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Correlated depressive symptoms within seroconcordant, expectant partners living with HIV in Zambézia Province, Mozambique: a cross-sectional study

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ABSTRACT

Approximately 15% of people with HIV in sub-Saharan Africa have comorbid depression, which impacts treatment outcomes. We describe predictors of baseline depressive symptoms in 1079 female and 1079 male participants in a cluster-randomized trial in Zambézia Province, Mozambique from November 2017 to December 2020. We modeled each partners' depressive symptoms (Patient Health Questionnaire-9 [PHQ-9]) using proportional odds models adjusted for enrollment date, age, body mass index [BMI], partner's PHQ-9 score, district, relationship status, education, occupation, WHO HIV clinical stage, and antiretroviral therapy use history. A *post hoc* analysis assessed covariate-adjusted rank correlation between partner depressive symptoms. Females were younger than males (median 23 vs. 28 years) and more likely to report no education (20.7% vs. 7.9%). Approximately 10% screened positive for depression (PHQ-9 score $\geq$ 10). Partner depressive symptoms were predictive of higher participant PHQ-9 scores. A male partner PHQ-9 score of 10 (versus 5) increased the odds that the female partner would have a higher PHQ-9 score (adjusted odds ratio: 7.25, 95% Confidence Interval [CI]: 5.43–9.67). Partner PHQ-9 scores were highly correlated after covariate adjustment (Spearman's rho 0.65, 95% CI 0.57–0.72). Interventions aimed to reduce depressive symptoms and improve HIV-related outcomes during pregnancy should address both partners' depressive symptoms.

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HIV; sexual partners; depression; patient health questionnaire; nonparametric statistics; cross-sectional studies

Introduction

Depression is a key mediator of adherence to HIV treatment and retention in care in sub-Saharan Africa (SSA) (Kulisewa et al., 2019), where approximately 14% of people with HIV (PWH) on antiretroviral therapy and approximately 15% of all PWH have comorbid depression (Bernard et al., 2017; Lofgren et al., 2020; Nakimuli-Mpungu et al., 2012). Comorbid depression and HIV impact approximately 3.63 million people across SSA, accounting for approximately 1.57 million disability adjusted life years (Lofgren et al., 2020). The high prevalence of depression, coupled with suboptimal mental health resources, likely undermines HIV testing uptake, linkage to and adherence to treatment, retention in care, and viral suppression (Kulisewa et al., 2019; Nakimuli-Mpungu et al., 2012; (UNAIDS), 2014). While the impact of depression on the care cascade has been studied, there is an incomplete understanding of the impact of depression during pregnancy and the post-partum period among PWH. Pregnancy presents providers an ideal opportunity to intervene to advance the objectives of the 95-95-95 UNAIDS goals to reduce HIV transmission given that pregnancy requires repeated interactions with health systems (Roberts et al., 2021; UNAIDS, n.d.; World Health Organization, 2016).

Among pregnant women with HIV in SSA, unemployment, unplanned pregnancy, intimate partner violence, food insecurity, fewer years of education, lack of male partner involvement in pregnancy, severe HIV, advanced age, lower income, and stigma have been associated with more depressive symptoms (Ayano et al., 2018; Brittain et al., 2017; Kaida et al., 2010; Peltzer et al., 2016, 2018). Better physical health, social support, a longer period on antiretroviral therapy, and greater viral suppression (such as participation in prevention of maternal-to-child HIV transmission activities) have been associated with fewer depressive symptoms (Ayano et al., 2018; Brittain et al., 2017; Kaida et al., 2010; Peltzer et al., 2016, 2018). Relationship status (being single or never married) has variably been associated with increased or decreased depressive

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symptoms (Ayano et al., 2018; Brittain et al., 2017; Kaida et al., 2010; Peltzer et al., 2016, 2018). Antenatal depression is also associated with decreased HIV testing, adherence to and retention in HIV care (in most cases) (Cholera et al., 2017), and adverse maternal and infant outcomes; such as low birth weight, diarrheal illness, decreased exclusive breastfeeding, impaired postnatal growth and infant attachment, and decreased or delayed infant social development (Christodoulou et al., 2019; Gelaye et al., 2016; Kulisewa et al., 2019; Nakimuli-Mpungu et al., 2012; Peltzer et al., 2018; Rahman et al., 2004; Stewart, 2007; Tuthill et al., 2017).

Male partner depression may influence male partner involvement in care, partner support, relationship quality, intimate partner violence, and female partner depression, all of which also have implications for maternal and child health outcomes (Ayano et al., 2018; Brittain et al., 2017; Kaida et al., 2010; Peltzer et al., 2016, 2018). Among expectant fathers with HIV in SSA, little is known about how depression influences their own health or its impact on maternal and infant health outcomes. The available data on paternal depression, from Western Europe and the United States, suggests that children with depressed fathers have an increased risk of behavioral problems and poor psychosocial functioning (Feldman et al., 2020; Ramchandani et al., 2008; Sweeney & MacBeth, 2016). Unfortunately, little evidence exists on how paternal depression impacts physical health outcomes (Feldman et al., 2020; Ramchandani et al., 2008; Sweeney & MacBeth, 2016). Preliminary data also suggest that in older children, strong paternal mental health may be protective when a child's mother is experiencing depressive symptoms (Gere et al., 2013). However, we could not find any data on male partner depression from SSA.

Over the last decade, the mental health system in Mozambique has shifted from an inpatient model focused on patients with psychosis to also include outpatient care for mood disorders (Fabian et al., 2020; Santos et al., 2016; Wagenaar et al., 2016). However, depressive symptoms and suicidal ideation remain common (lifetime prevalence of 17–19%), undertreated – 26% of those with symptoms seek care and Mozambique has the sixth highest suicide rate in the world – and the mental health system struggles to achieve functional improvement (Fabian et al., 2020; Halsted et al., 2019; World Health Organization, 2014). Of the estimated 2.2 million PWH, approximately 15% have concurrent major depression (18% of women and 13% of men), although there are insufficient data on depression in pregnant women with HIV (AIDSinfo | UNAIDS, n.d.; Lofgren et al., 2020).

To better understand predictors of depression symptoms among pregnant women and their male partners, we used baseline, cross-sectional data from the *Homens para Saúde Mais* (HoPS+) (Men for Health Plus), a clustered randomized controlled trial in Zambézia Province, Mozambique. We describe the prevalence and predictors of depressive symptoms in 1079 pregnant women and their partners with HIV.

Material and methods

Participant selection and setting

We included baseline, cross-sectional data from 2158 participants in the HoPS + cluster randomized trial, which recruited patients in Zambézia Province, Mozambique from November 2017 to December 2020 (Audet, Graves, et al., 2018). Zambézia is a rural north-central province, with some of the lowest health and development indicators in Mozambique including a HIV prevalence of approximately 15%, one of the highest in the region (IaM, 2017; National Institute of Statistics (INE) (Mozambique), 2017).

The HoPS + protocol is detailed elsewhere (Audet, Graves, et al., 2018). Briefly, it enrolled 1079 couples with HIV (with a pregnant female partner >2 weeks from expected delivery date) between November 2017 and December 2020. Both partners were 18 years or older, provided informed consent, not currently on antiretroviral therapy, and willing to enroll in treatment together. This paper includes baseline data collected at participant recruitment for the 2158 individuals enrolled in the HoPS+ trial (1079 women and 1079 men). Data collection, validation, storage, baseline covariates, other psychometric scales, and missingness are described in the supplement.

Depressive symptoms

Depressive symptoms were measured with the Patient Health Questionaire-9 (PHQ-9), a nine-item scale that measures depressive symptoms over the previous two weeks (American Psychiatric Association, 2013; Kroenke et al., 2001). The PHQ-9 has been used and validated across SSA, including in Zambézia Province (Audet, Wainberg, et al., 2018; Cholera et al., 2014; Cumbe et al., 2020), and validated for antenatal depression screening (Sidebottom et al., 2012). Psychological services were available immediately for any participant who disclosed suicidal ideation (item nine) during the data collection process. Notably, PHQ-9 is only a measure of symptom severity, since major depressive disorder also requires functional impairment

and symptoms not attributable to another condition (American Psychiatric Association, 2013). Each item is scored from 0 (not at all) to 3 (nearly every day), which, when summed, results in total scores between 0 and 27 that can be characterized alternatively by level of symptom severity [minimal (0–4), mild (5–9), moderate (10–14), moderately severe (15–19), and severe (20–27)], intended action [none (0–4), clinical judgement (5–14), and treatment warranted (15–27)], or as a binary screening tool whereby patients with a threshold score of 10 or higher screen positive for depression (Kroenke et al., 2001).

While our primary analysis operationalized PHQ-9 score as a 0–27 ordinal outcome, we also included sensitivity analyzes with the following alternative PHQ-9 coding described above: symptom severity (five levels), intended action (three levels), and a dichotomous outcome (score of ≥10 or <10) (with logistic regression). We also modeled log PHQ-9 scores (with scores of 0 replaced with 0.1 to avoid missing outcomes) using least squares regression and included a "missing scenario" where all participants with missing PHQ-9 data were given a score of 0. Finally, we excluded partner PHQ-9 as a predictor in a *post-hoc* sensitivity analysis.

Statistical analysis

We present baseline, cross-sectional data from HoPS+ participants stratified by sex and whether PHQ-9 was missing. Categorical data are presented as frequencies and percentages, while continuous variables are presented as medians and interquartile ranges (IQR). For the stigma, social support, and empathy scale, medians and IQR are presented by sub-scale.

We elucidated predictors of the baseline depressive symptoms, modeled with ordinal logistic regression after checking the proportional odds assumption (Harrell, 2015; Liu et al., 2017), stratified by sex to avoid interdependence among partners. All model covariates were selected as likely predictors of depressive symptoms *a priori* based on subject area knowledge, available covariates, and the relevant literature (Ayano et al., 2018; Brittain et al., 2017; Kaida et al., 2010; Peltzer et al., 2016, 2018). Each model included continuous (each participant's enrollment date, age, total stigma, total social support, body mass index, partner's PHQ-9 score), categorical (district, relationship status, education, occupation, WHO HIV clinical stage), and binary (antiretroviral therapy status – new user versus restarting after 60+ days off treatment) covariates. Continuous variables were modeled using restricted cubic splines with three knots, categorical variables were collapsed if any category included fewer than 10 participants, and missing covariates were multiply imputed 20 times with chained equations model variables (Harrell, 2015; Harrell, 2020). Model results are presented as adjusted odds ratios (aOR) with 95% confidence intervals (CI) and were validated across 1000 bootstrapped samples. We used partial effects plots to assess the relationship between continuous covariates and median predicted PHQ-9 scores. Odds ratios for continuous covariates were calculated comparing an integer around the median (25 years, 25 kg/m^2, 500 days, and a score of 5, 50, and 30 for PHQ-9, social support, and stigma, respectively) with integers near the first and third quartiles of the distribution or, in the case of body mass index and PHQ-9 scores, clinically meaningful values. Finally, we did a *post hoc* analysis assessing the unadjusted and covariate-adjusted rank correlation between female and male partner depressive symptoms (PHQ-9 scores) (Liu et al., 2020). Baseline data were cleaned in *STATA* (version 16.0) (author AM) and all analyses were done in *R Statistical Software* (version 4.1.0) (author DS). All *R* code is available at https://github.com/dannysack/hops_baseline_depression

Ethics

All participants provided voluntary, written informed consent at enrollment and the HoPS+ study protocol was reviewed and approved by the Ministry of Health in Mozambique (FWA00003139 IRB00002657) and Vanderbilt University Medical Center Institutional Review Board (IRB) (FWA00005756, IRB00000475–7, IRB00002125).

Results

There were an equal number of female and male participants ($n = 1079$, by design) (Table 1). Female participants were younger than males (median age 23 vs. 28 years) and half of participants reported that they were living together, ~30% reported that they were single, and ~19% reported that they were married, with some minor discordance across couples (Table 1). More female than male participants reported no education (20.7% vs. 7.9%) and males were more likely to have attended or completed more than primary school (Table 1). Female participants were more likely to report that they were farmers (56.9% vs. 33%) or domestic workers (34.2% vs. 11.3%), whereas male participants were more likely to report that they were traders (16.8% vs. 0.5%) or fishermen (15.6% vs. 0.0%) (Table 1).

Most participants, female and male, were classified as World Health Organization (WHO) HIV clinical stage I (82%) and they had similar median body mass indices

Table 1. Participant characteristics by sex

	Female		Male	
	All ($n = 1079$)	Non-missing ($n = 874$)	All ($n = 1079$)	Non-missing ($n = 874$)
Enrollment year				
2017	37 (3.4%)	16 (1.8%)	37 (3.4%)	16 (1.8%)
2018	460 (42.6%)	347 (39.7%)	460 (42.6%)	343 (39.2%)
2019	346 (32.1%)	304 (34.8%)	346 (32.1%)	297 (34.0%)
2020	236 (21.9%)	207 (23.7%)	236 (21.9%)	218 (24.9%)
Age (years)				
Median [Q1, Q3]	23.0 [20.0, 28.0]	23.0 [20.0, 28.0]	27.5 [24.0, 32.0]	28.0 [24.0, 32.0]
Missing	0 (0%)	0 (0%)	1 (0.1%)	1 (0.1%)
District				
Pebane	292 (27.1%)	268 (30.7%)	292 (27.1%)	264 (30.2%)
Inhassunge	191 (17.7%)	179 (20.5%)	191 (17.7%)	177 (20.3%)
Namacurra	179 (16.6%)	161 (18.4%)	179 (16.6%)	160 (18.3%)
Mocubela	181 (16.8%)	90 (10.3%)	181 (16.8%)	96 (11.0%)
Maganja da Costa	114 (10.6%)	94 (10.8%)	114 (10.6%)	91 (10.4%)
Gilé	101 (9.4%)	67 (7.7%)	101 (9.4%)	71 (8.1%)
Quelimane	21 (1.9%)	15 (1.7%)	21 (1.9%)	15 (1.7%)
Relationship status				
Living together	549 (50.9%)	451 (51.6%)	548 (50.8%)	457 (52.3%)
Single	331 (30.7%)	272 (31.1%)	327 (30.3%)	269 (30.8%)
Married	198 (18.4%)	150 (17.2%)	201 (18.6%)	145 (16.6%)
Missing	1 (0.1%)	1 (0.1%)	3 (0.3%)	3 (0.3%)
Education				
None	223 (20.7%)	184 (21.1%)	85 (7.9%)	67 (7.7%)
Some Primary School (Grades 1–7)	684 (63.4%)	547 (62.6%)	578 (53.6%)	473 (54.1%)
Completed Primary School (Grade 7)	66 (6.1%)	54 (6.2%)	120 (11.1%)	86 (9.8%)
Some Secondary School (Grades 8–10)	66 (6.1%)	55 (6.3%)	170 (15.8%)	146 (16.7%)
Completed Secondary School (Grade 10)	23 (2.1%)	22 (2.5%)	67 (6.2%)	56 (6.4%)
College/Higher Education	17 (1.6%)	12 (1.4%)	57 (5.3%)	44 (5.0%)
Missing	0 (0%)	0 (0%)	2 (0.2%)	2 (0.2%)
Occupation				
Farmer	661 (61.3%)	576 (65.9%)	419 (38.8%)	339 (38.8%)
Domestic	396 (36.7%)	282 (32.3%)	150 (13.9%)	105 (12.0%)
Trader	6 (0.6%)	5 (0.6%)	179 (16.6%)	157 (18.0%)
Fisher	0 (0%)	0 (0%)	183 (17.0%)	156 (17.8%)
Other	14 (1.3%)	10 (1.1%)	145 (13.4%)	115 (13.2%)
Missing	2 (0.2%)	1 (0.1%)	3 (0.3%)	2 (0.2%)
Previous antiretroviral therapy				
No	800 (74.1%)	641 (73.3%)	870 (80.6%)	698 (79.9%)
Yes	260 (24.1%)	220 (25.2%)	187 (17.3%)	155 (17.7%)
Missing	19 (1.8%)	13 (1.5%)	22 (2.0%)	21 (2.4%)
WHO HIV clinical stage				
I	884 (81.9%)	713 (81.6%)	894 (82.9%)	718 (82.2%)
II	86 (8.0%)	73 (8.4%)	81 (7.5%)	70 (8.0%)
III	18 (1.7%)	15 (1.7%)	30 (2.8%)	27 (3.1%)
IV	1 (0.1%)	1 (0.1%)	2 (0.2%)	2 (0.2%)
Missing	90 (8.3%)	72 (8.2%)	72 (6.7%)	57 (6.5%)
Body mass index				
Median [Q1, Q3]	21.7 [19.9, 23.4]	21.7 [19.9, 23.5]	21.5 [19.9, 23.0]	21.5 [19.9, 23.0]
Missing	121 (11.2%)	98 (11.2%)	125 (11.6%)	103 (11.8%)
Perceived community stigma				
Median [Q1, Q3]	18.0 [8.00, 26.0]	17.0 [8.00, 26.0]	17.0 [8.00, 27.0]	17.0 [8.00, 27.0]
Missing	194 (18.0%)	105 (12.0%)	171 (15.8%)	69 (7.9%)
Participant felt/experienced stigma				
Median [Q1, Q3]	12.0 [9.00, 14.0]	12.0 [9.00, 14.0]	12.0 [9.00, 14.0]	13.0 [9.00, 14.0]
Missing	132 (12.2%)	56 (6.4%)	115 (10.7%)	40 (4.6%)
Perceived support				
Median [Q1, Q3]	26.0 [23.0, 28.0]	26.0 [23.0, 28.0]	26.0 [23.0, 28.0]	26.0 [23.0, 28.0]
Missing	70 (6.5%)	20 (2.3%)	68 (6.3%)	19 (2.2%)
Needed support				
Median [Q1, Q3]	30.0 [27.0, 32.0]	30.0 [28.0, 32.0]	30.0 [28.0, 32.0]	30.0 [28.0, 32.0]
Missing	101 (9.4%)	27 (3.1%)	104 (9.6%)	28 (3.2%)
Cognitive empathy				
Median [Q1, Q3]	19.0 [13.0, 23.0]	19.0 [13.0, 23.0]	21.0 [15.0, 24.0]	21.0 [15.0, 24.0]
Missing	246 (22.8%)	124 (14.2%)	223 (20.7%)	105 (12.0%)
Affective empathy				
Median [Q1, Q3]	11.0 [6.00, 15.0]	11.0 [6.00, 15.0]	11.0 [6.00, 16.0]	11.0 [6.00, 16.0]
Missing	240 (22.2%)	125 (14.3%)	215 (19.9%)	94 (10.8%)
HIV knowledge (0–27)				
Median [Q1, Q3]	17.0 [13.0, 21.0]	17.0 [13.0, 21.0]	18.0 [14.0, 21.0]	18.0 [14.0, 21.0]
Missing	358 (33.2%)	208 (23.8%)	333 (30.9%)	189 (21.6%)

(*Continued*)

Table 1. Continued.

	Female		Male	
	All ($n = 1079$)	Non-missing ($n = 874$)	All ($n = 1079$)	Non-missing ($n = 874$)
Patient health questionaire-9 (0–27)				
Median [Q1, Q3]	3.00 [0, 5.00]	3.00 [0, 5.00]	2.00 [0, 5.00]	2.00 [0, 5.00]
Missing	205 (19.0%)	0 (0%)	205 (19.0%)	0 (0%)
Patient health questionaire-9				
Minimal (0–4)	603 (55.9%)	603 (69.0%)	626 (58.0%)	626 (71.6%)
Mild (5–9)	162 (15.0%)	162 (18.5%)	145 (13.4%)	145 (16.6%)
Moderate (10–14)	59 (5.5%)	59 (6.8%)	66 (6.1%)	66 (7.6%)
Moderately severe (15–19)	39 (3.6%)	39 (4.5%)	31 (2.9%)	31 (3.5%)
Severe (20–27)	11 (1.0%)	11 (1.3%)	6 (0.6%)	6 (0.7%)
Missing	205 (19.0%)	0 (0%)	205 (19.0%)	0 (0%)

(females: 21.7; IQR 19.9–23.4, males: 21.5; IQR 19.8–23.0). Females had lower median cognitive empathy scores than males (19; IQR 13–23 vs. 21; IQR 15–24), but other psychometrics scales were similar regardless of sex (Table 1). Depressive symptom severity per the PHQ-9 was also similar regardless of sex, with approximately 10% of participants reporting symptoms that would denote a positive depression screen (i.e., PHQ-9 $\geq$ 10; approximately 12% when excluding those with missing PHQ-9 scores). These results were similar among participants with and without missing PHQ-9 scores.

The included PHQ-9 predictors largely had a similar magnitude and direction in female and male participants with non-missing outcome data ($n = 874$) (Figure 1 and Supplemental Figure 1). Low PHQ-9 scores in one partner were associated with low scores in the other partner and high scores in one partner were associated with high scores in the other partner. For example, among female participants, compared to a male partner PHQ-9 score of 5, a male partner's score of 10 was associated with an increased likelihood that the female participant had a one point or higher PHQ-9 score (aOR 7.25; 95% CI 5.43, 9.67). Partner PHQ-9 scores were also highly correlated (Spearman's rho 0.68) and remained correlated after adjusting for female and male characteristics (Spearman's rho 0.65; 95% CI 0.57, 0.72) (Figure 2).

Higher stigma scores (e.g., a total stigma score of 40 versus 30) were associated with an increase in females' likelihood of a one point or greater increase in PHQ-9 score (aOR 1.39; 95% CI 1.14, 2.69),

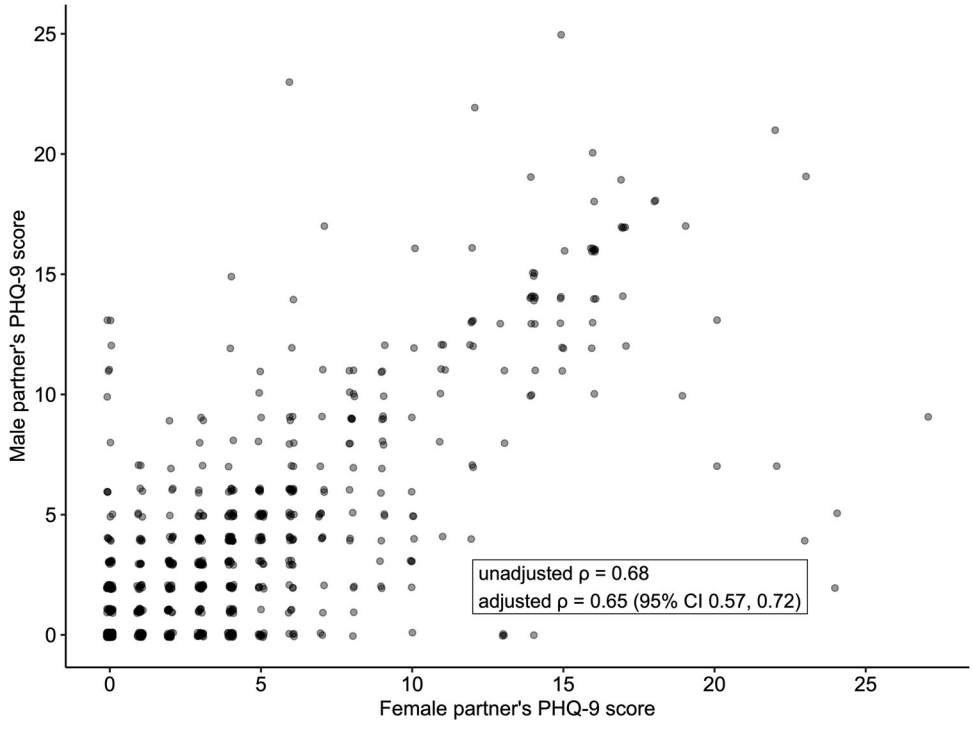

Figure 1. Predictors of depressive symptoms in female and male participants. This shows the predictors of depressive symptoms for female (orange) and male (purple) participants with non-missing outcome data ($n = 874$).

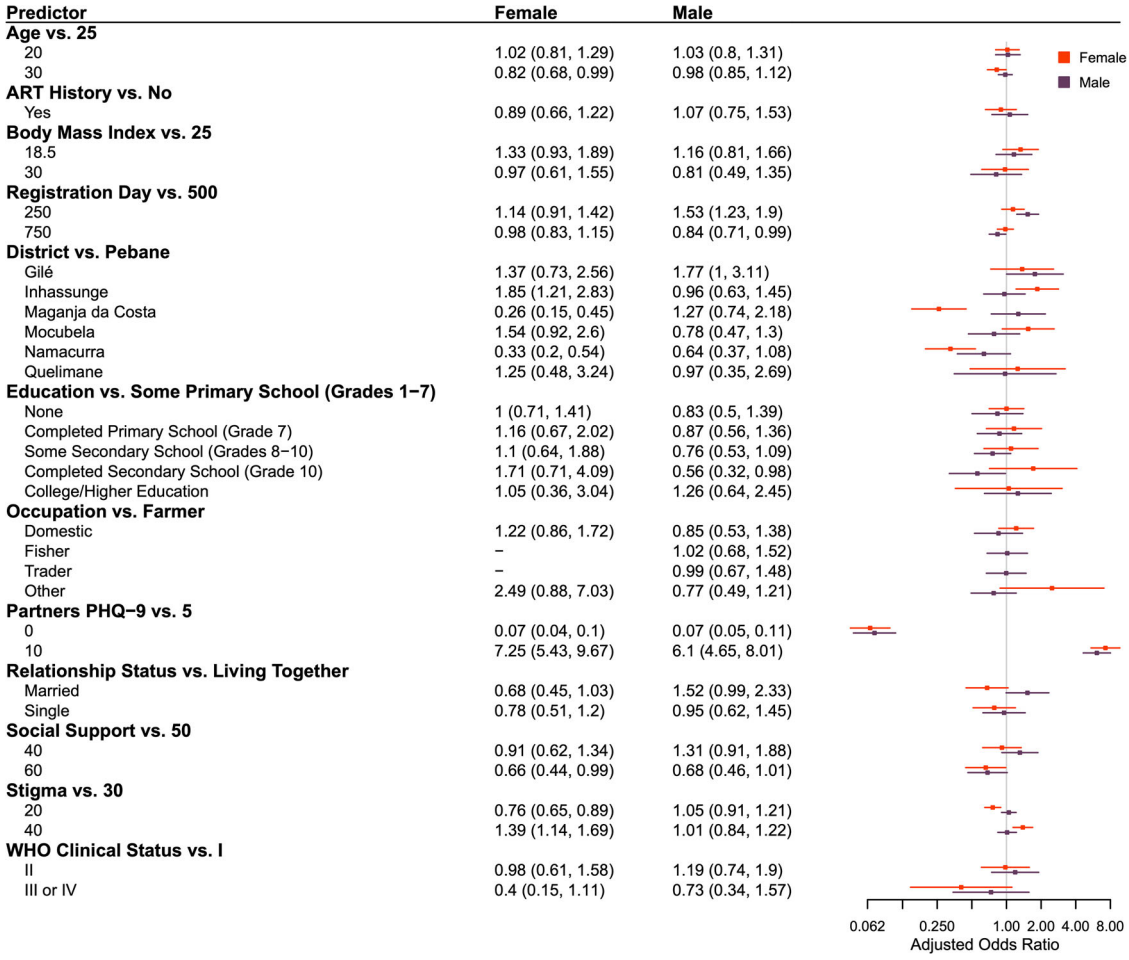

Figure 2. Female PHQ-9 scores (*x*-axis) plotted against male PHQ-9 scores (*y*-axis). This shows female Patient Health Questionaire-9 (PHQ-9) scores (*x*-axis) plotted against male PHQ-9 scores. Abbreviations: ρ (Spearman's rho); CI (confidence interval).

which was not the case among males (aOR 1.01, 95% CI 0.84, 1.22). There were also differential associations with depressive symptoms across districts. Married female participants were less likely to have a one point or higher PHQ-9 score (aOR 0.68; 95% CI 0.45, 1.03), whereas married male participants were more likely to have a one point or higher PHQ-9 score (aOR 1.52; 95% CI 0.99, 2.33; Figure 1). Both models met proportional odds assumptions and performed well across bootstrapped samples (Supplemental Figure 2, Supplemental Table 2).

Based on a series of sensitivity analyses, how we modeled the PHQ-9 outcome was largely irrelevant in most predictor coefficient estimates other than their level of uncertainty (which increased with fewer PHQ-9 categories) (Supplemental Tables 3 and 4). However, among males, having a college degree was not associated with an increased PHQ-9 score with a 27-level outcome (aOR 1.26; 95% CI 0.64, 2.45), but was highly associated with an increased PHQ-9 with a dichotomous outcome (aOR 3.40; 95% CI 1.24, 9.32) (Supplemental Table 4). Modeling the outcome as the log of PHQ-9 instead of ordinal decreased predicted PHQ-9 score precision and produced impossible values for males if their partner's PHQ-9 score was greater than 10 (Supplemental Figure 3). Finally, removing partner's PHQ-9 as a covariate increased the magnitude of the other covariates for both males and females (Supplemental Tables 3 and 4).

Discussion

In a descriptive cross-sectional study assessing predictors of depressive symptoms in pregnant women and their partners with HIV in rural Mozambique, we found that 10% screened positive for depression when presenting for antenatal care. This was similar, but slightly lower than both a household survey of female heads of household in the region (14%) (Audet, Wainberg, et al., 2018) and population-level estimates for PWH in Mozambique (12%) (Lofgren et al., 2020). The high prevalence of depressive symptoms among

pregnant women and their partners with HIV raises concerns that these individuals are at an increased risk of low adherence to and retention in HIV care and that their offspring are at increased risk of low birth weight, diarrheal illness, impaired growth, and poor infant attachment (Cholera et al., 2017; Christodoulou et al., 2019; Gelaye et al., 2016; Kulisewa et al., 2019; Nakimuli-Mpungu et al., 2012; Peltzer et al., 2018; Rahman et al., 2004; Stewart, 2007; Tuthill et al., 2017).

We also found partner PHQ-9 scores to be highly predictive of an individual's depressive symptoms. The relationship between depression within partners has been studied during various stages of pregnancy and the post-partum period, with a meta-analysis finding a small positive association between maternal and paternal depression (rho 0.31; 95% CI 0.23, 0.38) (Paulson & Bazemore, 2010). These studies were primarily conducted in high income countries and did not include PWH. The higher baseline rates of depression among PWH compared with the general population may explain the higher observed correlation among our participants. The meta-analysis concluded that understanding which partner's depressive symptoms manifest first (i.e., direction of causal effect) has not been elucidated and this research would benefit from more longitudinal assessments of depressive symptoms in partners (Paulson & Bazemore, 2010). Since our analysis was also cross-sectional, we could not assume temporality or causality (i.e., which partner's depressive symptoms manifest first), however, the HoPS+ study is well-poised to do so in future analyses. Furthermore, our population only included individuals newly starting or re-starting antiretroviral therapy, further limiting generalizability.

Finally, we found that higher levels of HIV stigma among females, but not males, were also associated with increased depressive symptoms. This aligns with findings in pregnant women with HIV in South Africa, where stigma modified the relationship between social support and depressive symptoms (Brittain et al., 2017). HIV stigma has also been associated with depressive symptoms in studies elsewhere in SSA that did not separate female and male individuals with HIV (Akena et al., 2012; Tesfaw et al., 2016). The relationship between HIV stigma and depression, however, will benefit from further investigation in longitudinal datasets.

We were reassured by the uniformity in our predictor effect across outcome definitions. The sensitivity analysis with imputed missing outcome values (to zero) revealed that outcome missingness may have been related to when an individual enrolled in the study (enrollment date) and what district they were enrolled in, which may reflect some initial difficulties with study administration. Though these findings require validation with longitudinal data, the high correlation between partners' depressive symptoms has important implications for intervention planning.

Our primary analyses analyzed PHQ-9 scores using the ordinal, 27-level outcome. Such an analysis has more power than analyses that categorize PHQ-9 scores at various thresholds, although our sensitivity analyses showed similar results after categorizing. Such an approach is also preferable to treating the ordinal PHQ-9 scores as a continuous outcome, which requires data transformation and stronger assumptions (Liu et al., 2017). When proportional odds assumptions are satisfied (as in our analyses), we suggest that an ordinal analysis should be considered the gold standard for PHQ-9 data.

A better understanding of the relationship between partners' depressive symptoms in the antenatal period could provide opportunities to address and improve mental health and HIV care and outcomes among PWH in Mozambique and beyond. This is especially relevant during the antenatal period, where pregnant women and their partners are more likely to interact with health systems. Although these findings represent a cross-sectional, baseline analysis from an ongoing cluster-randomized trial, we plan to assess the causal effects of partner depressive symptoms, and other predictors identified in this analysis, on maternal and infant outcomes at six, 12, and 18 months from trial onset in future analyses.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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Data availability statement

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

Geolocation statement

This study was conducted in Zambézia Province, Mozambique.

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