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ORIGINAL PAPER

Alcohol, But Not Depression or IPV, Reduces HIV Adherence Among South African Mothers Living with HIV Over 5 Years

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Abstract

Alcohol, depression, and intimate partner violence (IPV) are endemic in sub-Saharan Africa. This article examines whether and how these conditions affect mothers living with HIV (MLH), compared to mothers without HIV (MWOH). In particular, we assess the influence of these comorbidities on engagement in HIV care and adherence to antiretroviral therapies (ARV) among MLH. Data on maternal HIV care are typically based on clinic samples, with substantial loss to follow-up. This study fills that gap by including all mothers in specified areas. A cohort study examines MLH in Cape Town, South Africa recruited in pregnancy and followed repeatedly for 5 years, compared to MWOH. Almost all (98%) pregnant women in 12 neighborhoods (N = 594) were recruited in pregnancy. Mothers and children were reassessed five times over 5 years with high retention rates at each of the six assessments, from 98.7% at 2 weeks to 82.8% at 5 years post-birth. MLH's uptake and adherence to HIV care was evaluated over time associated with maternal comorbidities of alcohol use, depressed mood, and IPV using mixed effects logistic regression. MLH have fewer resources (income, food, education) and are more likely to face challenges from alcohol, depression, and having seropositive partners over time than MWOH. Only 22.6% of MLH were consistently engaged in HIV care from 6 months to 5 years post-birth. At 5 years, 86.7% self-reported engaged in HIV care, 76.9% were receiving ARVs and 87% of those on ARV reported consistent ARV adherence. However, data on viral suppression are unavailable. Alcohol use, but not depressed mood or IPV, was significantly related to reduced uptake of HIV care and adherence to ARV over time. Adherence to lifelong ARV by MLH requires a combination of structural and behaviorally-focused interventions. Alcohol abuse is not typically addressed in low and middle-income countries, but is critical to support MLH.

Keywords Alcohol use · HIV · Depression · Intimate partner violence · Adherence

Introduction

Pregnant women living with HIV require engagement in HIV care and adherence to antiretroviral treatment (ARV) in order prevent mother-to-child transmission (PMTCT). About 70% of mothers living with HIV (MLH)

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in sub-Saharan Africa are identified during pregnancy and the majority are linked to services [1]. Unfortunately, many studies have reported high loss to follow-up of pregnant MLH; about 33% to 50% of women drop out of PMTCT during pregnancy [2, 3], and another 20% to 33% are lost by 6 months post birth [4–7]. Furthermore, many MLH who remain on ARV are often not consistently adherent. Recent studies of pregnant and post-partum women found 13% of MLH already on ARV have unsuppressed viral loads at their first antenatal care visit, 50% are not adherent at 6 months, 37% of MLH will have at least one episode of viremia (viral load > 1000), and 13% will be virally unsuppressed (two consecutive episodes of viremia) within 12 months of ARV initiation [8–11]. With these rates of drop-out, poor adherence, and viremia breakthrough, many countries in sub-Saharan Africa are unlikely to achieve the Joint United Nations Programme on HIV/AIDS goals that by 2020 90% of all people living with HIV will know their status; 90% of all people with diagnosed HIV infection will receive sustained antiretroviral therapy; and 90% of all people receiving antiretroviral therapy will have viral suppression [12].

Therefore, understanding the barriers MLH face when caring for themselves is a high priority. For example, it is known that alcohol use accelerates HIV disease progression through both immunological and behavioral mechanisms [13]. Depression is associated with worse HIV adherence and viral suppression [14], and most new diagnoses for HIV and depression are made during the perinatal period, making this a time of increased risk [1, 15]. Intimate partner violence (IPV) affects about 30% of women globally and is associated with a higher risk of acquiring HIV [16]. One study in South Africa estimated that 12% of new HIV infections could be avoided if women did not experience more than one episode of IPV [17].

South Africa experiences syndemic comorbidities of HIV, alcohol use, depression, and IPV [18]. There is substantial evidence that these maternal comorbidities reduce uptake and adherence to ARV in low and middle-income countries [19–22]. Yet, most of these studies are based on cross-sectional analyses of clinic samples. There are few longitudinal samples of MLH and the impact of these comorbidities on HIV care uptake and adherence over time. The current study aims to help fill this gap.

To understand the rate of comorbidities among MLH, it is critical to concurrently compare the outcomes of mothers without HIV (MWOH) in the same communities. With such comparison, we can disentangle whether alcohol, depression and IPV affect MLH and then, by association, their engagement, retention, and adherence to HIV care. We hypothesize that the comorbid challenges of alcohol, depression, and IPV will reduce the ability of MLH to seek HIV care, thus playing a moderating role in long-term outcomes.

Methods

Ethics Statement

The Institutional Review Boards of University of California, Los Angeles (G07-02-033) and StellenboschUniversity (N08-08-218) approved the study. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Setting

Cape Town has a network of townships with both formal homes and informal shacks. Most families (70%) earn from 0 to 800 South African Rand (0–60 USD) per month. Townships typically have tarred roads, mast lighting, central water pumps, water-borne sewage services, and some access to electricity and telephones. We identified 24 neighborhoods of similar size (450–600 households) that were within 5 km of health clinics, had five to seven alcohol bars, and were non-contiguous and/or separated by natural barriers (e.g., a highway). Half of these neighborhoods were randomized to a control condition of a RCT and received standard care [23].

South African national recommendations for PMTCT changed during the recruitment time period. From 2008, they were: (1) lifelong triple drug ARV for MLH with CD4 counts ≤ 200 and single dose nevirapine (sdNVP) followed by 7 days zidovudine (AZT) for their infants; (2) AZT during pregnancy and sdNVP added during labor for MLH with CD4 counts > 200 and sdNVP followed by 7 days AZT for their infants; (3) for MLH who received less than 4 weeks of any ARV treatment during pregnancy, infants receive sdNVP and 28 days of AZT [24]. From 2010 they were: (1) lifelong triple drug ARV for MLH with CD4 counts ≤ 350 and 6 weeks NVP for their infants; (2) AZT during pregnancy, nevirapine (NVP) added during labor, and single dose dual ARV after delivery for MLH with CD4 counts > 350 and single dose NVP followed by 6 weeks minimum, continued as long as breastfeeding occurs, AZT for their infants [25].

Participants

All mothers from the 12 neighborhoods in the standard care condition are included in this report, both MLH and MWOH. Recruiters approached households in each neighborhood repeatedly from May 2009 to September 2010 and recruited 98% of pregnant women in a study of family well-being (n = 594).

Assessments

Township women were trained as interviewers and used mobile phones to enter data from questionnaires, observational measures, and performance tasks. Mothers were transported to a nearby research site for the assessments. Mothers were assessed during pregnancy, and 98.7% were reassessed at 2 weeks post-birth, 93.2% at 6 months, 91.7% at 18 months, 84.7% at 36 months, and 82.8% at 60 months post-birth. Seventy percent (70%) of mothers/children completed all assessments. Over 5 years 5 mothers and 55 infants died; dyads were removed at death of either mother or child.

Measures

Maternal demographic characteristics include age, highest grade of school completed, employment status, partnership status, household income, type of housing, the presence of water on the property (or not), flush toilets, and electricity on site. Food insecurity was assessed using one item ("How many days in the past week have you (i.e. mother, child, or both) gone hungry?") from the Household Food Insecurity Access Scale (HFIAS). This item has been found to be highly correlated with the nine-item scale used to distinguish food insecure from food secure households across different cultural contexts [26]. We also asked women about their recent sexual partnerships, their knowledge of the partners' HIV status, and the likelihood that they would ask them to test for HIV.

Maternal Comorbidities

Alcohol Use Women reported on any alcohol use at each assessment. At baseline, alcohol use prior to discovery of pregnancy was reported; at the post-birth assessment, alcohol use in the month prior to birth was reported; at 6 months, alcohol use since the baby was born was reported; and at the remaining assessments, alcohol use in the month prior to the assessment was reported. *Problematic drinking*, was constructed based on whether the participant experienced heavy episodic drinking (four or more drinks in a single day) at least once a month over a specified timeframe, and responded yes to at least one of the following three questions: (1) Have close friends or relatives worried or complained about your drinking?; (2) Do you sometimes take a drink in the morning when you first get up?; (3) Has a friend or family member ever told you about things you said or did while you were drinking that you could not remember [27]?

Depressive Symptoms At each assessment, the Edinburgh Postnatal Depression Scale (EPDS) [28] was administered. A cut-off of ≥ 13 was used to indicate depressed mood [29].

Intimate partner violence was captured at each assessment time point and asked whether the woman had been slapped, pushed or shoved, and/or threatened with a weapon by a current partner in the past 12 months.

Maternal HIV Care At each assessment, mothers self-reported their *HIV status.* Maternal self-reports of HIV status were validated in three ways. First, maternal HIV status was reported on children's government-issued Road-to-Health Card. These cards were reviewed at each assessment. Second, 62% of all mothers had additional children over the next 5 years (range 1–8 additional children). At each pregnancy, more than 98% of mothers were retested for HIV and again, the results are on the Road-to-Health card. Finally, at a 96-month assessment, we administrated rapid HIV tests. The correlation between self-report and the rapid HIV test was $r=0.84$. There were only 36 cases in which mothers self-reported that they were HIV seronegative, but tested seropositive on the rapid HIV test (6% inaccurate reports).

Additionally, among MLH, we measured *engagement in HIV care, receipt of ARV*, and *ARV adherence*. Based on self-report, mothers were considered engaged in HIV care if they reported having been to the clinic since the last assessment and/or currently being on ARVs, while ARV receipt was a "yes" or "no" response at each assessment at 6 months and on. MLH were considered adherent to the prescribed HIV regimen if they reported taking ARVs every day for the last 7 days starting from the 18-month assessment to 5 years.

Data Analysis

We examined potential selection effects related to participant loss-to-follow-up at the 5 year assessment by comparing baseline characteristics of mothers who did not follow up ($n=92$) to those who completed the 5 year assessment ($n=443$).

For the purpose of these analyses, MLH's HIV status was treated as a time-varying measurement since a mother could report a new infection at any follow-up assessment. However, once identified as positive, mothers' HIV status was not allowed to change at later assessments. Differences in MLH and MWOH groups were assessed using t-tests for continuous variables and Chi square tests for discrete variables.

Longitudinal models were used to compare MLH and MWOH for maternal comorbidities. Mixed-effects logistic regression models were used to analyze discrete outcomes. Multivariable longitudinal models for maternal comorbidities assessed at multiple time points included fixed effects

for mother's HIV status, time point, and an interaction between mother's HIV status and time point.

Regression models accounted for repeated subject measures within neighborhoods (i.e., nested design nature) and included random intercepts for neighborhood, as well as for the mother participant, where appropriate. For outcomes where model convergence was not achieved, we removed the neighborhood random effect and included neighborhood as a fixed effect in the model. Random slopes for time were assessed and if needed, were included in the longitudinal models in addition to the random intercepts and fixed effects. Appropriate covariance structure was then selected after comparison of models using likelihood ratio test (LRT) and Akaike information criterion (AIC) or Bayesian information criterion (BIC). In particular, we initially fed our model with the most complex covariance structure (e.g. unstructured); where applicable conducted LRT to test other candidate covariance structures (e.g. exchangeable, independent, identity) against the more complex model to see whether simpler model is adequate, and compared AIC/BIC between models, where the lower AIC/BIC indicates better fit to the data.

We examined mean differences between MLH and MWOH using the mean estimates on a measure at each follow-up point and the estimate on a measure at the baseline assessment, i.e. [(average of all MLH follow-up estimates) minus (MLH baseline estimate)] − [(average of all MWOH follow-up estimates) minus (MWOH baseline estimate)]. Missing data were assumed missing at random; thus, all analyses were performed on complete cases. We used all available observations up to the point where mothers died or were loss-to-follow-up. We used SAS 9.4 and Stata® SE software version 14.2. Regression analyses were performed using the -mixed- and -melogit- commands in Stata.

Results

Mothers who were lost to follow-up at the 5 year assessment (n = 92) were more educated, were less likely to live in formal housing or to have children who were hungry in the past week, less likely to have a prior child, were less likely to receive HIV results, and more likely to have knowledge of partner HIV status than those mothers who were retained at 5 years (n = 443). HIV status was not associated with loss-to-follow-up (Results are available as a supplementary online table).

Outcomes of MLH and MWOH

A full report of baseline characteristics of MLH and MWOH can be found in Table 1. Ten mothers did not disclose their HIV status and were not included in the analyses. At recruitment, 26% of women were MLH. Over the course of 5 years, 26 additional mothers acquired HIV; five were identified at 18 months, six at 36 months, and 15 at 60 months. These mothers were included in baseline analysis. There were 11 HIV + children identified over the 5 years. During the study, < 1.0% (n = 5/584) of the mothers had died; 3 were seropositive and 2 seronegative.

MLH were no more likely to die compared to MWOH. We display alcohol use, depressed mood, and IPV in MLH and MWOH at each time assessment from baseline to 60 months on Fig. 1. Alcohol was used by 25% of mothers prior to recognizing that they were pregnant and reduced for most women after recognizing that they are pregnant. Alcohol use decreased substantially after childbirth and slowly increased over time until reaching pre-pregnancy levels at 5 years. Any use of alcohol was significantly different between MLH and MWOH at baseline (32.2% vs. 23.4%, p = 0.04) and 60 months (33.3% vs. 19.6%, p ≤ 0.01).

In contrast to any use of alcohol, we observed that problematic drinking increased over time, showing a significant difference at 36 months (12.2% vs. 5.4%, p = 0.01) and 60 months (17.7% vs. 7.3%, p ≤ 0.01) associated with HIV status. Having a depressed mood or not varied significantly between MLH and MWOH at baseline (42.8% vs. 32.8%, p = 0.04), post-birth (29.0% vs. 19.1%, p = 0.02), 6 months (26.0% vs. 15.9%, p ≤ 0.01), 18 months (20.8% vs. 13.5%, p = 0.04), and 36 months (27.3% vs. 18.1%, p = 0.03) after birth. MLH and MWOH reported similar experiences of IPV throughout the 5 years.

Table 2 compares MLH and MWOH on multiple measures at 60 months and includes unadjusted analyses and adjusted analyses estimates from regression models (estimated mean differences and odds ratios). MLH were significantly more likely to drink any alcohol and to have problematic alcohol use compared to MWOH in the adjusted comparisons. The odds of drinking any alcohol was 3.6 times greater (95% CI 1.49–8.53) for MLH compared MWOH. Similarly, MLH had a 2.31 times the risk of problematic alcohol use compared to MWOH at 60 months (RR: 2.31, 95% CI 1.39–3.83). There were no significant differences in depressed mood or IPV between mothers with different HIV status in the unadjusted or adjusted analyses.

HIV Care of MLH

Engagement in HIV Care for all MLH

We followed-up 80.0% of MLH (n = 143/179) at 5 years. Of those, 86.7% (n = 124/143) were engaged in HIV care, 76.9% (n = 110/143) reported receipt of ARV, and of those who reported being on ARV treatment, 87.3% (n = 96/110) reported being adherent to the medication over the past 7 days from 18 months and on.

Table 1 Baseline characteristics of mothers living with HIV (MLH; n = 179) and mothers without HIV (MWOH; n = 405), as well as the overall sample

	MLH (N = 179)		MWOH (N = 405)		Total (N = 584)	
	n	%	n	%	n	%
Demographic characteristics						
Age, mean (SD)*	27.0	5.2	26.0	5.7	26.3	5.6
Highest education level (years), mean (SD)*	10.0	1.8*	10.4	1.8	10.3	1.8
Currently employed	25	14.0	78	19.3	103	17.6
Married or lives with partner	94	52.5	224	55.3	318	54.5
Monthly household income > 2000 Rand*	71	40.3	204	51.6	275	48.2
Formal housing	54	30.2	136	33.6	190	32.5
Water on site	94	52.5	227	56.0	321	55.0
Flush toilet on site	102	57.0	235	58.0	337	57.7
Electricity on site	159	88.8	375	92.6	534	91.4
Mother hungry past week*	103	57.5	190	46.9	293	50.2
Children hungry past week	62	34.6	118	29.1	180	30.8
Partnerships						
Reported a recent sexual partner[a]	156	87.2	356	87.9	512	87.7
Knowledge of recent partner's HIV status*						
Partner HIV+	50	32.1	0	0.0	50	9.8
Partner HIV−	34	21.8	257	72.2	291	56.8
Partner serostatus unknown	72	46.2	99	27.8	171	33.4
Requested partner to take HIV test	104	85.2	246	82.6	350	83.3
Alcohol						
Alcohol use in the month prior to pregnancy discovery*	50	32.1	77	23.1	127	25.9
Problematic drinking in the month prior to pregnancy discovery*	43	27.6	57	17.1	100	20.4
Alcohol use after pregnancy discovery	17	11.0	32	9.6	49	10.0
Problematic drinking after pregnancy discovery	8	5.2	16	4.8	24	4.9
Drank any alcohol, anytime during pregnancy*	57	31.8	95	23.5	152	26.0
Depression						
Edinburgh Postnatal Depression Scale (EPDS), mean (SD)*	11.4	7.3	9.9	7.0	10.3	7.1
EPDS > 13*	71	39.7	118	29.1	189	32.4
Intimate partner violence						
Woman reports being slapped, pushed, shoved, and/or threatened with a weapon by a current partner in the past 12 months.	69	38.6	144	35.6	213	36.5

[a]"Recent" refers to the last three months

*$p < 0.05$ (*t* tests for continuous variable or χ^2 tests for discrete variables)

There was a significant increase at each time point for MLH who were engaged in HIV care: 46.0% (n = 64/139) at 6 months, 54.3% (n = 75/138) at 18 months, 66.1% (n = 84/127) at 36 months, 86.7% (n = 124/143) at 60 months ($p \leq 0.01$). Also, 152 MLH were engaged in care at some point during the study. However, consistent engagement over time remained a challenge; only 26 MLH were engaged in care at all assessments.

Similarly, there was a significant increase at each time point for MLH who reported receipt of ARV treatment: 30.8% (n = 45/146) at 6 months, 47.1% (n = 65/138) at 18 months, 52.8% (n = 67/127) at 36 months, and 76.9% (n = 110/143) at 60 months ($p \leq 0.01$). Of those MLH who received ARVs, there was no significant difference in ARV adherence over time: 90.6% (n = 58/64) at 18 months, 89.6% (n = 60/67) at 36 months, and 87.3% (n = 96/110) at 60 months (p = 0.78). Although adherence was above 85% at 18 months and on, only 33 MLH were adherent at all 3 follow-up time points.

Comorbid Effects on HIV Care

Engaging in HIV care was significantly lower if mothers reported any drinking at 6 months (21.1% vs. 50.0%, p = 0.02), 18 months (34.8% vs. 58.3%, p = 0.04), and 36 months (48.3% vs. 71.4%, p = 0.02) compared to mothers who did not report any alcohol use. Receipt of ARV was significantly lower if mothers drank alcohol at 6 months

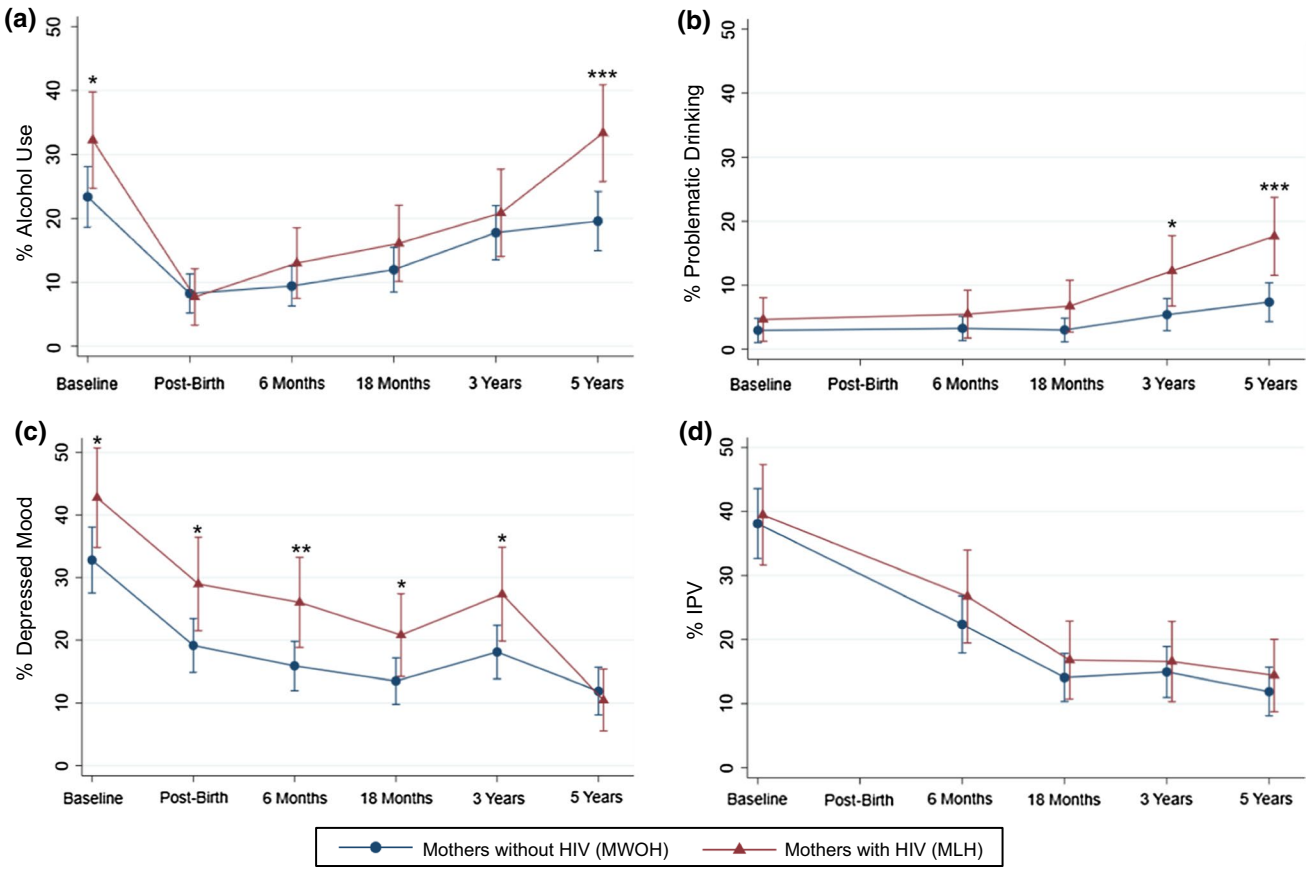

Fig. 1 Alcohol use, problematic drinking, depressed mood, and intimate partner violence (IPV) over time for mothers living with HIV (MLH) and mothers without HIV (MWOH). **a** Any alcohol use over time for MLH and MWOH; **b** problematic drinking over time for MLH and MWOH; **c** depressed mood (EPDS > 13) over time for MLH and MWOH; **d** experience of IPV over time for MLH and MWOH. *p < 0.05; **p < 0.01; ***p < 0.001

Table 2 Comparison of mothers living with HIV (MLH) and mothers without HIV (MWOH) on alcohol use, problematic drinking, depressed mood (EPDS > 13) and intimate partner violence at 5-years

	MLH (N = 153)		MWOH (N = 286)		Estimated odds ratio or risk ratio MLH versus MWOH	
	n	%	n	%	OR[1] or RR[2]	95% CI
Drinks any alcohol*	51	33.3	56	19.6	3.57[a,d,+]	1.49–8.53
Problematic alcohol use*	27	17.6	21	7.3	2.31[a,c,+]	1.13–3.48
Depressed Mood, EPDS>13	16	10.5	34	11.9	0.79[a,b]	0.37–1.65
Intimate partner violence	22	14.4	34	11.9	1.15[a,d]	0.48–2.76

*p < 0.05 (*t* tests or χ^2 tests)

[+]p < 0.05 (regression estimates)

[1]Mixed-effects logistic regression for binary outcomes

[2]Risk ratio was reported for problematic alcohol use due to the high prevalence of this outcome

[a]Random-intercept for neighborhood and mother

[b]Random-slope for time using unstructured covariance structure

[c]Random-slope for time using identity covariance structure

[d]Random-slope for time using independent covariance structure

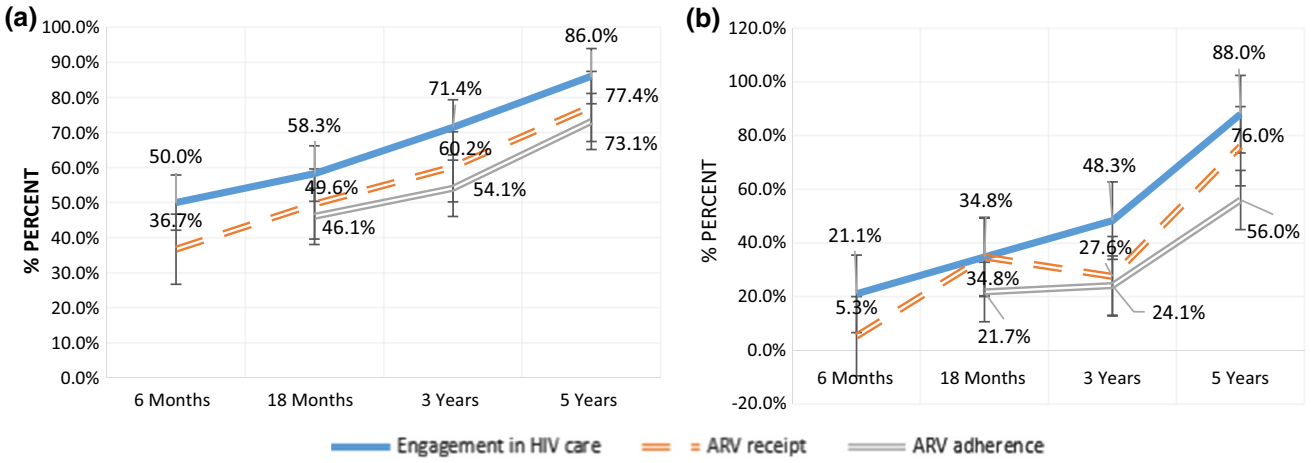

Fig. 2 Engagement in HIV Care, Antiretroviral (ARV) Receipt, and ARV Adherence for all mothers living with HIV (MLH), MLH abstaining from alcohol, and MLH using alcohol. **a** MLH who abstain from alcohol at 6 months (n=120), 18 months (n=115), 3 years (n=98), and 5 years (n=93); **b** MLH who use alcohol at 6 months (n=19), 18 months (n=23), 3 years (n=29), and 5 years (n=50)

(5.3% vs. 34.6%, p = 0.01) and 36 months (27.6% vs. 60.2%, p ≤ 0.01). ARV adherence was significantly lower if mothers drank alcohol at 18 months (21.7% vs. 46.1%, p = 0.03), 36 months (24.1% vs. 54.1%, p ≤ 0.01), and 60 months (56.0% vs. 73.1%, p = 0.04). We demonstrated these results in Fig. 2, which indicate the percentage of MLH who were engaged in HIV care, reported receipt of ARV treatment, and adherent to ARV based on whether the MLH reported alcohol use or not. There were no significant differences in engagement in HIV care, receipt of ARV and ARV adherence based on depressed mood across each of the assessment time points. There were no significant differences in engagement in HIV care if mothers experienced IPV at any assessment time point. However, mothers experiencing IPV were significantly less likely to be receiving ARV at 6 months (12.8% vs. 37.4%, p ≤ 0.01) and reported significantly lower ARV adherence at 60 months (70.6% vs. 90.3%, p = 0.04).

Discussion

This longitudinal study of a community-based sample of MLH and MWOH not only provides insight into patterns of alcohol use, depression, and IPV over time among mothers with and without HIV, but it also shows how these comorbid challenges may influence engagement in HIV care among MLH over time. MLH use alcohol more often, have more problematic alcohol use, and have depressed mood more often than MWOH. Yet, only alcohol use is significantly associated with decreased engagement with HIV care, receipt of ARVs, and ARV adherence. These finding are surprising and point to the importance of alcohol-related interventions for mothers, especially, MLH.

Both MLH and MWOH report the highest rates of alcohol use prior to knowledge of their pregnancy and at 5 years after delivery. Yet across time, more MLH use alcohol at each time point than MWOH. In addition, there is a significant increase in problematic alcohol use over 5 years post birth, and a widening gap in problematic alcohol use between MLH and MWOH. Many other studies report on alcohol use as a risk factor for HIV, with women who drink about twice as likely as those who abstain from alcohol to become HIV positive [21, 30, 31]. However, increased risk among women drinking alcohol cannot account for the increase in problematic drinking over time. Additional reasons for increased alcohol consumption among MLH include high levels of perceived HIV-related stigma, mental health problems, and health-related anxiety [32]. In this study, it appears that these negative factors compound over time.

Depressed mood, significantly greater among MLH than MWOH during pregnancy and for 3 years after birth, is not more common in MLH at 5 years. This is contrary to previous cross-sectional studies, which have found MLH to be at increased risk of depression [33, 34]. It is possible that the additional challenges of living with HIV, the fear of mother-to-child transmission, and the high rate of new diagnoses during the perinatal period (57%) make MLH more susceptible to depression earlier [33]. Yet, over time this increased risk of depression disappears.

The risk of IPV is greatest in the 12 months prior to pregnancy, when most MLH are unaware of their status. However, contrary to other research, we find that MLH are no more likely to experience IPV than MWOH at any time point over 5 years [17, 35]. Potentially, MLH who are unaware of their HIV status are not yet at elevated risk due to HIV stigma or partner disclosure. Additionally, our questions

related to IPV focuses on physical violence within relationships, but did not specifically ask about unwanted or forced sex. In this sample, IPV in South Africa is common (36.5%) and similar for both MLH and MWOH. These findings are similar to other researchers [17, 36, 37].

Our assessments of MLH over time indicate that the 90–90–90 goals set by the global community to eliminate HIV are unlikely to be met. Ensuring that MLH initiate ARV is not a sufficient condition for MLH to thrive; consistent engagement in care is essential. It is unclear if health issues or the Western Cape implementation of Option B+ in 2013 [38] prompted re-engagement; 37.3% of MLH had another child and would have received PMTCT again. However, even when almost all MLH are in care, 23.1% do not receive ARV and 12.7% of those taking ARV are not adhering to treatment. Another recent study, implemented after Option B+, has similar findings: 20% of MLH are not engaged in care and 13% are not virally suppressed at 12 months [11]. Option B+ does not appear to reduce the gap in engagement in care or adherence for many MLH. This may be similar to a pattern seen in the treatment of other chronic diseases: mothers are adherent to medication during pregnancy for the sake of their child, but are not adherent once the baby is born [39].

Interventions to promote consistent HIV care for MLH need to address the comorbid challenges that MLH are facing, particularly alcohol use. As previously observed, alcohol use significantly influences maternal HIV uptake and adherence [20, 21, 40]. We find that MLH who report any alcohol use are about half as likely to engage in HIV care early and remain disengaged from care at later time points. Once in care, MLH who drink alcohol are far less likely to be receiving ARVs. Finally, while over 90% of MLH who do not drink adhere to their medications at all-time points, MLH who drink fluctuate in adherence, falling as low as 63% adherent to ARV. Contrary to previous research, depressed mood does not appear to affect MLH's HIV care, and IPV has a limited role [41–43].

While there has been a substantial focus globally on addressing mental health care for MLH, [44, 45] the diffusion of alcohol interventions is far lower [46]. Interventions for alcohol use are not broadly implemented in South Africa. Rehabilitation facilities are limited and interventions for alcohol abuse are implemented in primary care facilities which lack the resources and expertise to manage abuse [47].

Paraprofessional home visiting, already being implemented nationally in South Africa, can significantly reduce alcohol use in pregnancy. In fact, among this cohort, perinatal home visiting reduces alcohol use 5 years post-birth [48]. This study demonstrates significant reductions in alcohol use and abuse 5 years post-birth [49]. However, these data also suggest that broad implementation of community-wide, structural or policy interventions is warranted.

Limitations

For data on the HIV treatment continuum, we are largely reliant in this study on maternal self-reports. As described in the Methods section, there are three ways that we are able to validate the HIV infections among mothers, suggesting the veracity of maternal reports. In particular, the results of the rapid HIV test are highly consistent with mothers' self-reports of their HIV status. It would have been desirable to obtain independent observations of medical records, NHLS data, pill counts, or viral load and ARV measures in the blood stream. The HIV rate in this cohort (31%, n = 179/584) is consistent with the estimated HIV prevalence for pregnant women in the study area, which is over 20% for the Cape Metro area as a whole and roughly 34% in the surrounding townships [50]. It is important that we followed a high percentage of the sample over time. Only 22 mothers are not reassessed at least once and 70% are assessed at all-time points.

Similarly, maternal self-reports are used to collect data on alcohol use, depression, and IPV, which may have been underreported due to recall bias and stigma around these issues [24, 32]. However, interviewers in this study are of the same cultural/ethnic background as participants, and the rate of consent to participate (98%) and retention (82.7% at 5 years) are high, suggesting that women in this study are open to discussing issues related to their health. The PETH alcohol test is a highly accurate measure of alcohol use/abuse, but at over $100 USD, it is not a viable field assessment at this time. A biomarker would have been desirable.

This sample reflects 98% of all pregnant women in 12 neighborhoods and more than 82% are followed across time. Seventy percent of mothers, both MLH and MWOH, completed all assessments from birth to 5 years. The neighborhoods were matched on multiple domains, including formal/informal housing, distance to medical care, HIV care options available, electricity, flush toilets, number of alcohol bars, and were designed to prevent contamination across neighborhoods. These characteristics demonstrate the high internal and external validity in the sample.

Conclusion

In the Cape Town townships, MLH are slow to re-engage in HIV care following childbirth. By 5 years, most MLH are in care, receiving ARV and adherent to their ARV. However, over time, there are high rates of inconsistent retention and adherence. There are few community-based studies of MLH that evaluate the impact of alcohol use, depression, and IPV on HIV care uptake and adherence over time. The current study helps fill this gap and demonstrates how ARV

adherence and engagement in HIV care are challenged by alcohol use in particular, especially after the child is born.

Alcohol use remains a significant yet modifiable barrier to consistent engagement in HIV care and ARV adherence. However, it is often overlooked in HIV treatment programs, particularly in LMIC. This study highlights the need for community-level, structural interventions to support MLH in low-resource communities, both during and after pregnancy, and reduce alcohol use and abuse in order to reach the 90–90–90 goals.

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Compliance with Ethical Standards

Conflict of interest The authors have no conflicts of interest to declare.

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