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Relationship dynamics are associated with self-reported adherence but not an objective adherence measure in Malawi

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Abstract

Couple relationships can be leveraged to improve adherence to antiretroviral therapy (ART), but few studies have identified relationship factors to target in interventions in sub-Saharan Africa. We conducted a cross-sectional study with 211 couples in southern Malawi with at least one partner on ART to test for associations between ART adherence and relationship dynamics (intimacy, trust, relationship satisfaction, unity, commitment, and partner support). We measured ART adherence through subjective measures (patient and partner reports) and an objective measure (ART drug levels in hair) and hypothesized that more positive relationship dynamics (e.g., higher intimacy) would be associated with better adherence. Multi-level logistic and linear regression models were used to evaluate study hypotheses, controlling for the clustering of individuals within couples. High levels of adherence were found by all three measures. Unity, satisfaction, and partner support were associated with higher patient and partner reports of adherence, and additional relationship dynamics (intimacy, trust) were associated with higher partner reported adherence. No associations were found between relationship dynamics and drug levels in hair, although drug levels were high overall. Future studies should perform longitudinal assessments of relationship dynamics and objective metrics of adherence, and examine these associations in populations with lower adherence levels such as young women or individuals starting ART.

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Code availability: Data analysis code is available upon request.

Keywords

Relationship dynamics; couples; adherence; HIV/AIDS; sub-Saharan Africa

Introduction

As of 2020, nearly 37 million people globally have died of AIDS-related illnesses and 38 million are living with HIV [1]. In response to this decades-long pandemic, the UNAIDS set an ambitious goal for 2020: 90% of people living with HIV would know their HIV status; 90% of those diagnosed with HIV would receive sustained antiretroviral therapy (ART); and 90% of those receiving ART would be virally suppressed [2]. Globally, the success of the UNAIDS 90-90-90 effort varies substantially between and within regions; however, regions such as eastern and southern Africa have nearly achieved UNAIDS targets including in Malawi [3]. As of 2021 around 86% of Malawians living with HIV know their status, 87% are on ART, and 93% of those on ART are virally suppressed [4]. According to UNAIDS data from 2019, an estimated 1.1 million Malawians were living with HIV and the adult (aged 15–49) prevalence rate was 8.9%. Thus, despite significant progress towards UNAIDS targets in this region, a substantial number of people living with HIV still remain without access to HIV care and treatment.

In Malawi and in other settings with high marriage rates, individuals who are married or cohabitating account for more than half of new HIV infections [5], suggesting that primary relationships could be an important target for HIV prevention, care, and treatment interventions. In sub-Saharan Africa (SSA), relationship dynamics such as commitment, equality, trust, intimate partner violence, and communication are key factors associated with uptake of HIV testing [6–9]. Social relationships such as primary partnerships are essential in resource-poor settings for helping HIV-positive patients overcome the economic challenges and other obstacles associated with receiving HIV care [10]. According to the dyadic model of communal coping, which is based on interdependence theory, positive aspects of relationships—including intimacy and commitment to the relationship—can help foster couple collaboration around a health issue and lead to health-enhancing behaviors [11, 12].

In general, research on the HIV care continuum in SSA among people living with HIV has failed to adequately study relationship factors, instead focusing primarily on psychosocial factors at the individual level (e.g., stigma, discrimination) and structural level (e.g., poverty, healthcare delivery) [13]. There is a small but growing body of research in SSA focused on the role of intimate partner violence on adherence to ART [14–16], however, less research has examined the positive aspects of relationships (e.g., intimacy and partner support) and HIV treatment outcomes. Qualitative findings have identified supportive aspects of couples that are important for adherence [17–19], but few quantitative studies have explicitly tested for associations between relationship dynamics and HIV treatment outcomes. In the US, research substantiates that positive relationship dynamics cannot be neglected; higher relationship quality and partner support are associated with better ART adherence and virologic control [20, 21]. The identification of these same relationship dynamics in SSA is critical to develop effective interventions harnessing the powerful role of primary partners on HIV treatment outcomes.

Although few couples-based HIV care interventions have been employed or systematically studied in SSA, several recent intervention trials in South Africa highlight the promising role of dyadic interventions in resource-limited settings. In *Masivukeni* ("Let's Wake Up"), dyads (patients and treatment supporters) engaged in multimedia education, structured discussions, problem-solving, and communication exercises maintained high levels of ART adherence. Pilot data showed a 10% improvement in adherence in the experimental group, compared to an 8% decrease in adherence for the control group [22]. A second intervention, *Uthando Lwethu* ("Our Love"), aimed to increase uptake of couples' HIV testing by improving relationship dynamics (e.g., intimacy, trust) and problem-solving skills [23]. The randomized controlled trial for *Uthando Lwethu* found that couples who received the intervention were significantly more likely to participate in couples' HIV testing and counseling than control couples (42% vs. 12%) [24]. A third couple-based intervention, the Couples Health Co-Op (CHC), reinforced positive relationship dynamics with skill-building around communication and sex [25]. Men in the couples arm reported less heavy alcohol use than men in male-only groups [26].

Despite these encouraging findings, gaps in knowledge remain. *Masivukeni*, for example, was designed for patient-treatment supporter dyads but not specifically couples, and utilized a technology-based approach, which may not be feasible in resource-poor or rural settings such as Malawi [22]. Furthermore, few interventions with couples have been designed to improve behaviors related to the post-HIV infection care continuum. *Uthando Lwethu* focused on increasing uptake of HIV testing [23], not subsequent care or treatment, while the CHC targeted HIV prevention behaviors such as reducing alcohol use, violence, and unsafe sex [26].

Given the dearth of formative research in this field, more work is needed to inform interventions for couples that aim to improve HIV care and treatment behaviors. To identify the most important relationship factors associated with engagement in care that could be targeted for intervention, we conducted a quantitative investigation to assess whether relationship dynamics and partner support around HIV treatment were positively associated with adherence to ART among married couples in Malawi. Because there is not a single gold standard for capturing adherence, with each measure offering its own set of strengths and weaknesses [27], we compared associations across two subjective measures of adherence (patient self-reports and partner reports on the patient's adherence), and one objective measure of adherence (ART drug levels in hair samples). In multiple settings, ART drug levels in hair have predicted virologic response more strongly than self-reported adherence [28–34]. There is evidence from SSA that hair collection is feasible and acceptable to local research participants, and may serve as a low-cost biomarker of adherence in resource-poor settings [35]. To our knowledge, this study is one of the first applications of hair biomarkers in a behavioral study with couples in SSA.

Materials and Methods

Study Procedures

The data were collected as part of the *Umodzi M'Banja* ("UMB"; Unity in the Family) study, which is a mixed-methods, observational study with people living with HIV on ART and their primary partners in Zomba, Malawi [14, 15, 36]. The primary objective of UMB was to understand how relationship dynamics correspond with behaviors related to engagement in HIV care and treatment, and to translate these findings into the development of a couple-based intervention for couples living with HIV. In August 2017, we conducted a cross-sectional survey with 211 couples (422 individuals). Couples were eligible to participate if: 1) in a married or cohabitating union for at least six months; 2) age 18 or higher; and 3) had at least one partner (i.e., the "index patient") on ART for at least 2 months who had disclosed their HIV status to the primary partner (which was verified by the partner). HIV status disclosure was required to assess HIV-related social support from both partners' perspectives. Polygamous couples, which only comprise 7% in this region, were excluded for feasibility of recruitment and because analytic methods for polygamous couples remain underdeveloped. Quota tables were used during recruitment to ensure a relatively equal balance of index patients by gender.

Recruitment took place at two high-volume HIV clinics in the Zomba district: 1) an urban clinic at a large district hospital, and 2) a faith-based, private clinic at a rural community hospital. Around half of participants were recruited from each clinic. Research staff announced the study during the morning health information session when patients arrived to pick up their medications and then patients could approach the staff if interested. If the index patient was eligible, they were given an information card to give to their primary partner and arranged a time with the recruiter to speak with the partner over the phone. Partner eligibility was then confirmed in-person at the couples' interview appointment. Both members of the couple were asked to self-report their HIV status during screening.

Prior to recruitment, the lead investigator trained the local research team on the study procedures, data collection instruments, and protecting research participants. The survey was translated into the local language of Chichewa and back-translated into English by an independent person not affiliated with the project. During the training, the research team reviewed each item of the survey to ensure items were understood, clear, culturally-appropriate, and correctly translated. Research assistants administered the surveys on tablet devices using a secure, web-based data collection platform called Survey CTO (Dobility, Inc; https://www.surveycto.com). The electronic survey was first piloted with a small sample of 10 couples to further train the interviewers, gauge the length of the survey, identify errors with skip patterns, and ensure the data were stored properly. We held de-briefing sessions with the research team to assess items that were confusing to respondents and made final modifications to the survey (e.g., clarifying translations, correcting errors in fields or skip patterns).

Both partners provided informed consent, separately but simultaneously, in private locations of the HIV clinics and each partner was provided a small incentive (around $2 USD) for their time. Interviewers were trained to monitor for whether partners were coerced to participate in the study and to facilitate referrals for domestic violence. All participants were provided with a list of community-based resources for couples, including services for domestic violence, at the start of the study. Ethical approval was obtained from the Human Research Protection Program at the University of California San Francisco and the National Health Science Research Committee in Malawi.

Partners were interviewed separately, but simultaneously, by gender-matched interviewers in private areas of the HIV clinics. We chose the HIV clinics for privacy and convenience for the interviewers and participants, who lived across a large geographical area. Both partners were asked the same questions on relationship dynamics and engagement in care behaviors. Once the surveys were uploaded to a secure server, the US-based research team regularly checked the data for errors and to ensure that couples were properly linked. Discrepancies and queries were tracked in a spreadsheet and discussed at weekly phone calls between the US-based team and the Malawi team until all issues were resolved.

All participants living with HIV and on ART were asked to provide a small hair sample to measure ART drug levels, following established procedures developed by Gandhi et al. [29] In brief, around 100 strands of hair were cut as close to the scalp as possible from each participant. The distal end of the hair sample was marked and placed in aluminum foil to avoid sun exposure. The enclosed foil was labeled and placed in a sealed plastic bag, labeled with the participant identification number. Respondents with hair too short were rescheduled for hair collection 2–4 weeks later (around 8%). Hair samples were stored at room temperature in locked cabinets at the research center in Malawi until transported back to UCSF for analysis. Hair assays at the UCSF Hair Analytical Laboratory (HAL) have been developed and validated for the most common antiretrovirals used in Malawi, including Tenofovir (TFV) disoproxil fumarate (TDF), Nevirapine (NVP), and Atazanavir (ATV). All participants in this study were on an ART regimen that included one of these drugs. ART regimens were extracted from patient medical records for all participants currently on ART. Liquid chromatography-mass spectrometry methods were used to determine the concentrations of three antiretroviral drugs: TFV, NVP, and ATV [37, 38]. The UCSF HAL methods have been peer reviewed and approved by the US National Institute of Health's Clinical Pharmacology and Quality Assurance Program [39].

Measures

Explanatory Variables – Positive Relationship Dynamics

Intimacy.: Emotional intimacy was measured with a 5-item subscale from the Triangular Scale of Love (e.g., "I have a relationship of mutual understanding with my partner") [40]. We used the shortened version of the Triangular Scale of Love intimacy sub-scale previously validated through another study in Malawi [41]. Response options range from 1 (strongly disagree) to 5 (strongly agree), with higher scores indicating higher intimacy. Cronbach's alpha for this scale was 0.90. For scales on relationship dynamics, we created a couple-level mean composed of the average scores from both partners.

Trust.: Trust was measured with the 8-item Dyadic Trust Scale (e.g., "My partner is honest with me") [42]. Response options range from 1 (strongly disagree) to 5 (strongly agree), with higher scores indicating higher trust. We created a sum score across all items (no missing responses). The Cronbach's alpha for the trust scale was 0.82.

Relationship satisfaction.: A single item from the Couple Satisfaction Index was used to assess relationship satisfaction (e.g., "Generally, I am satisfied with my relationship") [43]. Response options range from 1 (strongly disagree) to 5 (strongly agree), with higher scores indicating higher relationship satisfaction.

Unity.: A single item was used to measure relationship unity or "we-ness" using the inclusion-of-self-in-other diagram [42]. This diagram asks respondents to pick a set of overlapping circles that best describes their current relationship with their partner. Response options included seven sets of circles ranging from 1 (no overlap) to 7 (complete overlap) with higher scores indicating higher relationship unity.

Commitment.: Relationship commitment was measured with the 8-item subscale from the Triangular Scale of Love (e.g., "I am committed to maintaining my relationship with my partner) [40]. We used the shortened version of the Triangular Scale of Love scale previously validated through another study in Malawi [41]. Response options range from 1 (strongly disagree) to 5 (strongly agree), with higher scores indicating higher relationship commitment. The Cronbach's alpha for the trust scale was 0.82.

Partner support.: Based on the Social Provisions Scale [44] and the HIV-specific Social Support Scale [45], we developed a measure of HIV treatment-specific partner support ("I can depend on my partner to help me with my antiretrovirals if I really need it"; 9 items). Response options range from 1 (strongly disagree) to 5 (strongly agree), with higher scores indicating higher partner support. Cronbach's alpha for the HIV treatment-specific partner support scale was 0.84.

Dependent Variables – ART Adherence

Self and partner-reported ART adherence.: We used two subjective measures to assess adherence: the patient's self-reported 30-day adherence and the partner's estimate of the patient's 30-day adherence. We included the partner's perception of the index patient's adherence because other studies have found that partner reports may be as reliable as the patient's own report in predicting viral suppression [46]. To account for low education levels, we used an innovative "bean method" based that asked about the past 30-day adherence [14]. The interviewer gave the respondent two bowls, one with beans and one empty, and stated, "I am going to give you a bowl of beans. Pretend that these are the ARVs you take each month. If you take ARVs once per day, there are 30 beans for the month. If you take ARVs twice per day, there are 60 beans. Please select the number of beans corresponding to the ARVs you did not take in the last month and put them in the second bowl." We calculated the percent adherence by subtracting the number of expected doses (adjusted based on whether participant was on a once or twice a day regimen) from the number of missed pills corresponding to the beans placed in the empty bowl. Patients were also asked a second question, "In the past 30 days, how many doses of ARVs (pills) did you not take"? and if the response did not match the number of beans, respondents were asked to rectify their answer. We created a binary outcome variable in which adherence corresponded to taking 90% or more of pills and non-adherence corresponded to taking less than 90% of pills, a validated threshold that is commonly used in other studies in SSA [47]. For the partner version, partners were asked a single item, "In the past 30 days, how many doses of ARVs (pills) did your partner not take?" Similar to the self-reported measure, we created a binary variable corresponding to taking 90% or more of pills. For the analyses of partner-reported adherence, the data were restructured such that the partner's report on the patient's adherence became the outcome variable.

Antiretroviral drug levels in hair.: We created a variable corresponding to the concentration levels for the primary ART drug in the participants' regimen (TFV, NVP, or ATV), with undetectable concentrations set to equal the limit of detection. The concentration level for each participant's primary ART drug was naturally log-transformed to satisfy the assumptions of normality and to better reflect the clinical importance of differences between concentrations. All models allowed for district residual variances for the different drugs.

Covariates—Multivariable models controlled for covariates deemed important the HIV literature in SSA [15, 36], including gender, age, years of education, household wealth score [48], relationship duration (in months), couple HIV status (serodiscordant or seroconcordant positive), and length of time on ART (in months).

Data Analysis

To characterize the sample, we computed one-way frequency tables and measures of central tendency. To compare ART drug level concentrations to self-reported adherence, we created scatter plots and computed the Pearson's correlation coefficient between the log-transformed drug level concentrations and the log-transformed percent adherence variable. For the binary outcome of adherence, we used generalized estimating equations (GEE) clustering on the couple identifier with the robust standard error option, a binary distribution, and a logit link function to yield odds ratios. For ART drug concentration levels in hair, we used linear mixed models with clustering on the couple identifier to model log-transformed normalized drug concentrations. We allowed the variances in these models to vary by drug type, and also adjusted for drug type. Finally, we examined correlations between the two subjective measures of adherence and ART drug levels.

We fit separate models for each positive relationship dynamic for the primary outcomes above, controlling for the covariates listed above. This approach was selected because we were interested in identifying relationship dynamics that could be targeted in an intervention. We also examined whether associations differed by couple serostatus (concordant positive or discordant) and included an interaction term in the multivariate models. We found no evidence of statistical interaction, finding a non-significant interaction term in the model ($p<0.05$), and thus retained the main effects models in the presentation of our results below. Finally, we checked for multi-collinearity among all explanatory variables by examining the variance inflation factor (VIF), which were all well below the recommended cutoff of 10 [49]. Missing data were negligible (less than 5% on any given variable). The models were estimated using either Stata or SAS, using listwise deletion for missing data.

Results

Sample characteristics

Of the 211 couples (422 individuals), the mean age was 40.5 and the majority (80.8%) had a primary school education or less (Table 1). All couples were in married or cohabitating unions for an average of 12.5 years. Approximately two-thirds of couples were sero-concordant positive (one-third were sero-discordant). Of participants who were HIV-positive (N=352), 98.9% were on ART for an average of 4.8 years. Levels of optimal adherence were high based on self and partner reports: 95% and 96%, respectively. Self-reported adherence was weakly correlated with partner-reported adherence (r=0.11; p<0.05). Hair samples were provided by 95% of participants on ART (N=332). As shown in Table 1, drug levels in hair were high for all three drugs, corresponding to 90–100% adherence by other models [29, 31, 50].

Relationship dynamics and self-reported ART adherence

The unadjusted models showed that individuals with more positive relationship dynamics on the following variables had higher odds of self-reported adherence to ART: unity (OR=2.72; p<0.001), relationship satisfaction (OR=2.81; p<0.01), and HIV treatment-specific partner support (OR=1.11; p<0.01). In the adjusted models, after controlling for socio-demographic variables, relationship characteristics, and clinical variables, unity (AOR=2.11; p<0.01), relationship satisfaction (AOR=3.80; p<0.01), and HIV treatment-specific partner support (AOR=1.12; p<0.01) remained significantly associated with self-reported ART adherence (Table 2).

Relationship dynamics and partner-reported ART adherence

The overall patterns of findings were similar for partner-reported adherence to ART, with additional significant findings (Table 2). The unadjusted models showed that individuals with more positive relationship dynamics on the following variables had a higher odds of partner-reported adherence to ART: intimacy (OR=4.42; p<0.01), trust (OR=1.16; p<0.05), unity (OR=2.72; p<0.001), relationship satisfaction (OR=3.43; p<0.01), commitment (OR=4.86; p<0.01), and HIV treatment-specific partner support (OR=1.11; p<0.01). In the adjusted models, all of these associations held: intimacy (AOR=4.24; p<0.01), trust (AOR=1.18; p<0.05), unity (AOR=2.66; p<0.01), relationship satisfaction (AOR=3.43; p<0.05), commitment (AOR=5.88; p<0.05), and HIV treatment-specific partner support (AOR=1.17; p<0.01).

Relationship dynamics and antiretroviral drug levels in hair

The unadjusted models did not show any significant associations between relationship dynamics and drug levels in hair (Table 3). This held after controlling for covariates in the adjusted models.

Antiretroviral drug levels in hair, and self and partner reports of adherence

The Pearson's correlation coefficient for the association between the log-transformed normalized concentrations and the log-transformed self-reported adherence percentage was 0.01 (95% CI: −0.12–0.10) and the log-transformed partner-reported adherence percentage was −0.01 (95% CI: −0.13–0.10). In a scatter plot (not shown) of self-reported adherence and lab-based log-transformed concentrations, with an added LOESS smoother, we failed to observe a meaningful relationship with each of the two adherence variables, with high variability of lab-based values among individuals who self-reported 100% adherence. Similarly, in histograms and smoothed probability densities (not shown) of log-transformed lab-based values stratified by dichotomous adherence variables, we failed to see a strong distinction in the models.

Discussion

This is the first quantitative dyadic study to examine the intersection of relationship dynamics and engagement in HIV care and treatment in an African population of couples living with HIV. Our findings are consistent with previous research on the association between relationship quality and self-reported measures of engagement in HIV care and treatment, however, findings suggest a more complex picture of the association between relationship quality and adherence to HIV medications as suggested by the inclusion of ART drug levels in hair.

Both self-reported and partner-reported measures of ART adherence were positively correlated with measures of relationship quality—specifically unity, relationship satisfaction, and HIV treatment-specific partner support. These findings are consistent with the theory of communal coping, which argues that higher quality relationships allow partners to cope collaboratively with HIV and offer support. This is consistent with prior research. For example, qualitative research indicates that partners may offer treatment-specific forms of support via direct reminders to take pills or attend clinic appointments [17, 18]. In addition, research suggests that unity and relationship satisfaction may enhance adherence through multiple direct and indirect mechanisms, such as by facilitating social support for HIV adherence [17], through its positive impact on mental health [36], and by reducing the likelihood of marital infidelity and its social and economic consequences [19]. Conversely, violent, psychologically abusive, and neglectful relationships can negatively affect adherence and the likelihood of attending appointments both directly and indirectly [16, 51] as we found in this same sample of couples from Malawi [14]. For example, in-depth interviews and survey research has found that extra-marital affairs can pull economic resources away from a household, leading to food insecurity and missed pills, or through interpersonal conflict that can cause one partner to forget their pills or the other to intentionally dispose of them [14, 15]. The present study extends this body of literature by demonstrating strong positive correlations between relationship quality and subjective adherence measures and enhances the generalizability of prior (mostly qualitative) research in SSA and quantitative research in non-African settings on the association between relationship quality and ART adherence [52].

In addition, our analysis and findings allowed us to parse out which relationship dynamics may be more important than others. Across many settings, couple-based interventions are a successful approach for reducing HIV risk behavior [53]. A systematic review and meta-analysis found that couple-based approaches tend to be more effective than individual-level alternatives when it comes to HIV-related prevention, testing, and treatment behaviors [54]. However, the specific findings of these interventions differ. For example, the US-based intervention “SMART Couples” improved ART adherence by working with couples to identify treatment barriers within the relationship, develop communication skills, build problem-solving strategies, and optimize partner support [55]. “Stronger Together” —also developed in the US—combined couples HIV testing and counseling with dyadic adherence counseling to improve partner interactions and collaboration [56]. Finally, the *Uthando Lwethu* intervention in South Africa provided health and HIV-specific education as well as individual and dyadic counseling aimed at improving general problem-solving and communication skills [24]. While the present cross-sectional study cannot assess causality as with clinical trials, it does identify which relationship dimensions to consider in future couple-based interventions—particularly, unity, relationship satisfaction, and partner support around HIV treatment. Dyadic interventions to improve ART adherence could focus on improving couple unity and overall satisfaction by including relationship-building exercises or by helping partners learn skills and tactics to provide each other with tangible forms of support specific to adherence (e.g., providing reminders to take pills, offering encouragement).

Drug level concentrations in hair suggest high levels of ART adherence in this sample, consistent with a median adherence of 6–7 doses per week as found in the Strand Study [50]. Despite the promise indicated by the correlations between relationship factors and subjective adherence measures, our hair results do raise questions around the use of self-reports. Correlations between ART drug levels in hair and self-reported measures of adherence have been weak in the existing literature [57], and consequently there is a growing body of research that advocates for the use of hair drug levels (or drug levels in any biomatrix) as an objective, presumed superior, alternative to subjective measures of adherence [29, 35, 58]. However, because drug levels in hair are an underutilized tool for measuring adherence, there is little social-behavioral research, especially from SSA, to contextualize our findings. We were only able to find one comparable study, which found that social support mitigated the negative impact of food insecurity on ART adherence (i.e., measured via hair levels) among pregnant women in Kenya [59]. This, combined with qualitative literature and our subjective self-report data, suggests that we could have expected to find an association between relationship quality and drug levels in hair.

Because we did not find the expected correlation, we must consider what this means for our overall findings. One interpretation is that biomarkers offer a more accurate picture of adherence compared with self- and partner-reports. If this is true, it is possible that the correlations that we found between self-reported adherence and relationship quality could be spurious. Indeed, research comparing different measures of adherence shows that participants are prone to recall and social desirability bias in their self-reports [21]. Specifically, while self-report is quite good at identifying very poor adherence, it is less accurate for distinguishing between moderate non-adherence (not severe) and good adherence [22]. By this reasoning, it is possible that a single factor—such as social desirability bias or optimism—could contribute to over-reporting of good ART adherence and positive relationship status, explaining the correlation between the two. For example, people who rate their relationships positively (or negatively) may also rate their adherence more positively (or negatively) if they are generally very optimistic (or pessimistic). However, because we found similar results between relationship dynamics and patient reports of adherence, and between relationship dynamics and partner reports of adherence, this somewhat strengthens the possibility that self-reports may be reliable. It would be rare for partners to be as equally optimistic as the patient (or report the similar levels of socially desirable responses). Although because these are couples, they are likely to be more similar than any other two people in the sample (i.e., couple interdependence). Our qualitative research with the same population of couples in Malawi and South Africa also supports the findings on self-reported adherence, in that higher quality relationships promoted better adherence [15, 17] and while social desirability bias could have influenced the current study's findings, we found high reporting of sensitive behaviors such as intimate partner violence, with close to 40% of couples reporting sexual and emotional abuse, and women also admitting to being perpetrators of violence [14]. This, in turn, also offers credence to the authenticity of the self-reports.

There are several other possible reasons for why we did not find associations with drug levels. Drug level-based adherence and self-reported adherence are both correlated with viral load and clinical outcomes [60–62], although the association tends to be stronger between drug levels and viral suppression as compared with self-report [31]. With generally high drug levels among all participants, it is possible that adherence was generally good across the sample but that participants recalled poorer adherence than actual levels. It is also possible that factors like low body mass index (BMI), kidney or liver function, sex, and drug interactions could affect the pharmacokinetics of ART (and subsequent drug levels in hair) in this population, independent of adherence [63, 64]. Although we adjusted for sex and potential drug interactions with other antiretroviral drugs, we could not adjust for all factors, and residual confounding could remain. As most participants reported very high self-reported adherence, it is possible that true differences in adherence could be quite small (i.e., restriction of range of responses). If this is the case, the impact of low BMI and other factors on subsequent pharmacokinetics could bias results to the null hypothesis, obscuring effects of relationship dynamics on drug levels that we would have found otherwise. Future studies should perform longitudinal assessment of hair antiretroviral drug levels and relationship dynamics to understand the contribution of interindividual and intraindividual variability to differences in adherence across time. Reasons for high adherence in our sample could be related to being married, older, and having multiple years of experience on ART. Future studies should examine whether relationship factors have a greater impact in populations with lower adherence such as young women and among individuals just starting ART.

Several strengths of this study are noteworthy. Methodologically, this research used relevant and novel approaches to reduce bias and enhance the significance of our findings. By incorporating both partners' accounts of their relationship into each predictor variable, this study sought to overcome some of the biases commonly seen in only individuals' self-reports. In addition, by examining partner reports of patients' adherence, we leveraged the dyadic nature of the study to bolster self-report measures. Furthermore, by showing even stronger associations when using partner-reported adherence, our results suggest that partner involvement may enhance not only adherence but also the accuracy of adherence-monitoring efforts by including partner reports. This finding is supported by other studies in the U.S. with gay male couples finding that partner reports of a patient's adherence to ART may be more closely associated with viral suppression status than the patients' own report of their adherence [46]. Therefore, for some patients who struggle with memory recall of missed pills (e.g., heavy alcohol users), including the primary partner in monitoring of the patient's adherence could be beneficial and be used to trigger clinical interventions for non-adherence.

Despite these strengths, our study had limitations. First, we did not collect data on viral load, which could have given us important clues about actual HIV clinical outcomes and insights into the meaning of our mismatched findings between subjective and objective adherence measures. Second, it is possible that couples who enrolled in the study might already have positive relationship dynamics as both partners decided to enroll, and it might not be rare for such couples to be equally optimistic. However, our prior work highlights the many challenges in this sample of couples including very high rates of intimate partner violence and marital conflict [14, 15]. Third, we would like to note that the confidence intervals for the findings are partner-reported adherence are wide and should be interpreted with caution. Given that primary partners are reporting on patient adherence to the best of their ability, there may be greater variability present in these data and these findings should be replicated in larger samples. Finally, the study was cross-sectional in nature, collecting data at a single point in time. This means that we are unable to assign directionality or causality to associations. It is possible, although less plausible, that missing pills or having poor adherence could damage the relationship, accounting for the association seen between low reported adherence and low relationship quality. For example, lower partner-reported adherence could cause an HIV-negative partner to fear becoming infected with HIV through their partner having a detectable viral load, leading to a strained relationship. Future studies should take a longitudinal, prospective approach to examining how relationship dynamics impact adherence to ART over time among couples living with HIV in order to tease apart the directions of such effects.

Conclusions

We found that relationship dynamics such as unity, satisfaction, and HIV treatment-specific partner support are associated with self and partner-reported ART adherence. We could not demonstrate the same associations using an objective measure of adherence, namely, ART drug levels in hair. Before concluding that drug levels in hair are a superior measure of adherence by overcoming self-report bias, more research is needed to rule out other issues that may impact hair drug levels. First, surveys on self-reports could include additional scales to capture social desirability bias and optimism in reporting to help disentangle whether participants who report favorably on their relationships also report more favorable adherence. Second, we recommend collecting additional clinical information such as BMI, liver function, and viral load to help tease out individual-level differences that may impact the hair results. Finally, longitudinal studies and additional research in populations with generally lower levels of adherence could help confirm the potential impact of relationship factors on adherence.

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Availability of data and material:

De-identified data is available upon request.

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Table 1.

Sample characteristics of HIV-affected married couples in the Umodzi M'Banja Study in Malawi (N=211 couples)

Variable	Total sample %, Mean (SD)	Men %, Mean (SD)	Women %, Mean (SD)	Intra-class correlation coefficient
Demographic characteristics				
Age (years)	40.5 (10.2)	43.5 (10.6)	37.4 (8.8)	
Education level				
Primary school or less	80.8	73.5	88.2	
Secondary school	18.7	25.6	11.8	
Tertiary school or higher	0.5	1.0	0.0	
Relationship characteristics				
Relationship duration (years)	12.5 (9.0)	12.92 (9.2)	12.1 (8.8)	
Sero-concordant positive	66.8	--	--	
Clinical characteristics				
Currently on ART (N=348)	98.8	98.3	99.4	
Length of time on ART (months; N=348)	58.1 (36.7)	54.9 (36.6)	61.2 (36.6)	
ART drug regimen (N=332)				
TDF/3TC/EFV (TDF analyzed)	90.1			
TDF/3TC + NVP (TDF analyzed)	3.3			
AZT/3TC/NVP (NVP analyzed)	3.3			
AZT/3TC + ATV/r (ATV analyzed)	2.1			
TDF/3TC + ATV/r (TDF analyzed)	0.9			
Positive relationship dynamics				
Intimacy (range: 1–5)	4.5 (0.6)	4.5 (0.6)	4.5 (0.7)	0.24^{***}
Trust (range: 15–40)	32.5 (5.8)	32.9 (4.8)	32.1 (6.6)	0.08
Unity (range: 1–7)	6.3 (1.1)	6.6 (0.9)	6.0 (1.3)	0.42^{***}
Relationship satisfaction (range: 1–5)	4.6 (0.6)	4.7 (0.6)	4.6 (0.6)	0.16^{*}
Commitment (range: 1–5)	4.6 (0.6)	4.6 (0.6)	4.6 (0.6)	0.15^{*}
HIV treatment-specific partner support (range: 0–45)	39.3 (7.0)	38.7 (7.9)	39.8 (6.2)	0.21^{*}
Engagement in HIV care and treatment (out of N=348)				

Variable	Total sample %, Mean (SD)	Men %, Mean (SD)	Women %, Mean (SD)	Intra-class correlation coefficient
Self-reported 90–100% adherence	95.6	96.4	94.8	
Partner-reported 90–100% adherence	96.1	92.4	99.4	
Missed 1+ HIV care appointment	23.6	19.2	27.8	
ART drug concentrations (log10 scale), ng/ml	−1.09 (0.67)	−1.03 (0.69)	−1.09 (0.66)	

The ICC was computed only for relationship dynamics collected from both partners.

* $p<.05$;

** $p<0.01$;

*** $p<0.001$

Table 2.

Unadjusted and adjusted odds ratios for associations between relationship dynamics and self- and partner-reported ART adherence among couples from Malawi

Explanatory variables (Couple-level)	Self-reported 90–100% adherence (334 individuals nested in 211 couples)		Partner-reported 90–100% adherence (326 individuals nested in 207 couples)	
	Unadjusted Odds Ratios (95% CI)	Adjusted Odds Ratios (95% CI)	Unadjusted Odds Ratios (95% CI)	Adjusted Odds Ratios (95% CI)
Intimacy	1.79 (0.62, 5.21)	2.07 (0.75, 5.68)	4.42 (1.91, 10.22)**	4.24 (1.48, 12.11)**
Trust	1.01 (0.91, 1.12)	1.05 (0.93, 1.18)	1.16 (1.02, 1.32)*	1.18 (1.00, 1.39)*
Unity (“We-ness”)	1.69 (1.07, 2.67)*	2.11 (1.23, 3.61)**	2.72 (1.70, 4.38)***	2.66 (1.45, 4.86)**
Relationship satisfaction	2.81 (1.12, 7.02)*	3.80 (1.50, 2.67)**	3.43 (1.38, 8.55)**	3.43 (1.16, 10.15)*
Commitment	1.70 (0.50, 5.83)	2.06 (0.58, 7.31)	4.86 (1.80, 13.09)**	5.88 (1.46, 23.60)*
HIV treatment-specific social support from partner	1.09 (1.02, 1.17)*	1.12 (1.04, 1.20)**	1.11 (1.04, 1.19)**	1.17 (1.04, 1.32)**

Multivariable models controlled for gender, age, years of education, household wealth score, relationship duration, couple HIV status, and length of time on ART.

† $p<0.10$;

* $p<.05$;

** $p<0.01$;

*** $p<0.001$

Table 3.

Unadjusted and adjusted coefficients for associations between relationship dynamics and antiretroviral drug levels in hair among couples from Malawi (332 individuals nested in 211 couples)

Explanatory variable (couple-level)	Unadjusted model Fold-effects[a], 95% CI	Adjusted model[b] Fold-effects, 95% CI
Intimacy	1.15 (0.62, 4.80)	1.20 (0.39, 3.69)
Trust	1.00 (0.98, 1.03)	1.00 (0.97, 1.02)
Unity (“We-ness”)	1.03 (0.92, 1.15)	1.01 (0.91, 1.13)
Relationship satisfaction	0.95 (0.79, 1.15)	0.92 (0.76, 1.12)
Commitment	0.99 (1.26, 1.59)	1.22 (0.96, 1.54)
HIV treatment-specific partner support	0.99 (0.98, 1.01)	0.99 (0.97, 1.01)

[a]Hair levels were logarithmically transformed for modeling purposes because raw differences of a given magnitude have differing meanings depending on whether hair levels are high or low and differing meanings across different drugs, while relative differences of a given magnitude remain comparably meaningful in these different situations. Regression coefficients were back-transformed from the log scale to obtain fold-effects.

[b]Multivariable models controlled for gender, age, years of education, household wealth index, relationship duration, couple HIV status, and length of time on ART.

† $p<0.10$;

* $p<.05$;

** $p<0.01$;

*** $p<0.001$