherence. Our results may best represent older, established couples who are better engaged in care, as opposed to younger couples who may face greater challenges with adherence and stigma. We also do not know the HIV status of couples at the time of marriage, and so we cannot speculate as to whether people were trying to sero-sort or choose partners based on their HIV status. Future studies that follow couples at the start of the partnership could help to disentangle the effects of stigma over the course of the relationship. In addition, all measures, including adherence measures, were self-reported and may be affected by social desirability bias. Finally, as this was a cross sectional study, we cannot establish causality. Longitudinal

research would be needed to explore how relationship dynamics and anticipated stigma impact adherence to ART over time among couples living with HIV. Qualitative studies that explore the nature of stigma in dyads would also add nuance to this topic.

Conclusions

This research suggests that couple relationships could be leveraged as an important source of resilience and support. Interventions that build resiliency in couples and strengthen couple relationships, with a focus on constructive forms of communication, building emotional and practical support within couples, and a healthy sexual life, could reduce the negative impact of extra-dyadic HIV stigma on the health of couples living with HIV in sub-Saharan Africa. Such interventions could have a positive impact on HIV care outcomes, such as ART adherence, which can help to attain population-level goals for reducing new HIV infections. In over 40 years of the HIV epidemic, not enough progress has been made on eliminating HIV stigma by focusing on individuals in isolation of their social environment. By working with both partners together to fight HIV stigma, we can target the experience of stigma within the dyad while also addressing societal and structural stigma by building couple resiliency.

Abbreviations

ART	Antiretroviral therapy
CSSS-Gen	General Couple Sexual Satisfaction Scale
GEE	Generalized estimating equation
HIV	Human immunodeficiency virus
PLHIV	People living with HIV

Acknowledgements

We would like to extend out thanks to our research participants and people living with HIV in Malawi.

Authors' contributions

AC, SG, and AR conceptualized the study. AC and JM designed the study and collected the data. AC and SG analyzed the data and drafted the manuscript. All authors read and edited the manuscript and then approved the final paper.

Funding

This research was supported by National Institutes of Mental Health of the U.S. Public Health Service under grants K01 MH107331, P30-AI027763, and T32 MH19105.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study was approved by the National Health Science Research Committee in Malawi (IRB # 15/12/1512) and the Human Research Protection Program at the University of California, San Francisco (IRB # 15-17394). Informed consent was obtained for all individual participants included in the study.

All procedures followed were in accordance with the Helsinki Declaration of 1975, as revised in 2000.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Author details

¹Department Of Community Health Systems, School of Nursing, University of California, San Francisco (UCSF), 2 Koret Way, San Francisco, CA 94143, USA. ²Wheaton College, 501 College Avenue, Wheaton, IL, USA. ³Department of Health Behavior and Biological Sciences, School of Nursing, University of Michigan, 400 North Ingalls Building, Ann Arbor, MI, USA. ⁴Division of Prevention Sciences, University of California, San Francisco (UCSF), 550 16Th Street, #3311, San Francisco, CA 94158, USA. ⁵Invest in Knowledge, Old Naisi Road, P.O. Box 506, Zomba, Malawi.

Received: 18 May 2023 Accepted: 14 September 2023

Published online: 28 September 2023

References

- Nyblade L, Mingkwan P, Stockton MA. Stigma reduction: an essential ingredient to ending AIDS by 2030. *Lancet HIV*. 2021;8:e106–13.
- Turan JM, Nyblade L. HIV-related stigma as a barrier to achievement of global PMTCT and maternal health goals: a review of the evidence. *AIDS Behav*. 2013;17:2528–39.
- Spangler SA, Abuogi LL, Akama E, Bukusi EA, Helova A, Musoke P, et al. From 'half-dead' to being 'free': resistance to HIV stigma, self-disclosure and support for PMTCT/HIV care among couples living with HIV in Kenya. *Cult Health Sex*. 2018;20:489–503.
- Hatzenbuehler ML, Phelan JC, Link BG. Stigma as a fundamental cause of population health inequalities. *Am J Public Health*. 2013;103:813–21.
- Turan JM, Bukusi EA, Onono M, Holzemer WL, Miller S, Cohen CR. HIV/AIDS stigma and refusal of HIV testing among pregnant women in rural Kenya: Results from the MAMAS study. *AIDS Behav*. 2011;15:1111–20.
- Kohler PK, Ondenge K, Mills LA, Okanda J, Kinuthia J, Ollilo G, et al. Shame, guilt, and stress: Community Perceptions of Barriers to Engaging in Prevention of Mother to Child Transmission (PMTCT) Programs in Western Kenya. *AIDS Patient Care STDS*. 2014;28:643–51.
- Hlongwa M, Mashamba-Thompson T, Makhunga S, Hlongwana K. Barriers to HIV testing uptake among men in sub-Saharan Africa: a scoping review. *Afr J AIDS Res*. 2020;19:13–23.
- Jones HS, Floyd S, Stangl A, Bond V, Hodidinott G, Pliakas T, et al. Association between HIV stigma and antiretroviral therapy adherence among adults living with HIV: baseline findings from the HPTN 071 (PopART) trial in Zambia and South Africa. *Trop Med Int Health*. 2020;25:1246–60.
- Shubber Z, Mills EJ, Nachega JB, Vreeman R, Freitas M, Bock P, et al. Patient-reported barriers to adherence to antiretroviral therapy: a systematic review and meta-analysis. *PLoS Med*. 2016;13:e1002183.
- Kalichman SC, Mathews C, Banas E, Kalichman MO. Treatment adherence in HIV stigmatized environments in South Africa: stigma avoidance and medication management. *Int J STD AIDS*. 2019;30:362–70.
- Adam A, Fusheni A, Ayanore MA, Amuna N, Agbozo F, Kugbey N, et al. HIV stigma and status disclosure in three municipalities in Ghana. *Ann Glob Health*. 2021;87:49.
- Adeniyi OV, Nwogwugwu C, Ajayi AI, Lambert J. Barriers to and facilitators of HIV serostatus disclosure to sexual partners among postpartum women living with HIV in South Africa. *BMC Public Health*. 2021;21:915.
- Earnshaw VA, Smith LR, Shuper PA, Fisher WA, Cornman DH, Fisher JD. HIV stigma and unprotected sex among PLWH in KwaZulu-Natal, South Africa: a longitudinal exploration of mediating mechanisms. *AIDS Care*. 2014;26:1506–13.
- Hargreaves JR, Pliakas T, Hodidinott G, Mainga T, Mubekapi-Musadaidzwa C, Donnell D, et al. HIV stigma and viral suppression among people living with HIV in the context of universal test and treat: analysis of data From the HPTN 071 (PopART) trial in Zambia and South Africa. *J Acquir Immune Defic Syndr*. 2020;85:561–70.

15. Denison JA, Burke VM, Miti S, Nonyane BAS, Frimpong C, Merrill KG, et al. Project YES! Youth Engaging for Success: a randomized controlled trial assessing the impact of a clinic-based peer mentoring program on viral suppression, adherence and internalized stigma among HIV-positive youth (15–24 years) in Ndola, Zambia. *PLoS One*. 2020;15:e0230703.
16. Esber A, Dear N, Reed D, Bahemana E, Owouth J, Maswai J, et al. Temporal trends in self-reported HIV stigma and association with adherence and viral suppression in the African Cohort Study. *AIDS Care*. 2022;34:78–85.
17. Simbayi LC, Kalichman SC, Strebel A, Cloete A, Henda N, Mqeketo A. Disclosure of HIV status to sex partners and sexual risk behaviours among HIV-positive men and women, Cape Town, South Africa. *Sex Transm Infect*. 2007;83:29–34.
18. Akatukwasai C, Getahun M, Ayadi AME, Namanya J, Maeri I, Itiakorit H, et al. Dimensions of HIV-related stigma in rural communities in Kenya and Uganda at the start of a large HIV “test and treat” trial. *PLoS One*. 2021;16:1–17.
19. Ogoina D, Ikuabe P, Ebuenyi I, Harry T, Inatimi O, Chukwueke O. Types and predictors of partner reactions to HIV status disclosure among HIV infected adult Nigerians in a tertiary hospital in the Niger delta. *Afr Health Sci*. 2015;15:10.
20. Maeri I, El Ayadi A, Getahun M, Charlebois E, Akatukwa D. How can I tell? Consequences of HIV status disclosure among couples in eastern African communities in the context of an ongoing HIV “test-and-treat” trial. *AIDS Care*. 2016;28:59–66.
21. Shamu S, Zarowsky C, Shefer T, Temmerman M, Abrahams N. Intimate partner violence after disclosure of HIV test results among pregnant women in Harare, Zimbabwe. *PLoS One*. 2014;9:e109447.
22. Colvin CJ, Konopka S, Chalker JC, Jonas E, Albertini J, Amzel A, et al. A systematic review of health system barriers and enablers for antiretroviral therapy (ART) for HIV-infected pregnant and postpartum women. *PLoS One*. 2014;9:e108150.
23. Cuca YP, Onono M, Bukusi E, Turan JM. Factors associated with pregnant women’s anticipations and experiences of HIV-related stigma in rural Kenya. *AIDS Care*. 2012;24:1173–80.
24. Gourlay A, Wringe A, Birdthistle I, Mshana G, Michael D, Urassa M. “It is like that, we didn’t understand each other”: exploring the influence of patient-provider interactions on prevention of mother-to-child transmission of HIV service use in rural Tanzania. *PLoS One*. 2014;9:e106325.
25. Breitnauer BT, Mmeje O, Njoroge B, Darbes LA, Leddy A, Brown J. Community perceptions of childbearing and use of Safer conception strategies among HIV-discordant couples in Kisumu. *Kenya J Int AIDS Soc*. 2015;18:1–7.
26. Lewis MA, McBride CM, Pollak KI, Puleo E, Butterfield RM, Emmons KM. Understanding health behavior change among couples: an interdependence and communal coping approach. *Soc Sci Med*. 2006;62:1369–80.
27. Conroy AA, McKenna SA, Comfort ML, Darbes LA, Tan JY, Mkandawire J. Marital infidelity, food insecurity, and couple instability: a web of challenges for dyadic coordination around antiretroviral therapy. *Soc Sci Med*. 2018;214:110–7.
28. Mbweza E, Norr KF, McElmurry B. Couple decision making and use of cultural scripts in Malawi. *J Nurs Scholarsh*. 2008;40:12–9.
29. Abbamonte JM, Ramlagan S, Lee TK, Cristofari NV, Weiss SM, Peltzer K, et al. Stigma interdependence among pregnant HIV-infected couples in a cluster randomized controlled trial from rural South Africa. *Soc Sci Med*. 2020;253:112940.
30. Rogers AJ, Achiro L, Bukusi EA, Hatcher AM, Kwena Z, Musoke PL, et al. Couple interdependence impacts HIV-related health behaviours among pregnant couples in southwestern Kenya: a qualitative analysis. *J Int AIDS Soc*. 2016;19:21224.
31. Conroy AA, Ruark A, McKenna SA, Tan JY, Darbes LA, Hahn JA, et al. The unaddressed needs of alcohol-using couples on antiretroviral therapy in Malawi: formative research on multilevel interventions. *AIDS Behav*. 2020;24:1599–611.
32. Conroy AA, McKenna SA, Ruark A. Couple interdependence impacts alcohol use and adherence to antiretroviral therapy in Malawi. *AIDS Behav*. 2019;23:201–10.
33. Conroy A, Leddy A, Johnson M, Ngubane T, van Rooyen H, Darbes L. ‘I told her this is your life’: relationship dynamics, partner support and adherence to antiretroviral therapy among South African couples. *Cult Health Sex*. 2017;19:1239–53.
34. Kidman R, Violari A. Growing up positive: adolescent HIV disclosure to sexual partners and others. *AIDS Care*. 2020;32:1565–72.
35. Zgambo M, Arabiat D, Ireson D. It cannot happen, never: a qualitative study exploring youth views on disclosure of HIV diagnosis to their sexual Partners in Southern Malawi. *J Assoc Nurses AIDS Care*. 2021;32:652–61.
36. Dessalegn NG, Hailemichael RG, Shewa-Amare A, Sawleshwarkar S, Lodebo B, Amberbir A, et al. HIV disclosure: HIV-positive status disclosure to sexual partners among individuals receiving HIV care in Addis Ababa Ethiopia. *PLoS One*. 2019;14:e0211967.
37. Mengwai K, Madiba S, Modjadji P. Low disclosure rates to sexual partners and unsafe sexual practices of youth recently diagnosed with HIV; implications for HIV prevention interventions in South Africa. *Healthcare (Basel)*. 2020;8:253.
38. Powell-Cope G. The experiences of gay couples affected by HIV infection. *Qual Health Res*. 1995;5:36–62.
39. van der Straten A, Vernon KA, Knight KR, Gómez CA, Padian NS. Managing HIV among serodiscordant heterosexual couples: serostatus, stigma and sex. *AIDS Care*. 1998;10:533–48.
40. Wamoyi J, Renju J, Moshabela M, Mclean E, Nyato D, Mbata D, et al. Understanding the relationship between couple dynamics and engagement with HIV care services: insights from a qualitative study in Eastern and Southern Africa. *Sex Transm Infect*. 2017;93(Suppl 3):1–6.
41. Talley AE, Ann BB. A relationship-oriented model of HIV-related stigma derived from a review of the HIV-affected couples literature. *AIDS Behav*. 2010;14:72–86.
42. Huang J, Zhang J, Yu NX. Couple identity and well-being in Chinese HIV serodiscordant couples: resilience under the risk of stigma. *AIDS Care*. 2018;30:558–66.
43. National Statistical Office (NSO) [Malawi] and ICF. Malawi Demographic and Health Survey 2015–16. Zomba and Rockville: NSO and ICF; 2017
44. Centers for Disease Control and Prevention. Malawi Country Profile. <https://www.cdc.gov/globalhivtb/where-we-work/malawi/malawi.html>. Accessed 28 Nov 2022.
45. UNAIDS. Malawi Country Factsheet 2021. 2021. <https://www.unaids.org/en/regionscountries/countries/malawi>. Accessed 28 Nov 2022.
46. Conroy AA, McKenna S, Ruark A, Neilands TB, Spinelli M, Gandhi M. Relationship dynamics are associated with self-reported adherence but not an objective adherence measure in Malawi. *AIDS Behav*. 2022. <https://doi.org/10.1007/s10461-022-03636-2>.
47. Tuthill EL, Neilands TB, Johnson MO, Saucedo J, Mkandawire J, Conroy AA. A dyadic investigation of relationship dynamics and depressive symptoms in HIV-affected couples in Malawi. *AIDS Behav*. 2019;23:3435–43.
48. Conroy AA, Leddy AM, Darbes LA, Neilands TB, Mkandawire J, Stephenson R. Bidirectional violence is associated with poor engagement in HIV care and treatment in Malawian Couples. *J Interpers Violence*. 2022;37:NP4258–77.
49. Earnshaw VA, Smith LR, Chaudoir SR, Amico KR, Copenhaver MM. HIV stigma mechanisms and well-being among PLWH: a test of the HIV stigma framework. *AIDS Behav*. 2013;17:1785–95.
50. Sileo KM, Wanyenze RK, Kizito W, Reed E, Brodine SK, Chemusto H, et al. Multi-level determinants of clinic attendance and antiretroviral treatment adherence among fishermen living with HIV/AIDS in communities on Lake Victoria. *Uganda AIDS Behav*. 2019;23:406–17.
51. Gutin SA, Harper GW, Moshashane N, Ramontshonyana K, Stephenson R, Shade SB, et al. Relationship, partner factors and stigma are associated with safer conception information, motivation, and behavioral skills among women living with HIV in Botswana. *BMC Public Health*. 2021;21:2231.
52. Kwena Z, Kimbo L, Darbes LA, Hatcher AM, Helova A, Owino G, et al. Testing strategies for couple engagement in prevention of mother-to-child transmission of HIV and family health in Kenya: study protocol for a randomized controlled trial. *Trials*. 2021;22:1–16.
53. Conroy AA, Ruark A, Neilands TB, Darbes LA, Johnson MO, Tan JY, et al. Development and validation of the couple sexual satisfaction scale for HIV and sexual health research. *Arch Sex Behav*. 2021;50:3297–311.
54. Sternberg R. Construct validation of a triangular love scale. *Eur J Soc Psychol*. 1997;27:313–35.
55. Ruark A, Chase R, Hembling J, Davis VR, Perrin PC, Brewster-Lee D. Measuring couple relationship quality in a rural african population: validation of a couple functionality assessment tool in Malawi. *PLoS One*. 2017;12:e0188561.

56. Larzelere R, Huston T. The dyadic trust scale: toward understanding interpersonal trust in close relationships. *J Marriage Fam.* 1980;42:595.
57. Musoke P, Darbes L, Hatcher AM, Helova A, Kwena Z, Owino G, et al. Couple efficacy and communal coping for HIV prevention among Kenyan pregnant couples. *AIDS Behav.* 2022;26:2135–47.
58. Woolf-King SE, Conroy AA, Fritz K, Johnson MO, Hosegood V, van Rooyen H, et al. Alcohol use and relationship quality among South African couples. *Subst Use Misuse.* 2019;54:651–60.
59. Conroy AA, McGrath N, van Rooyen H, Hosegood V, Johnson MO, Fritz K, et al. Power and the association with relationship quality in South African couples: Implications for HIV/AIDS interventions. *Soc Sci Med.* 2016;153:1–11.
60. Kurdek LA. The deterioration of relationship quality for gay and lesbian cohabiting couples: a five-year prospective longitudinal study. *Pers Relatsh.* 1996;3:417–42.
61. Aron A, Aron EN, Smollan D. Inclusion of other in the self scale and the structure of interpersonal closeness. *J Pers Soc Psychol.* 1992;63:596–612.
62. Cutrona C, Russell D. The Provisions of Social Relationships and Adaptation to Stress. In: Jones WH, Perlman D, editors. *Advances in Personal Relationships.* Vol. 1. Greenwich: JAI Press Inc; 1987. p. 37–67.
63. Darbes LA, Lewis MA. HIV-specific social support predicts less sexual risk behavior in gay male couples. *Health Psychol.* 2005;24:617–22.
64. Christensen A, Shenk JL. Communication, conflict, and psychological distance in nondistressed, clinic, and divorcing couples. *J Consult Clin Psychol.* 1991;59:458–63.
65. Walsh JC, Mandalia S, Gazzard BG. Responses to a 1 month self-report on adherence to antiretroviral therapy are consistent with electronic data and virological treatment outcome. *AIDS.* 2002;16:269–77.
66. Viswanathan S, Justice AC, Alexander GC, Brown TT, Gandhi NR, McNicholl IR, et al. Adherence and HIV RNA suppression in the current era of highly active antiretroviral therapy. *J Acquir Immune Defic Syndr.* 2015;69:493–8.
67. Bezabhe WM, Chalmers L, Bereznicki LR, Peterson GM. Adherence to antiretroviral therapy and virologic failure: a meta-analysis. *Medicine.* 2016;95:e3361.
68. Thirumurthy H, Siripong N, Vreeman RC, Pop-Eleches C, Habyarimana JP, Sidle JE, et al. Differences between self-reported and electronically monitored adherence among patients receiving antiretroviral therapy in a resource-limited setting. *AIDS.* 2012;26:2399–403.
69. Johnson MO, Dilworth SE, Taylor JM, Darbes LA, Comfort ML, Neilands TB. Primary relationships, HIV treatment adherence, and virologic control. *AIDS Behav.* 2012;16:1511–21.
70. Filmer D, Pritchett LH. Estimating wealth effects without expenditure data—or tears: an application to educational enrollments in states of India. *Demography.* 2001;38:115–32.
71. Kenny DA, Kashy DA, Cook WL. *Dyadic data analysis.* New York: Guilford; 2006.
72. Darbes LA, van Rooyen H, Hosegood V, Ngubane T, Johnson MO, Fritz K, et al. Uthando Lwethu (our love): a protocol for a couples-based intervention to increase testing for HIV: a randomized controlled trial in rural KwaZulu-Natal South Africa. *Trials.* 2014;15:64.
73. Huber PJ. The behavior of maximum likelihood estimates under non-standard conditions. In: *Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability.* Berkeley: University of California Press; 1967. p. 221–33.
74. White HL. A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica.* 1980;48:817–38.
75. Rogers WH. *Regression standard errors in clustered samples.* College Station: Stata Press; 1993.
76. Loehys T, Molenberghs G. Modeling actor and partner effects in dyadic data when outcomes are categorical. *Psychol Methods.* 2013;18:220–36.
77. Press WH, Teukolsky SA, Vetterling WT, Flannery BP. *Numerical recipes: the art of scientific computing.* 3rd ed. Cambridge: Cambridge University Press; 2007.
78. Rising B. *Graphics tricks for models.* 2011 Stata Conference. Chicago. 2011. http://fmwww.bc.edu/repec/chic2011/chi11_rising.pdf.
79. Stanik CE, Bryant CM. Sexual satisfaction, perceived availability of alternative partners, and marital quality in newlywed African American couples. *J Sex Res.* 2012;49:400–7.
80. Schwartz P, Young L. Sexual satisfaction in committed relationships. *Sex Res Soc Policy.* 2009;6:1–17.
81. Ruark A, Green EC, Nunn A, Kennedy C, Adams A, Dlamini-Simelane T, et al. Navigating intimate sexual partnerships in an era of HIV: dimensions of couple relationship quality and satisfaction among adults in Eswatini and linkages to HIV risk. *Sahara J.* 2019;16:10–24.
82. Higgins JA, Mullinax M, Trussell J, Davidson JKS, Moore NB. Sexual satisfaction and sexual health among university students in the United States. *Am J Public Health.* 2011;101:1643–54.
83. Higgins JA, Hirsch JS. The pleasure deficit: revisiting the “sexuality connection” in reproductive health. *Int Fam Plan Perspect.* 2007;33:133–9.
84. Wang Q, Fong VWI, Qin Q, Yao H, Zheng J, Wang X, et al. Trends in the psychosocial and mental health of HIV-positive women in China from 2015 to 2020: Results from two cross-sectional surveys. *Health Expect.* 2022;25:1555–62.
85. Nevedal A, Sankar A. The significance of sexuality and intimacy in the lives of older African Americans With HIV/AIDS. *Gerontologist.* 2016;56:762–71.
86. Okoror FA, Falade CO, Walker EM, Olorunlana A, Aneale A. Social context surrounding HIV diagnosis and construction of masculinity: a qualitative study of stigma experiences of heterosexual HIV positive men in southwest Nigeria. *BMC Public Health.* 2016;16:507.
87. Turan JM, Darbes LA, Musoke PL, Kwena Z, Rogers AJ, Hatcher AM, et al. Development and piloting of a home-based couples intervention during pregnancy and postpartum in Southwestern Kenya. *AIDS Patient Care STDS.* 2018;32:92–103.
88. Darbes LA, McGrath NM, Hosegood V, Johnson MO, Fritz K, Ngubane T, et al. Results of a couples-based randomized controlled trial aimed to increase testing for HIV. *J Acquir Immune Defic Syndr.* 2019;80:404–13.
89. Fonner VA, Ntogwisangu J, Hamidu I, Joseph J, Fields J, Evans E, et al. “We are in this together:” dyadic-level influence and decision-making among HIV serodiscordant couples in Tanzania receiving access to PrEP. *BMC Public Health.* 2021;21:1–11.
90. Rispel LC, Cloete A, Metcalf CA. “We keep her status to ourselves”: experiences of stigma and discrimination among HIV-discordant couples in South Africa. *Tanzania and Ukraine SAHARA J.* 2015;12:10–7.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Ready to submit your research? Choose BMC and benefit from:

- fast, convenient online submission
- thorough peer review by experienced researchers in your field
- rapid publication on acceptance
- support for research data, including large and complex data types
- gold Open Access which fosters wider collaboration and increased citations
- maximum visibility for your research: over 100M website views per year

At BMC, research is always in progress.

Learn more biomedcentral.com/submissions

