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Maternal Health Outcomes and Male Partner Involvement Among HIV Infected Women in Rural South Africa

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Abstract

Introduction This study aimed to investigate the association between Male Partner Involvement (MPI) and maternal health outcomes among women attending Prevention of Mother-to-Child Transmission of HIV (PMTCT) services in rural South Africa. The association between Male Partner Participation in the main study (MPP) and maternal health outcomes among these women was also investigated.

Methods The study utilized data collected from 535 HIV infected women in a randomized controlled trial between 2015 and 2016. Maternal health outcome data (delivery mode, pregnancy systolic and diastolic blood pressure, pregnancy body mass index, pregnancy CD4 count, and pregnancy viral load) were collected from the women's antenatal record forms accessed from the primary healthcare facilities. Bivariate and multivariable logistic regression models were used to estimate the association between socio-demographic characteristics of the women, MPI, and MPP with maternal health outcomes.

Results The mean age of the women was 29.03 years (SD = 5.89). No significant associations were found between MPI and any of the maternal health outcomes contrary to what was hypothesized. Both the bivariate and multivariate analysis indicated a significant association between MPP and higher pregnancy viral load, contrary to the study hypothesis. Insignificant associations were found between MPP and both pregnancy CD4 count and pregnancy blood pressure. The only significant association between maternal health outcomes and socio-demographic characteristics, was between educational attainment and higher pregnancy CD4 count in both the bivariate and multivariate analysis.

Conclusion for Practice The study showed no significant support for MPI in improving maternal health outcomes of women in PMTCT in rural South Africa. Future studies should include additional maternal health outcomes for investigation.

Keywords Maternal health outcomes · Male partner involvement · HIV positive women · PMTCT

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Significance Statement

Male partner involvement has led to improved maternal health outcomes. However, little is known regarding the association between MPI and maternal health outcomes in the context of PMTCT in rural South Africa. This study proposed that male partner involvement in PMTCT will lead to improved maternal health outcomes (i.e. normal delivery, normal pregnancy systolic and diastolic blood pressure, normal pregnancy body mass index, higher pregnancy CD4 count, and lower pregnancy viral load). Contrary to what was hypothesized, no significant associations were found between MPI and any of the maternal health outcomes under investigation. Additional maternal health outcomes should be investigated as this information is important for planning and development of interventions aimed at increasing male partner involvement in PMTCT programs.

Introduction

Over 99% of maternal deaths occur in low and middle-income countries, with nearly half of these taking place in Sub-Saharan Africa (Africa Progress Panel 2010). Women living in Sub-Saharan Africa have a higher risk of dying while giving birth than women in any other region of the world. An estimated 10 million women survive pregnancy each year, yet experience some type of severe negative maternal health consequence (Africa Progress Panel 2010). Maternal health refers to the health of women during pregnancy, childbirth, and the postpartum period (WHO 2017a). Motherhood is often a positive and fulfilling experience and yet is associated with suffering, ill-health, and even death for too many women (WHO 2017a). The major direct causes of maternal morbidity and mortality include hemorrhage, infection, high blood pressure, unsafe abortion, and obstructed labour (WHO 2017a).

Growing evidence has shown that male partner involvement promotes better maternal and newborn health outcomes (Yargawa and Leonardi-Bee 2015; Msuya et al. 2008; Farquhar et al. 2004). Positive maternal health outcomes may include the use of skilled health care during pregnancy, birth, and after birth, which encompasses the use of Skilled Birth Attendant (SBA) and health facility-based delivery. None experience of complications during pregnancy and birth, and surviving birth are also some of the positive maternal health outcomes. Furthermore, maternal health outcomes among pregnant HIV positive women include their immunological (i.e. CD4 count) and virological profiles (i.e. viral load).

Male partner involvement may be defined using a single activity such as men attending Antenatal Care (ANC) visits with their pregnant partners, and many other activities to support pregnant partners. For example, previous studies have defined male partner involvement in maternal health and related care as men taking part in their pregnant partners' birth plans, encouraging exclusive breastfeeding and immunization for their children, supporting their partners, and communicating about pregnancy-related health care (Bhatta 2013; Montgomery et al. 2011). Other studies have defined male partner involvement as male partner participation in HIV testing solely during ANC (Byamugisha et al. 2011; Ditekemena et al. 2011; Msuya et al. 2008), while others defined it as male partner participation in couple counseling (Byamugisha et al. 2010; Reece et al. 2010; Nkuoh et al. 2010). In most instances, male partner involvement has been defined as a man's physical presence in the antenatal or postnatal clinic with his female partner, which is the most commonly used measure of male partner involvement (Montgomery et al. 2011).

Male partner involvement may also be defined using an index to capture a broader notion of MPI that includes aspects such as, accompaniment to antenatal care appointments, couple communication, knowing the ANC schedule, discussing the ANC/PMTCT interventions with a female partner; supporting the ANC fees, knowing what happens at the ANC visit, and condom use with the female partner during current pregnancy (Ampt et al. 2015; Byamugisha et al. 2010; Matseke et al. 2017).

Studies have demonstrated that even though MPI is one of the most challenging aspects of the PMTCT protocol, it has led to improved health and PMTCT outcomes in women and infants (Msuya et al. 2008; Farquhar et al. 2004; Aguiar and Jennings 2015). In a review of seven studies, to ANC by male partner positively impacted women's knowledge of danger signs, but did not affect birth preparedness, ANC utilization, or miscarriages (Aguiar and Jennings 2015). Furthermore, during labor and delivery, men's presence at ANC was associated with increases in health facility-based delivery and SBA, but with no effect for birth-related outcomes (Aguiar and Jennings 2015). Male partner accompaniment to ANC was associated with higher uptake of postnatal care services, but with mixed effects on breastfeeding and newborn survival (Aguiar and Jennings 2015).

Another systematic review of 14 male partner involvement studies indicated that MPI was significantly associated with reduced odds of postpartum depression and decreased likelihood of childbirth complications (Yargawa and Leonardi-Bee 2015). Other maternal health-related outcomes that have been associated with MPI were reduced maternal smoking, reduced risk of pre-term birth, and reduced infant mortality (Carter 2002; Alio et al. 2013, 2011). Studies found an association between male partner attendance at ANC and delivery by a skilled birth attendant (Mangeni

et al. 2013). Similarly, male partner attendance at ANC was associated with higher odds of women giving birth at a health facility (Kalembo et al. 2013; Chattopadhyay 2012; Tweheyo et al. 2010). In contrast, in Nepal, no significant differences were found in health facility-based delivery rates or birth attendance by a skilled provider between women randomized to receive antenatal education with their husbands compared to women receiving antenatal education alone (Mullany et al. 2007). Mode of delivery (i.e. birth by cesarean-section or vaginal birth) was not associated with male partner involvement among HIV positive women in Malawi (Kalembo et al. 2013). In South Africa, there was no statistically significant difference in stillbirths between women randomized to receive or not receive ANC counseling with their male partners (Kunene et al. 2004).

Mother-to-Child-Transmission of HIV (MTCT) is known to be also influenced by the virological profile of pregnant HIV positive women (Njom et al. 2011). Maternal viral load has been proven to be the strongest predictor of vertical transmission of HIV. Rates of MTCT has been estimated at 0.3% when a maternal viral load is < 1000 copies/ml, at 3% between 1000 and 10,000 copies/ml, and at 7% when a viral load is > 10,000 copies/ml (Njom et al. 2011; Mayaux et al. 1997; Fawzi et al. 2001). Furthermore, two consecutive measurements showing a viral load of fewer than 1000 copies/ml indicates HIV treatment success (WHO 2017b). According to WHO (2017b), CD4 count is the best predictor for disease status and immediate risk of death and should be used to identify people with advanced HIV disease. People with a CD4 count of 200 or less are considered to be at risk of HIV related illness, while the risk is lower at a CD4 count of over 350 (Jung et al. 1998; Hughson 2017).

Maternal body mass index (BMI) and weight gain during pregnancy are known to be associated with perinatal outcomes (Ota et al. 2011). Low BMI and suboptimal weight gain during pregnancy are long-recognized risk factors for the delivery of infants too small for gestational age (Ota et al. 2011). However, the impact of MPI on these factors has not been reported in South Africa and elsewhere.

The influence of male partner involvement on maternal Blood Pressure (BP) levels has not been documented. According to South African BP guidelines, normal or healthy BP is 139/89 mmHg or less, that is, a systolic BP of 139 mmHg or less and a diastolic BP of 89 mmHg or less (The Heart and Stroke Foundation South Africa 2017). The BP measurements above 139/89 mmHg are considered to be high or hypertensive and therefore not normal. The American Heart Association (2019) adheres to slightly different BP guidelines, where BP measurements below 120/80 mmHg are considered to be normal while levels from 120/80 show elevated BP levels. Blood pressure measurements from 130/89 mmHg indicate the onset of hypertension according to the American Heart Association (2019).

Ample evidence has been documented on the effects of male partner involvement on maternal health outcomes during pregnancy, labour, delivery, and postnatal. However, an investigation on the influence of male partner involvement on maternal health outcomes in the context of PMTCT is also of importance. This study hypothesized that male partner involvement will be associated with better maternal health outcomes, that is, delivery by natural birth, normal systolic and diastolic BP, normal BMI, higher CD4 count, and lower viral load. Also, this study hypothesized that male partner participation in the main study (i.e. in the randomized controlled trial) will be associated with better maternal health outcomes (i.e., delivery by natural birth, normal systolic and diastolic BP, normal BMI, higher CD4 count, and lower viral load).

This study seeks to investigate the influence of male partner involvement on maternal health outcomes in HIV infected women attending PMTCT services in primary healthcare facilities in Mpumalanga, South Africa. The influence of male participation in the main study (i.e., actual co-enrollment of a male partner in the study as a participant together with their female HIV positive partner) on maternal health outcomes in the same sample was also investigated in this paper.

Methods

Study Setting

This study utilized secondary data collected cross-sectionally in the baseline phase of the "Protect Your Family (PYF)" clinic-randomized controlled trial aimed at increasing the adherence and uptake of PMTCT protocols and increase male partner involvement in ANC and postnatal care processes in twelve community health centers based in Gert Sibande and Nkangala districts in Mpumalanga province, South Africa (Jones et al. 2014). The PYF clinic-randomized controlled trial protocol has been published (Jones et al. 2014) and is registered on clinicaltrials.gov, number NCT02085356. The baseline data were collected during the recruitment phase of the clinic randomized controlled trial from April 2015 to January 2017.

Participants and Procedures

Maternal health data for 686 HIV infected women was collected from clinic records. However, the data were available for 535 women while the rest was unavailable due to missing clinic records. To be eligible for participation in the study, women had to be 24 weeks (6 months) or less

pregnant, 18 years and older, HIV seropositive, and have a male partner.

Interested participants were offered an appointment and enrolled after the provision of informed consent. Once enrolled, all participants completed an assessment in their preferred language (English, isiZulu, or Sesotho) to enhance disclosure and accommodate different levels of literacy. Assessors were available at all times and completed the demographic component of the questionnaire first with participants, as a way to familiarize the participants with the software program (see measures).

Measures

The cross-sectional data collection instrument was developed through the Questionnaire Development System's (QDS) Audio Computer-Assisted Self-Interview (ACASI) software. The data collection instrument included sections regarding demographic information, sexual diary, intimate partner violence, stigma, male partner involvement, HIV knowledge, and other additional sections such as HIV medication adherence and family planning assessment.

The section regarding socio-demographic information included questions in relation to participants' age, language, religion, level of education, employment status, relationship status, income, and number of children.

Male Partner Involvement (MPI) served as the primary dependent variable. The Male Partner Involvement Index was used as adapted from a previous similar studies (Jones et al. 2014; Byamugisha et al. 2010), and comprised of 11 items related to the male partners' participation in specific areas of ANC, including PMTCT. Items included, "male partner attend antenatal care visits with you, male partner know your antenatal appointment time, discussed antenatal HIV prevention for your baby with your male partner, male partner support your antenatal visits financially, male partner know what happens in the antenatal clinic, after testing for HIV, partner asked to take an HIV test, told partner that you were told to take ARV drugs (HIV medication), discussed feeding options for your baby with your partner, discussed the place of delivery for the baby with your partner, discussed testing your baby for HIV with your partner, and discussed condom use with your partner". All items were summed up to form a scale or composite MPI variable, with scores from 0 to 11. Since there were only 28 women who had a total score of '0' on the scale, scores were then coded as "0" and "1". Code "1" indicated scores of 2 or more which included "male partner attends ANC visit with you", while "0" indicated a score of 1 or less and did not include "male partner attends ANC visit with you". This approach was motivated by the fact that previous studies showed that the most commonly used measure of male partner involvement in maternal health and related care was men attending ANC visits with their pregnant partners.

Male Partner Participation (MPP), the actual co-enrollment of the male partner with a female partner in the main study (i.e., in the "PYF" clinic-randomized controlled trial) was also considered as a dependent variable. Participation of a male partner has been coded as "0" for non-participation in the study and "1" for participation in the study. Male partners completed separate assessments, corresponding to female assessments, upon co-enrollment.

Maternal health outcome measures. Measures of maternal health outcomes, considered as the independent variables in this paper, were collected from women's (female partners) clinic records/forms during pregnancy and after delivery. A data collection form designed specifically for this purpose was used. Outcomes recorded at first ANC visit included BMI, weight, height, BP, and current illnesses while CD4 count and viral load were recorded at subsequent ANC visits upon availability of the results. Outcomes recorded after delivery included delivery mode, birth complications, and place of delivery. Data collectors indicated a "yes" or "no" for preterm birth, birth complications, alcohol use, and smoking.

Pregnancy BP. Both Systolic BP and Diastolic BP were assessed separately in this paper, with 'Normal BP (below 120/80 mmHg)' and 'Elevated BP (from 120/80 mmHg)' as categories for each. The cut-off points for the two BP categories were determined using the BP guidelines from the American Heart Association (2019). The South African BP guidelines could not be used, as was initially intended, since the cut-off points (i.e., 139/89 mmHg or less and above 139/89 mmHg) were too high and yielded a very low prevalence in one of the categories, making it impossible to run the analyses.

Pregnancy BMI. This outcome was recorded in some clinic forms. In clinic forms where the BMI was not recorded, it was calculated using the recorded "weight" and "height" of the women.

Pregnancy CD4 count. Pregnancy CD4 count was a once-off measurement as per the antenatal clinic form. The cut-off points for the two CD4 count categories were '$< 350/mm^3$' and '$\geq 350/mm^3$'.

Pregnancy Viral load. Although the antenatal clinic form allows recording of up to three viral load measurements, only one viral load measurement was recorded in all the women's forms. The cut-off points for the two viral load categories (< 1000 copies/ml and ≥ 1000 copies/ml) were determined according to the possible lowest (0.3%) and high rates (3% to 7%) of MTCT as already documented in the literature above.

Birth complications. This outcome could not be part of the analyses as there were only three (3) women with birth complications out of a total of the twenty-three (23)

recorded. This means that this outcome was not recorded for the majority of the women in the study.

Preterm birth. Clinic records indicated either "yes" where preterm birth occurred or "no" where preterm birth did not occur.

Delivery mode. This outcome comprised of "natural birth" or "C-section" as the mode of delivery/ birth.

Place of delivery. Clinic records indicated the place of birth/delivery as either "hospital" or "clinic". Similar to birth complications above, this outcome was not recorded for the majority of the women in the study and thus was dropped out of the analyses.

Alcohol use during pregnancy. Clinic records indicated "yes" for women who used alcohol and "no" for women who did not use alcohol during pregnancy. This measure was self-reported and was recorded once-off by clinic nurses during ANC.

Smoking during pregnancy. Clinic records indicated "yes" for women who smoked and "no" for women who did not smoke. Smoking was a self-reported measure recorded once-off by clinic nurses during ANC.

Ethical Considerations

Approval to conduct the study was obtained from the Human Sciences Research Council (HSRC) Research Ethics Committee, the University of Miami Institutional Review Board, and the Mpumalanga Department of Health and Welfare (at provincial, district, sub-district and clinic levels).

All study procedures were in accordance with the ethical standards of the institutional research committees and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Written informed consent for participation was obtained from each study participant.

Data Analyses

Data analyses were conducted using SPSS version 24. Univariate analyses were utilized to describe the demographic and socioeconomic characteristics of the women in the study. T-tests and chi-square tests were used to estimate associations between independent variables and maternal health outcomes. Variables associated with maternal health outcomes were included in subsequent models as covariates to estimate the associations between male involvement, male participation, and maternal health outcomes. Then, a series of bivariate and multivariable logistic regression models were used to estimate unadjusted and adjusted associations between demographic and socioeconomic characteristics of the women, male involvement, and male participation in the study with maternal health outcomes (pregnancy BP, pregnancy CD4, and pregnancy viral load). A cutoff of $p < 0.050$ was used for statistical significance.

Delivery mode, preterm birth, place of delivery, alcohol use during pregnancy, and smoking during pregnancy were all dropped out the analyses due to low prevalence in one of the response categories, which prevented model estimation.

Results

Sample Characteristics

Socio-demographic Characteristics

Table 1 indicates the characteristics of a sample of 535 HIV positive women in this study. The mean age of the women was 29.03 (SD = 5.89). The majority (66.0%) of the women had educational attainment of less than grade 12, were unemployed (75.8%), and had an income of less than R1000 (75.5%). Just above three-quarters (78.6%) of the women had at least one child. Over half (53.5%) of the women were living together with their male partners while 46.5% were living separately from their partners. An overwhelming majority of the women indicated not using alcohol (93.3%) and not smoking (96.1%).

Anthropometric Measurements, Immunological and Virological Profile of Women

The mean pregnancy BMI of the women in this study was 26.55 (SD = 6.19), as indicated further down in Table 1. An overwhelming majority (90.5%) of the women had a natural birth. Over half (53.4%) of the women had a normal systolic BP while 46.6% had elevated systolic BP. Just above two-thirds (68.8%) of the women had a normal diastolic BP while 31.2% had elevated diastolic BP. About 82.3% of the women had a pregnancy viral load of fewer than 1000 copies/ml while 17.7% had had a pregnancy viral load of ≥ 1000 copies/ml. Over two-thirds (69.2%) of the women had a pregnancy CD4 count of more than 350/mm^3 while 30.8% had a pregnancy CD4 count of less than 350/mm^3.

Associations Between MPI and Maternal Health Outcomes

Table 2 shows the results of the logistic regression analysis predicting pregnancy BP. Results of the bivariate analysis (unadjusted logistic regression model) indicated that pregnancy BP was not significantly associated with MPI, MPP, age, educational attainment, relationship status, employment status, income, and the number of children. Similarly, in the

Table 1 Maternal factors associated with male involvement in PMTCT (N = 535)

Characteristics	No male partner involvement	Male partner involvement	Total	t/X^2	p-value
Socio-demographic					
Age	29.03 (5.89)	28.27 (5.84)	28.78 (5.88)	1.39	0.38
Educational attainment					
Less than grade 12	215 (61.6%)	130 (74.7%)	345 (66.0%)	8.89	0.003
Grade 12 or more	134 (38.4%)	44 (25.3%)	178 (34.0%)		
Relationship status					
Living together	199 (57.0%)	81 (46.6%)	280 (53.5%)	5.12	0.024
Not living together	150 (43.0%)	93 (53.4%)	243 (46.5%)		
Number of children					
None	78 (22.3%)	34 (19.5%)	112 (21.4%)	0.55	0.46
One or more	271 (77.7%)	140 (80.5%)	411 (78.6%)		
Employment status					
Employed	249 (71.3%)	143 (82.2%)	392 (75.0%)	7.26	0.007
Not employed	100 (28.7%)	31 (17.8%)	131 (25.0%)		
Income					
R1000	251 (71.9%)	144 (82.2%)	395 (75.5%)	7.38	0.007
≥ R1000	98 (28.1%)	30 (17.2%)	128 (24.5%)		
Maternal health outcomes					
Delivery mode					
Natural	308 (90.9%)	166 (89.7%)	474 (90.5%)	0.18	0.675
C-section	31 (9.1%)	19 (10.3%)	50 (9.5%)		
Pregnancy systolic blood pressure					
Normal blood pressure	174 (51.6%)	98 (57.0%)	272 (53.4%)	1.31	0.253
Elevated blood pressure	163 (48.4%)	74 (43.0%)	237 (46.6%)		
Pregnancy diastolic blood pressure					
Normal blood pressure	222 (66.7%)	125 (73.1%)	347 (68.8%)	2.18	0.14
Elevated blood pressure	111 (33.3%)	46 (26.9%)	157 (31.2%)		
Pregnancy BMI	26.74 (6.75)	26.08 (5.19)	26.55 (6.19)	0.96	0.337
Pregnancy CD4 count					
$< 350/mm^3$	113 (32.4%)	48 (27.6%)	161 (30.8%)	1.25	0.263
$\geq 350/mm^3$	236 (67.6%)	126 (72.4%)	362 (69.2%)		
Pregnancy viral load (copies/ml)					
< 1000	261 (81.8%)	135 (83.3%)	396 (82.3%)		
≥ 1000	58 (18.2%)	27 (16.7%)	85 (17.7%)	0.53	0.768
Behavioural					
Alcohol use during pregnancy					
No	322 (92.5%)	177 (94.7%)	499 (93.3%)	0.87	0.35
Yes	26 (7.5%)	10 (5.3%)	36 (6.7%)		
Smoking during pregnancy					
No	335 (96.5%)	178 (95.2%)	513 (96.1%)	0.59	0.442
Yes	12 (3.5%)	9 (4.8%)	21 (3.9%)		

multivariate analysis (adjusted logistic regression model) pregnancy BP was not significantly associated with MPI, MPP, and any of the socio-demographic characteristics.

Table 3 shows the results of the logistic regression analysis predicting pregnancy CD4 count. Bivariate analysis results showed that pregnancy CD4 count was not significantly associated with MPI, age, relationship status, employment status, income, and the number of children. Results of the multivariate analysis indicated that there was no significant association between MPI and pregnancy CD4 count as hypothesized. No significant association was found between MPP and pregnancy CD4 count in both the bivariate and multivariate analyses. However, there was a significant association between

Table 2 Unadjusted and adjusted logistic regression models predicting pregnancy blood pressure (N = 522)

Predictor	Unadjusted OR [95% CI]	p-values	Adjusted OR [95% CI]	p-values
Age	1.02 [0.99, 1.05]	0.302	1.02 [0.99, 1.06]	0.27
Educational Attainment (ref = less than grade 12)	1.03 [0.71, 1.48]	0.879	0.95 [0.65, 1.39]	0.79
Relationship status (ref = not living together)	0.92 [0.65, 1.30]	0.622	0.91 [0.62, 1.33]	0.63
Employment Status (ref = unemployed)	1.38 [0.92, 2.07]	0.116	1.31 [0.82, 2.1]	0.256
Income (ref = R1000)	1.11 [0.74, 1.66]	0.618	0.93 [0.57, 1.51]	0.769
Number of Children (ref = none)	0.90 [0.58, 1.39]	0.622	0.81 [0.49, 1.34]	0.414
Male partner involvement	0.80 [0.56, 1.16]	0.247	0.84 [0.57, 1.23]	0.364
Male partner participation	1.01 [0.67, 1.50]	0.978	1.14 [0.75, 1.74]	0.536

Table 3 Unadjusted and adjusted logistic regression models predicting pregnancy CD4 count (N = 522)

Predictor	Unadjusted OR [95% CI]	p-values	Adjusted OR [95% CI]	p-values
Age	0.98 [0.95, 1.01]	0.116	0.96 [0.95, 1.02]	0.416
Educational Attainment (ref = less than grade 12)	1.80 [1.20, 2.69]	0.005	1.84 [1.120, 2.83]	0.005
Relationship status (ref = not living together)	1.00 [0.70, 1.45]	0.987	1.04 [0.69, 1.57]	0.836
Employment Status (ref = unemployed)	0.75 [0.50, 1.13]	0.174	0.76 [0.47, 1.24]	0.273
Income (ref = R1000)	0.81 [0.54, 1.22]	0.316	0.93 [0.56, 1.54]	0.763
Number of Children (ref = none)	1.01 [0.64, 1.58]	0.979	1.21 [0.71, 2.05]	0.483
Male partner involvement	1.26 [0.84, 1.88]	0.264	1.29 [0.85, 1.96]	0.231
Male partner participation	1.05 [0.69, 1.61]	0.808	0.99 [0.63, 1.55]	0.963

Table 4 Unadjusted and adjusted logistic regression models predicting pregnancy viral load (N = 500)

Predictor	Unadjusted OR [95% CI]	p-values	Adjusted OR [95% CI]	p-values
Age	0.97 [0.93, 1.01]	0.117	0.98 [0.93, 1.02]	0.316
Educational Attainment (ref = less than grade 12)	0.66 [0.39, 1.10]	0.108	0.63 [0.37, 1.08]	0.095
Relationship status (ref = not living together)	0.83 [0.52, 1.33]	0.438	0.84 [0.49, 1.42]	0.505
Employment Status (ref = unemployed)	1.05 [0.62, 1.79]	0.865	1.24 [0.67, 2.29]	0.487
Income (ref = R1000)	0.74 [0.42, 1.30]	0.295	0.84 [0.43, 1.62]	0.593
Number of Children (ref = none)	0.71 [0.42, 1.22]	0.218	0.94 [0.49, 1.82]	0.864
Male partner involvement	0.89 [0.54, 1.47]	0.654	0.77 [0.46, 1.29]	0.320
Male partner participation	2.21 [1.16, 4.21]	0.016	2.59 [1.3, 5.14]	0.007

higher levels of educational attainment and higher pregnancy CD4 count in both the bivariate and multivariate analyses.

Table 4 shows the results of the logistic regression analysis predicting pregnancy viral load. Results of both the bivariate and multivariate analyses showed that MPI,

age, educational attainment, relationship status, employment status, income, and the number of children were not significantly associated with pregnancy viral load. However, there was a significant association between higher pregnancy viral load and MPP in the study in both the bivariate and multivariate analyses.

Discussion

Motherhood is often associated with worse health outcomes, such as high blood pressure, hemorrhage, pregnancy complications, and birth complications. Despite the growing evidence that male partner involvement promotes better maternal health outcomes, the results of this study did not support this notion. Contrary to what has been hypothesized, the final results of this study indicated that there was no association between male partner involvement and any of the maternal health outcomes under investigation (i.e., delivery mode, pregnancy systolic and pregnancy diastolic blood pressure, pregnancy body mass index, pregnancy CD4 count and pregnancy viral load). Male partner participation in the study was, however, associated with higher pregnancy viral load of the women while pregnancy CD4 count and pregnancy BP were not.

Male partner involvement in ANC encompasses multiple activities and includes aspects such as accompaniment to ANC appointments, knowing the ANC schedule, and couple communication (Ampt et al. 2015; Byamugisha et al. 2010; Matseke et al. 2017). Prior research has demonstrated an association between couple communication and increased knowledge of maternal and reproductive health (Valente and Shaba 2001; Mutombo et al. 2014). Informing men about the importance of healthy practices such as proper nutrition and delivery in a health facility implies that they may have been more likely to encourage the adoption of these behaviours by their partners (Aguiar and Jennings 2015). The 'male partner involvement' measure in this study includes couple communication regarding ANC and PMTCT matters affecting both the women and unborn infants. Informing men regarding these matters means they might be more likely to encourage adoption of health-promoting behaviours such as non-alcohol use and non-smoking or smoking cessation among women in this study. The fact that an overwhelming majority of women in this study indicated not using alcohol (93.3%) and not smoking (96.1%) should be acknowledged. However, determination of the association between male partner involvement and alcohol use and smoking in this study has not been possible due to low prevalence issues which prevented statistical analyses.

The association between male partner participation in the study and higher pregnancy viral load among women may be difficult to explain. A high viral load is a risk for HIV progression, usually indicates a low CD4 count which in turn is a sign of advanced HIV disease and illness. In this study, it might mean that women with higher viral loads in this study might have been experiencing more illnesses in their prenatal and postnatal periods and as a result, solicited all the support (including accompaniment to clinics) they could get from their male partners. Participation in the study by male partners of these women might have been easier due to their availability, by virtue of already being in the clinics with their female partners for antenatal and postnatal visits.

There may be other important factors, moderators, and mediators that are not assessed and that could have uncovered more complex relationships and pathways between male partner involvement and maternal health outcomes. Future studies could also expand on this research by including more maternal health outcomes (such as pregnancy and birth complications, place of delivery, and hemorrhage) for investigation.

Limitations

Although the results of this study provide important information for consideration by policymakers in the maternal and child health programs, certain limitations should be noted. Study limitations included the low prevalence of some of the maternal health outcomes which prevented some of the statistical analyses.

Also, although the original sample size was N = 686, 535 women had available data on maternal health outcomes. Although antenatal record forms allow recording of up to three viral load measurements, only one viral load measurement was recorded on all the forms.

In this study, male partner involvement was measured using a scale that quantifies MPI as participating in antenatal care. A more comprehensive measure of male involvement may be needed, particularly one that is specific to the South African context.

Conclusions

The results of this study showed no support for male partner involvement in improving maternal health outcomes (under investigation) of women in PMTCT in rural South Africa. Study results showed no significant association between male partner involvement and pregnancy blood pressure, pregnancy CD4 count, and pregnancy viral load. However, male partner participation in the study was associated with a higher pregnancy viral load among the women. Future

studies should include additional maternal health outcomes for investigation as these may be useful for the planning and development of appropriate interventions.

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