Viral suppression and factors associated with failure to achieve viral suppression among pregnant women in South Africa

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Objective: To describe viral load levels among pregnant women and factors associated with failure to achieve viral suppression (viral load ≤50 copies/ml) during pregnancy.

Design: Between 1 October and 15 November 2017, a cross-sectional survey was conducted among 15–49-year-old pregnant women attending antenatal care (ANC) at 1595 nationally representative public facilities.

Methods: Blood specimens were taken from each pregnant woman and tested for HIV. Viral load testing was done on all HIV-positive specimens. Demographic and clinical data were extracted from medical records or self-reported. Survey logistic regression examined factors associated with failure to achieve viral suppression.

Result: Of 10 052 HIV-positive participants with viral load data, 56.2% were virally suppressed. Participants initiating antiretroviral therapy (ART) prior to pregnancy had higher viral suppression (71.0%) by their third trimester compared with participants initiating ART during pregnancy (59.3%). Booking for ANC during the third trimester vs. earlier: [adjusted odds ratio (AOR) 1.8, 95% confidence interval (CI):1.4–2.3], low frequency of ANC visits (AOR for 2 ANC visits vs. ≥4 ANC visits: 2.0, 95% CI:1.7–2.4), delayed initiation of ART (AOR for ART initiated at the second trimester vs. before pregnancy:2.2, 95% CI:1.8–2.7), and younger age (AOR for 15–24 vs. 35–49 years: 1.4, 95% CI:1.2–1.8) were associated with failure to achieve viral suppression during the third trimester.

Conclusion: Failure to achieve viral suppression was primarily associated with late ANC booking and late initiation of ART. Efforts to improve early ANC booking and early ART initiation in the general population would help improve viral suppression rates among pregnant women. In addition, the study found, despite initiating ART prior to pregnancy, more than one quarter of participants did not achieve viral suppression in their third trimester. This highlights the need to closely monitor viral load and strengthen counselling and support services for ART adherence.

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Introduction

Maternal HIV viral load and timing of antiretroviral therapy (ART) initiation are the two most important predictors of perinatal mother-to-child HIV transmission (MTCT) [1]. ART initiation prior to conception and maintaining viral load of 50 copies/ml or less throughout pregnancy and delivery can reduce perinatal MTCT rates to levels below the WHO target for elimination of MTCT (eMTCT) (defined as $\leq$50 new infections per 100 000 live births) [1,2]. With high viral load levels (>1000 copies/ml), perinatal MTCT rates of up to 30% have been reported [3]. MTCT has been found to occur with relatively low maternal viral load levels: Myer et al. [4] reported perinatal MTCT rates of 2% with viral load levels of 50–1000 copies/ml. This indicates that maintaining viral load of 50 copies/ml or less throughout pregnancy and breastfeeding is essential for the achievement of the eMTCT target. Maintaining low viral load levels also helps prevent the sexual transmission of HIV, HIV-related maternal illness, and development of drug resistance; and contributes to the achievement of the Joint United Nations Programme on HIV/AIDS (UNAIDS) target of 73% viral suppression among people living with HIV (PLHIV) [5,6].

A number of factors may be associated with nonsuppressed viral load during pregnancy. High viral load levels prior to ART initiation, delayed initiation of ART, new HIV infection during pregnancy, and poor treatment adherence have been identified as the main predictors of nonsuppressed viral load during pregnancy [7,8]. In most sub-Saharan African countries due to health-systems factors (e.g. clinic overcrowding and distance to clinic) and patient-related barriers [e.g. inadequate knowledge of the role of early antenatal care (ANC), and late recognition of unplanned pregnancy], women often initiate ANC late in their pregnancy, which delays initiation of ART and viral suppression among women not previously on ART [9–12]. Other social, behavioural, and biological factors that influence adherence to ART and viral suppression during pregnancy include nondisclosure of HIV status, drug toxicity, treatment fatigue, substance abuse, and lack of family support [13–16].

South Africa has made great strides in reducing MTCT. In 2011, life-long ART was first introduced in South Africa for pregnant women with a CD4$^+$ cell count of 350 cells/μl or less [17]. In 2015, South Africa adopted Option B+ which recommended life-long ART for all pregnant women [18], and in 2016, the 'test and treat' initiative was introduced which recommended life-long ART to be offered to all PLHIV regardless of CD4$^+$ cell count [19]. Since the introduction of life-long ART, perinatal MTCT rate at 6 weeks has reduced from 3.5% in 2010 to 1.5% in 2015 [20,21], and in-utero transmission in 2017 was reported to be 0.9% [22]. However, HIV prevalence among pregnant women is still high at approximately 30% [23]. With the current high maternal HIV prevalence, to reduce MTCT rates to the level required to achieve the eMTCT goal, South Africa must prioritize early initiation of ART and ensure that women maintain 50 copies/ml or less viral load throughout pregnancy and breastfeeding [24]. In addition, monitoring performance against viral suppression targets and characteristics that influence viral suppression among pregnant women is essential for overcoming barriers to eMTCT. In this study, we examined viral load levels of pregnant women and factors associated with failure to achieve viral load of 50 copies/ml or less during pregnancy using data from the 2017 national antenatal survey.

Methods

The antenatal survey is a cross-sectional survey, conducted every 1–2 years, to measure HIV prevalence among pregnant women attending ANC at public healthcare facilities in South Africa. The 2017 survey planned to enrol 36 015 pregnant women aged 15–49 years from 1595 public health facilities selected from all 52 districts of South Africa. With the planned sample size for the 2017 survey, it was possible to estimate viral suppression rates among all HIV-positive women regardless of ART status at provincial level within 2–4% accuracy (assumptions include viral suppression rate of 55–60% (using viral suppression cut off point: $\leq$50 copies/ml), with HIV prevalence of 30%, design effect of 1.5, using 95% confidence interval (CI), and 10% error rate). Sites from each district were selected using probability proportional to size stratified multistage cluster sampling method.

The survey was conducted between 1 October and 15 November 2017. Data were collected by health workers providing routine ANC services. The data collection procedures included a brief interview, data abstraction from medical records, and blood specimen collection from each consecutive eligible (15–49 years old) consenting pregnant women attending ANC service during the survey period. In the overall sample, survey response rate was high (>99%). Demographic and clinical information collected through interview included the woman's education, marital status, race, gravidity, parity, and ART adherence (among known HIV-positive women receiving treatment) in the three days preceding the survey. Data on age of the woman, gestational age, and ANC visit type were extracted from medical records of enrolled women, while data on initiation of ART was extracted from medical records (if available) or by self-report. A blood specimen was taken from each woman regardless of prior knowledge of HIV status or ART history. Detailed descriptions of site selection criteria, sampling of women, data collection procedures and training provided to nurses prior to data collection is presented in the main report [25].

Blood specimen testing for HIV
Blood specimens were tested for HIV using two fourth-generation enzyme-immunoassay (EIA): screening assay (EIA-1) and confirmatory assay (EIA-2). Specimens that were reactive on both EIA-1 and EIA-2 were classified as HIV-positive and tested for viral load. A detailed description of the HIV testing procedures is provided in the main report [25].

Viral load testing
HIV viral load testing on all confirmed HIV positive (plasma) specimens was carried out using the COBAS AmpliPrep/COBAS TaqMan (CAP/CTM) HIV-1 Quantitative test (Roche Molecular Systems, Inc., Branchburg, New Jersey, USA) following the manufacturer's manual instructions. In addition to the internal control, the assay included external controls in each run, a low positive control, high positive control, and a negative control. The reported assay's lower limit of quantification was 20 copies/ml and its upper limit of quantification was 10 000 000 copies/ml.

Data analysis
All eligible (15−49 years) consenting HIV-positive pregnant women with viral load data were included in this analysis. Data analysis took into account the survey design (clustering within facilities, and stratification by district) and was poststratified (benchmark weighted) to the Statistics South Africa (Stats SA) 2017 mid-year population size of reproductive age (15−49 years) women, at provincial level [26].

We first described participants' HIV treatment status, demographic, and clinical characteristics. We categorized 'time of ART initiation' into the following four groups: (first), initiated ART before pregnancy; (second), initiated ART at a prior ANC visit during the current pregnancy; (third), initiated ART on the day of the survey or did not initiate ART at all; and (fourth), time of ART initiation unknown. The variables 'gestational age at survey enrolment', 'timing of ART initiation' and 'current visit type (that is: first-ANC-visit vs. follow-up visit)' were used to categorize 'time of ART initiation' into the above four groups, as specific date of ART initiation was not directly asked in the questionnaire (a detailed description of the categorization method is presented in Supplementary Table 1, http://links.lww.com/QAD/B594).

Duration of ART was calculated for participants who started ART in the second and third trimester of the current pregnancy, by subtracting the mid-week of the trimester ART was initiated from the participants' gestational age at survey enrolment. For participants initiated on ART in the first trimester, time of ART initiation was set at 10 weeks as most women do not attend ANC before 10 weeks. Duration of ART could not be calculated for participants who started ART prior to pregnancy as reference time for ART initiation was not available for these participants.

We described viral load level by timing of ART initiation, gestational age at the time of the survey, treatment adherence in the 3 days preceding the survey, age and gravidity using viral suppression cut off points: 50 copies/ml or less, and 1000 copies/ml or less. Median viral load level and interquartile range (IQR) is reported for the overall sample and for participants who were not initiated on ART at the time of the survey.

Multivariable binary logistic regression was used to examine factors associated with failure to achieve viral load of 50 copies/ml or less. This analysis was performed separately for each of the three gestational age categories (first, second, and third trimester) for two reasons: first, given that all factors may not have the same effect across gestational age categories, separate analysis of each gestational category allowed for the flexibility to account for variables relevant to each gestational stage; separate analysis of each gestational age category also allowed controlling for the confounding effect of gestational age; second, viral load at the third trimester is a good proxy for viral load at delivery; therefore, it was of particular interest to analyse factors associated with virologic failure in the third trimester. A binary variable for late ANC booking was created which was equal to 1 if the gestational age at the time of the survey was more than 27 weeks and the participant attended her first-ANC-visit on the day of the survey; this variable was coded 0 if gestational age at the time of the survey was more than 27 weeks and the participant attended at least one other ANC visit prior to the survey. Adjusted odds ratios (AORs), and 95% CIs are reported from multivariable logistic modelling.

Ethical considerations
Participation was voluntary. Written consent was obtained from participants at enrolment in the survey. Ethical approval was obtained from the University of the Witwatersrand Human Research Ethics Committee (Medical), and the nine provincial health research ethics committees. The study protocol was reviewed in accordance with the Centers for Disease Control and Prevention (CDC) human research protection procedures.

Results
In the 2017 antenatal survey, a total of 36 128 participants were interviewed, of which, 10 358 were HIV-positive. Specimens for 3.0% (306/10 358) of HIV-positive participants were not tested for viral load due to insufficient sample. 10 052 (97.0%) of HIV-positive participants had viral load data and were included in this analysis.

Demographic characteristics of participants

The majority of participants with viral load data (10 052) were Black African (97.1%, 9567) (missing responses excluded when calculating percentages); single (defined as never married and not cohabiting) (73.8%, 7271); and had attended at least secondary school (88.0%, 8550). Just below two-thirds (64.4%, 6534) of survey participants were follow-up ANC visit attendees and 35.6% (3518) were first-ANC-visit attendees. Less than one-fifth (16.2%, 1644) of participants reported that the current pregnancy was their first (Table 1). The median age of participants was 28 years (IQR: 24–33 years).

Treatment status

Of the 10 052 participants with viral load data, 95.5% (9603) had data on treatment status. More than three quarters (78.0%, 7604/9603) of participants with treatment data had already initiated ART prior to the survey. ART was initiated prior to pregnancy in 55.7% (5483) of participants, 22.3% (2121) of participants initiated ART during a prior ANC visit in the current pregnancy (18.6% initiated ART in the first trimester and 3.7% in the second trimester) (Table 1). About 4% (3.7%, 367) of participants reported initiating ART during pregnancy but timing of ART initiation was not known (Table 1). Approximately one-fifth, 18.3% (1632) did not initiate ART because of one of the following reasons: did not know their HIV-positive status (4.0%, 372), tested positive on the day of the survey (11.6%, 1015) or date of diagnosis unknown (1%, 88); 1.6% (157) had known their HIV-positive status prior to pregnancy, and were attending their first-ANC-visit at the time of the survey but not yet initiated ART. The median duration of ART for participants that initiated ART in prior ANC visits during pregnancy was 17 weeks (IQR: 11–23 weeks).

Treatment status during the third trimester

At the time of the survey, 39.5% (3801/9528) of the participants were in the third trimester of their pregnancy, 46.9% (4425/9528) were in the second trimester, and

Table 1. Viral suppression by demographic and clinical characteristics of women in the 2017 South African antenatal survey.

	All women	% with viral load (95% CI) n = 10 052	
	n (%)	≤1000 copies/ml	≤50 copies/ml
Gestational age			
1st trimester (≤12 weeks)	1302 (13.6)	74.1 (72.0–76.1)	52.0 (49.8–54.3)
2nd trimester (13–27 weeks)	4425 (46.9)	75.2 (74.0–76.4)	52.2 (50.9–53.5)
3rd trimester (≥28 weeks)	3801 (39.5)	87.2 (86.2–88.1)	63.5 (62.2 –64.8)
Timing of ART initiation			
Before pregnancy	5483 (55.7)	91.0 (90.3–91.6)	69.7 (68.5–70.8)
During pregnancy but at prior ANC visit	2121 (22.3)	85.1 (83.8–86.4)	56.0 (54.2–57.9)
ART naive or ART initiated on the day of the survey	1632 (18.3)	38.5 (36.4–40.6)	19.0 (17.5–20.7)
ART initiated during pregnancy (timing of ART initiation could not be determined)	367 (3.7)	83.4 (80.0–86.4)	46.6 (42.6–50.6)
Duration of ART among women initiated on ART during pregnancy (n = 2121)			
1–6 weeks	149 (7.0)	79.9 (74.2–84.7)	46.2 (39.8–52.6)
7–12 weeks	490 (23.1)	81.8 (78.5–84.6)	49.1 (45.4–52.7)
13–18 weeks	593 (28.0)	83.6 (81.0–85.9)	53.5 (50.0–56.9)
19–24 weeks	554 (26.1)	87.2 (84.7–89.3)	61.0 (57.6–64.4)
25–31 weeks	335 (15.8)	92.1 (89.1–94.2)	67.6 (63.3–71.5)
Self-reported taking ART in the preceding 3 days (n = 7604 women initiated on ART prior to the survey)			
Yes	7308 (97.8)	90.1 (89.6–90.7)	66.7 (65.6–67.7)
No	174 (2.2)	49.1 (42.7–55.6)	26.1 (21.1–31.7)
Primigravida			
Yes	1644 (16.2)	72.9 (71.0–74.6)	47.4 (45.3–49.4)
No	8268 (83.8)	80.7 (79.9–81.5)	58.1 (57.1–59.1)
Age in years			
15–19	500 (5.0)	66.2 (62.4–69.8)	37.8 (34.2–41.5)
20–24	1951 (20.4)	73.7 (71.8–75.5)	49.7 (47.9–51.6)
25–29	2791 (29.7)	79.9 (78.5–81.1)	57.1 (55.6–58.7)
30–34	2417 (26.7)	83.7 (82.4–84.9)	60.1 (58.4–61.9)
35–49	1619 (18.1)	84.6 (83.0–86.0)	63.1 (61.1–65.1)
Province			
Eastern Cape	1323 (11.9)	78.8 (76.6–80.9)	54.9 (52.3–57.4)
Free state	877 (3.6)	80.2 (78.0–82.2)	63.9 (61.3–66.3)
Gauteng	1528 (28.6)	73.6 (71.7–75.5)	58.0 (55.9–60.1)
KwaZulu-Natal	3363 (27.6)	87.7 (86.7–88.5)	60.1 (58.5–61.7)
Limpopo	535 (6.9)	76.3 (72.8–79.4)	29.7 (26.4–33.3)
Mpumalanga	1058 (9.9)	79.9 (77.7–81.9)	57.2 (54.6–59.7)
Northern Cape	561 (1.7)	75.4 (71.1–79.2)	36.4 (33.0–39.9)
North West	264 (3.8)	79.1 (76.2–81.9)	59.1 (54.0–64.0)
Western Cape	543 (6.1)	76.1 (72.5–79.3)	59.5 (56.3–62.6)
South Africa	10 052	79.5 (78.7–80.2)	56.2 (55.2–57.1)

Weighted data; missing data excluded. ANC, antenatal care; ART, antiretroviral therapy; CI, confidence interval.

13.6% (1302/9528) were in the first trimester (Table 1). Of the 3801 participants who were in their third trimester at the time of the survey, 54.4% (2069) reported initiating ART prior to pregnancy, 26.4% (966) initiated ART during first trimester, 9.8% (327) during second trimester, 1.7% (68) had a date of ART initiation that was not known, and 7.7% (261) were ART naïve at third trimester (Table 2).

The main reasons for not initiating ART by the third trimester among the 261 ART naïve participants were: (1) late (>27 weeks gestational age) ANC booking (48.7%, 127/261); (2) HIV-negative result: 35.6% (93/261) of participants reported they had an HIV-negative test result in a test performed during ANC; (3) a few (3.4%, 9/261) who were first-ANC-visit attendees, had known their HIV-positive status prior to the survey but they reported not initiating ART; and (4) date of HIV diagnosis was not known for 12.3% (32/261) of participants not initiated on ART.

Viral suppression
The median viral load was 227 copies/ml (IQR: 63–4122) after excluding lower than detectable limit (viral load <20 copies/ml) results. The median viral load for participants who had not initiated ART at survey enrolment was 5282 copies/ml (IQR: 591–22 505). Overall, more than three-quarters (79.5%) of participants achieved viral load of 1000 copies/ml or less; and 56.2% achieved viral load of 50 copies/ml or less (Table 1).

Initiation of ART prior to pregnancy was associated with higher viral suppression rate. 91.0% (95% CI: 90.3–91.6%) and 69.7% (95% CI: 68.5–70.8%) of participants who started ART prior to pregnancy achieved viral load of 1000 copies/ml or less and 50 copies/ml or less respectively at the time of the survey compared with 85.1% (95% CI: 83.8–86.4%) and 56.0% (95% CI: 54.2–57.9%) viral load of 1000 copies/ml or less and 50 copies/ml or less, respectively among participants who started ART during pregnancy (Table 1). Among participants who started ART during pregnancy, viral suppression increased with increasing duration of ART (92.1% viral load ≤1000 copies/ml with ART duration of 25–31 weeks compared with 79.9% viral load ≤1000 copies/ml with ART duration of ≤6 weeks). Viral load of 50 copies/ml or less was 67.6% among women who initiated ART during pregnancy and received ART for the longest duration (25–31 weeks).

Table 2. Factors associated with unsuppressed (viral load >50 copies/ml) viral load at the third trimester, the 2017 antenatal survey, South Africa.

	Proportion, N = 3801	Proportion VL ≤ 1000 copies/ml (95% CI)	Proportion VL ≤ 50 copies/ml (95% CI)	AOR (95% CI)[a] for VL > 50 copies/ml
Timing of ART initiation				
Before pregnancy	2069 (54.4)	92.4 (91.4–93.4)	71.0 (69.2–72.7)	1.0
1st trimester	966 (26.4)	88.0 (86.2–89.6)	62.0 (59.4–64.5)	1.5 (1.3–1.7)
2nd trimester	327 (9.8)	84.0 (80.5–86.9)	52.0 (47.7–56.3)	2.2 (1.8–2.7)
Date of ART initiation not known[b]	68 (1.7)	83.5 (74.7–89.7)	44.2 (34.6–54.2)	2.7 (1.7–4.2)
ART naïve	261 (7.7)	54.2 (49.2–59.2)	35.2 (30.8–39.9)	3.3 (2.6–4.2)
Receipt of ART in the 3 days preceding				
Yes	3268 (99.0)	90.5 (89.6–91.3)	66.7 (65.3–68.1)	[c]OR = 4.7 (2.7–8.0)
No	39 (1.0)	53.0 (39.4–66.2)	28.3 (18.5–40.7)	1.0
Age in years				
15–24	917 (24.9)	90.3 (88.2–92.0)	56.4 (53.6–59.1)	1.4 (1.2–1.8)
25–34	2012 (57.1)	80.8 (78.4–83.0)	65.8 (64.0–67.5)	1.1 (0.9–1.3)
35–49	616 (18.0)	89.0 (87.8–90.1)	67.8 (64.8–70.7)	1.0
Gravidity				
Primigravida	616 (15.8)	85.1 (82.6–87.4)	59.7 (56.3–63.0)	1.0 (0.8–1.2)
multigravida	3178 (84.2)	87.6 (86.5–88.5)	64.3 (62.8–65.7)	1.0
First ANC booking (model 1)				
Third trimester	309 (8.7)	62.1 (57.4–66.6)	44.7 (40.3–49.1)	1.8 (1.4–2.3)
1st or 2nd trimester	3453 (91.3)	89.6 (88.7–90.4)	65.1 (63.7–66.4)	1.0
Frequency of ANC visits (model 2)				
1 ANC visit	309 (8.7)	62.1 (57.4–66.6)	44.7 (40.3–49.1)	2.2 (1.7–2.7)
2 ANC visit	461 (12.7)	86.2 (83.5–88.5)	51.3 (47.5–55.2)	2.0 (1.7–2.4)
3 ANC visit	772 (21.0)	87.2 (84.9–89.1)	62.6 (59.7–65.5)	1.3 (1.1–1.5)
≥4 ANC visit	2220 (57.6)	91.2 (90.2–92.1)	69.0 (67.3–70.7)	1.0
Overall	**3801**	**87.2 (86.2–88.1)**	**63.5 (62.2–64.8)**	

Weighted data; missing data excluded. ANC, antenatal care; AOR, adjusted odds ratio; ART, antiretroviral therapy; CI, confidence interval; VL, viral load.
[a]Adjusting for education level and marital status did not have significant effect on the model.
[b]Participants reported as 'time of ART initiation unknown' as they were initiated on ART at the third trimester either in prior ANC visit or on the day of the survey.
[c]Not included in multivariable model as the sample size of participants not receiving ART in the 3 days preceding the survey was small.
Due to multicollinearity effect between first ANC booking and frequency of ANC visit, to estimate the effect of both variables, two models were fitted to determine the odds ratio for both variables.

Viral suppression rates varied by gestational age. During the first and second trimesters close to three-fourths of participants achieved viral load of 1000 copies/ml or less and only about half achieved viral load of 50 copies/ml or less (Table 1). During the third trimester, both rates of viral load 1000 copies/ml or less (87.2%) and viral load of 50 copies/ml or less (63.5%) were higher. The highest rate of viral load 50 copies/ml or less was among participants who initiated ART before pregnancy and continued ART until the third trimester (71.0%) (Table 2) as opposed to participants who initiated ART during pregnancy and continued ART until the third trimester (59.3%).

Viral suppression by demographic and clinical characteristics

The proportion of participants who reported not taking ART in the three days preceding the survey were few (2.2%, 174/7604) – of the 174 participants who reported not taking ART in the three days preceding the survey, 50.9% had viral load more than 1000 copies/ml (Table 1). Rates of viral load 50 copies/ml or less were lower among adolescents (15−19 years: 37.8%, 95% CI: 34.2−41.5%), and young women (20−24 years, 49.7%, 95% CI: 47.9−51.6%), compared with older women (35−49 years: 63.1%, 95% CI: 61.1−65.1%) (Table 1). Rates of viral load 1000 copies/ml or less was above 70% in all provinces, with the highest achievement in KwaZulu-Natal at 87.7% (Table 1).

Factors associated with viral load more than 50 copies/ml

Among participants in their third trimester, shorter duration of ART was associated with failure to achieve viral load of 50 copies/ml or less during the third trimester. After adjusting for participant age, gravidity, ANC visit type and ANC visit frequency, participants who started ART during their first trimester, second trimester, and ART naïve participants had 1.5 (95% CI: 1.3−1.7), 2.2 (95% CI: 1.8−2.7) and 3.3 (95% CI: 2.6−4.2) times higher odds of having viral load more than 50 copies/ml during the third trimester, respectively, compared with participants who initiated ART prior to pregnancy (Table 2).

Participants who attended their first ANC visit during the third trimester were more likely to have viral load more than 50 copies/ml compared with participants who booked first ANC visit before the third trimester (AOR: 1.8, 95% CI: 1.4−2.3). Participants who had only 2 ANC visits during pregnancy were more likely to have viral load more than 50 copies/ml at the third trimester compared with participants who attended at least four ANC visits [AOR: 2.0 (95% CI: 1.7−2.4)]. Younger age (15−24 years) compared with age 35−49 years was associated with not achieving viral load of 50 copies/ml or less at the third trimester (AOR: 1.4, 95% CI: 1.2−1.8).

All variables associated with suppression status in the third trimester were also associated with suppression status in the second trimester. The only variable that was significantly associated with suppression status in the first trimester was whether or not the participant started ART prior to pregnancy (data not presented).

Discussion

The current study provides the first national level estimates of viral suppression rates among pregnant women attending ANC visit in South Africa. The study showed that the UNAIDS target of 73% of PLHIV being virally suppressed (i.e. viral suppression ≤1000 copies/ml) was met amongst pregnant women at both national and provincial levels. Given that about half of the women in the survey were initiated on ART prior to pregnancy, this finding reflects the success of both the adult ART and the PMTCT programme in identifying and initiating women living with HIV on ART and ensuring achievement of viral suppression among these women.

For PMTCT, the global target is to reach the WHO eMTCT target. Studies have shown, to achieve the eMTCT target, especially in high HIV burden countries such as South Africa, viral load should be suppressed to 50 copies/ml or less throughout pregnancy, delivery, and breastfeeding [1,4]. Our study demonstrated that with close to half of pregnant women with more than 50 copies/ml viral load, South Africa is far from achieving the eMTCT target.

While long duration on ART improved viral suppression of 50 copies/ml or less, viral suppression rate at third trimester was 71% among participants initiated on ART prior to pregnancy and 67.6% among participants who initiated ART during pregnancy and received ART for 25−31 weeks during pregnancy. Suboptimal viral suppression rates despite long duration of ART among these participants indicates the need to strengthen the monitoring of viral load and treatment adherence throughout pregnancy. Our study showed self-reported adherence to treatment in the three days preceding the survey was a strong predictor of viral suppression. In prior studies, failure to achieve viral load of 50 copies/ml or less was associated with suboptimal adherence to treatment, treatment interruption, nondisclosure of status, inadequate counselling, and high pre-ART viral load level [8,27]. South Africa has well developed guidelines in place for viral load monitoring during pregnancy [28]. However, coverage of maternal viral load monitoring during pregnancy is low with up to 45% of HIV-positive pregnant women on treatment not receiving viral load testing during pregnancy [29]. Studies that assess the viral load monitoring practices during pregnancy are also limited [30].

Although the majority of participants were initiated on ART either prior to pregnancy (55.7%) or during the first trimester (18.6%), a sizable proportion of participants in this study were either not initiated on ART (18.3%) or were initiated on ART late in pregnancy (second trimester, 3.7%). Our study showed that women who initiate ART during the second trimester were 2.2 times more likely to have more than 50 copies/ml viral load during the third trimester of their pregnancy compared with women who initiated ART prior to pregnancy. Other studies have shown similar findings on the association between duration of ART and viral suppression rates [1,4,31−33].

Late ANC booking was the main reason for not initiating ART at all and for late initiation of ART, while both late ANC booking and low frequency of ANC visits were strong predicators of failure to achieve viral suppression in the third trimester. This shows the critical role of early ANC booking and frequency of ANC attendance (per WHO recommendation) in achieving viral suppression. Improving early ANC booking could improve both frequency of ANC visit and early initiation of ART. In the literature, unplanned pregnancy, misperception of the benefit of early initiation of ANC, cultural norms that promote initiation of ANC after first trimester, poor quality of care, and health worker attitudes have been reported as the main reasons for late ANC booking [11,34−36]. To address these barriers, interventions must target the second PMTCT prong (preventing unwanted/unplanned pregnancy and ensuring women make informed decision about their reproductive lives, including when to seek care) and address health systems factors and societal norms.

Adolescent girls and young women (AGYW) had the lowest viral suppression rate in this study. In a previous analysis, we showed AGYW were more likely than older women to know their HIV status and initiate ART after pregnancy [25]. This delayed initiation of ART is likely to negatively impact viral suppression rates among AGYW [37].

This study had some limitations. The survey was restricted to public facilities, which may limit the generalizability of its findings to HIV-positive women receiving ANC in private facilities. However, since the majority of pregnant women in South Africa receive ANC from public facilities, the findings of the study are applicable to most pregnant women. This cross-sectional study measured viral load at one point during pregnancy, which may not be representative of women's viral load burden throughout pregnancy. The self-reported timing of ART initiation data may be susceptible to recall bias. A relatively high percentage (38.5%) of ART naive participants in this study were virally suppressed. This could be due to misclassification of participants on ART as ART naïve due to clerical errors during administration of the survey questionnaires.

In conclusion, while most women achieved viral load of 1000 copies/ml or less, rates of achieving viral load of 50 copies/ml or less were low. Late initiation of ANC booking and late initiation of ART were both associated with unsuppressed viral load. Efforts to improve early ANC booking and early ART initiation in the general population would help improve viral suppression rates among pregnant women. Our findings also indicate that despite initiating ART prior to pregnancy, more than one quarter of participants did not achieve 50 copies/ml or less viral load in their third trimester. This highlights the need to closely monitor viral load and strengthen counselling and support services for ART adherence. In addition, since the majority of MTCT are now occurring during the postpartum period through breastfeeding, continued viral load testing during breastfeeding will be equally important. In this regard, further surveys at national level may be needed to assess viral suppression during postpartum period.

Conflicts of interest

There are no conflicts of interest.

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