

Breastfeeding and antiretroviral access among HIV-exposed children during the peak COVID-19 pandemic lockdown in a rural district in South Africa

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Background. There is limited information on whether the period of highest movement restrictions during the COVID-19 pandemic impacted on antiretroviral coverage for supporting safe breastfeeding among HIV-exposed children.

Objectives. To (i) measure the prevalence of breastfeeding among HIV-exposed children during peak COVID-19 lockdown (March - June 2020); and (ii) explore its association with antiretroviral coverage and other factors.

Methods. A cross-sectional telephonic survey was conducted (September to November 2020), among women living with HIV (WLHIV) from rural Ehlanzeni District, South Africa (SA). Participants who were previously enrolled in a face-to-face study during 2019 and who provided consent for future studies, were invited to take part in the present survey. Data, including child feeding practices, were collected from maternal recall of the COVID-19 pandemic peak lockdown period. Descriptive statistics were calculated and factors associated with breastfeeding were analysed using log binomial regression.

Results. A total of 322 WLHIV aged between 19 and 46 years were successfully interviewed. Of these, only 6.4% reported disruption in antiretroviral treatment (ART), 18 (5.6%) had children living with HIV (CLHIV), all of whom were on ART. Out of the 300 HIV-exposed uninfected children (HEUs) who were eligible for extended postnatal prophylaxis (extended PNP) (those still breastfeeding, and the mother either had a viral load (VL) $\geq 1\ 000$ copies/mL or had not undergone VL testing within the past 6 months), 47.7% received it. During the COVID-19 peak lockdown, 30.1% of children were breastfed, including 28.6% ($n/N=87/304$) of HEUs and 62.1% of breastfeeding HEUs were on extended PNP. Log binomial regression analysis showed HEUs on extended PNP and CLHIV had increased likelihood of breastfeeding (prevalence ratio (PR) 1.8 (95% confidence interval (CI) 1.2 - 2.6) and PR 2.6 (95% CI 1.6 - 4.4), compared with eligible HEUs who were not on extended PNP.

Conclusion. Good antiretroviral coverage supported safe breastfeeding practices during the COVID-19 peak lockdown in this rural setting in SA, with promising ongoing adoption of extended PNP during breastfeeding.

Keywords. HIV-exposed infants; breastfeeding; COVID-19.

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Sufficient anti-HIV antiretroviral coverage in populations where breastfeeding is a common socioeconomic practice is critical, particularly in countries where maternal HIV prevalence is high. The 2019 South Africa (SA) national antenatal HIV survey reported an average national HIV prevalence of 30%, during antenatal care.^[1] Breastfeeding prevalence in various settings across the country has been reported to be between 26% and 99%.^[2] Vertical HIV transmission (VHT) during the postnatal period has been reported to decline at a lower rate compared with intra-uterine transmission. While on average intra-uterine transmission rates remain under 1%, postnatal VHT rate are still relatively high. For example, a cross-sectional study in Kenya reported a decline in postnatal VHT at 18 months from 5.7% in 2017 to 2.2% in 2021.^[3] Other studies have reported postnatal transmission rates ranging from 1.1% to 2.0% in countries such as SA and Zambia.^[4,5] In addition,

the targets for eliminating VHT, guided by the World Health Organization (WHO),^[6] have not been fully met due to existing ongoing challenges, such as delayed maternal viral suppression, and missed opportunities for early infant prophylaxis or timely ART initiation in mothers during breastfeeding.^[7-9] The reasons for new VHT cases include: insufficient HIV testing for women of childbearing age and pregnant women; inadequate testing of partners, which increases the risk of HIV infections during pregnancy and breastfeeding; low retention rates in care, especially in breastfeeding populations, which increases the transmission rate through breastmilk; and the lack of sufficient viral load (VL) monitoring among breastfeeding and pregnant women.^[10,11] Therefore, at the time of the study the SA national guidelines for the routine universal treatment programme for prevention of VHT (PVHT) included a recommendation for extended infant postnatal

antiretroviral prophylaxis (extended PNP) only for high-risk children (if the mother has a VL $\geq 1\ 000$ copies/mL at delivery or in the last 12 weeks of antenatal care, or lacks a VL result for the past 12 weeks), until the mother's VL drops below 1 000 copies/mL or 4 weeks after breastfeeding cessation), among other revisions for improved HIV care.^[12] However, the most recent (2023) guidelines redefine a high-risk infant as one born to a mother with a VL of ≥ 50 copies/mL and breastfeeding. In such cases the child should continue AZT for 6 weeks and nevirapine (NVP) for at least 12 weeks and only stop once the mother's VL is < 50 copies/mL or 4 weeks after breastfeeding cessation.^[13]

The coronavirus disease 2019 (COVID-19) pandemic likely interfered with implementation of the then newly updated guidelines and/or exacerbated some of the existing challenges. Lockdowns limiting patient access to healthcare severely impacted continuity of PVHT services.^[14] Modeling predicts a 1.6-fold increase in VHT due to interrupted antiretroviral treatment (ART), and a decrease in PNP coverage among HIV-exposed uninfected children (HEUs) was reported in some settings during the COVID-19 pandemic.^[15,16] Confusion over COVID-19 transmission risks through breastmilk and mother-child separation also likely influenced infant feeding practices during the pandemic.^[17,18] This study aimed to assess whether HIV-exposed children who were breastfeeding during the COVID-19 pandemic peak lockdown period (with the highest level of restricted movement), and their mothers, in a rural setting in SA were sufficiently provided with extended PNP or ART, as appropriate. Other factors with potential to influence breastfeeding practice among HIV-exposed children during the peak lockdown period were also investigated.

Methods

Study design, setting and participants

We conducted a cross-sectional follow-up telephonic survey during September and November 2020 to assess feeding practices during the COVID-19 pandemic peak lockdown period (March 2020 to June 2020) in SA, in a sample of postpartum women living with HIV (WLHIV). The participants were previously enrolled in a cross-sectional district-level study conducted in Ehlanzeni District, Mpumalanga Province, from September to December 2019 (baseline study). At baseline (September - December 2019), the participants were recruited as either third-trimester pregnant women or postpartum mother-child pairs, at the eight largest community healthcare centres in the district, which are 24-hour clinics providing pregnancy, delivery, and postnatal care services. A total of 667 WLHIV (including those who were pregnant at the time) were successfully recruited in the baseline study and were targeted for the follow-up cross-sectional telephonic survey. The details of the baseline study sample are described elsewhere and included an observed maternal VL non-suppression (VL $> 1\ 000$ copies/mL) prevalence of 14.7% and maternal low-level viraemia (VL 50 - 1 000 copies/mL) prevalence of 13.8% (i.e. a total of 28.5% had elevated VL). Participants in this telephonic survey comprised all WLHIV who had previously participated in the baseline study, were contactable, had progressed to postpartum if previously pregnant at baseline and had expressed willingness to take part in the current study.

Data collection

During the follow-up telephonic survey, a 30 - 35-minute guided questionnaire was administered by trained research assistants. Self-reported maternal recall on infant feeding practices, uptake of HIV care, as well as sociodemographic and pandemic-related factors, during the peak COVID-19 lockdown period were collected. Data

were captured directly into a REDCap database. Child age, maternal VL and maternal age information were extracted from the baseline study data.

Exposure variables

Exposure variables relating to the pandemic peak lockdown period, collected from WLHIV, included confirmation of maternal and infant age, recall of uptake of HIV care including clinic visit barriers, child and mother's PNP/ART adherence, PNP uptake (those on PNP, eligible but not on PNP, non-eligible and not on PNP). PNP eligibility was determined using ongoing breastfeeding and maternal VL status. Standard PNP recommends 6 or 12 weeks of PNP based on risk and extended PNP refers to continuing treatment beyond these periods, so children on extended PNP are expected to be older than 6 or 12 weeks. A child was considered eligible for extended PNP if the child had passed the age for standard PNP, was still breastfeeding, and the mother either had a VL $\geq 1\ 000$ copies/mL or had not undergone VL testing within the past 6 months.^[17] Given the uncertainty around VL timing for WLHIV due to the release of new recommendations at the end of 2019 and healthcare interruptions by the COVID-19 pandemic in 2020, we referenced the 2015 SA PVHT guidelines for VL repeat testing, to define extended PNP eligibility.^[19] These 2015 guidelines recommended conducting a repeat VL test after 6 months for women with suppressed VL ($< 1\ 000$ copies/mL). To manage data complexity, we created an 'unknown' group that included mothers without a VL test in the past 6 months and mothers who had a VL test but whose results were unknown (Table 3). The exposure variables of primary interest were infant uptake of ART or PNP and mother's uptake of ART.

Outcome variables

The primary study outcome was the proportion of children who were breastfeeding (received breastmilk, regardless of whether they were exclusively breastfed or received other foods or liquids alongside breastmilk) during the peak COVID-19 lockdown period. Formula/milk feeding, and solid feeding were also described. The secondary outcome was the association between breastfeeding and uptake of PNP and ART.

Statistical analysis

Data were cleaned and analysed using the STATA software version BE-17.0 or SE-14 (StataCorp., USA). Proportions were calculated to report the prevalence of each feeding characteristic. Chi-squared tests were conducted to assess the distribution of the feeding characteristics by each exposure variable and to compare demographic characteristics of WLHIV included (successfully interviewed) in the study with the data of those who were not included. A *p*-value < 0.05 was used to indicate a significant Chi-squared result. A log binomial regression model was used to identify factors associated with breastfeeding practice among WLHIV during the peak lockdown period. Prevalence ratios with corresponding 95% confidence intervals (CIs) were reported. Only binary tests were conducted. A multivariable model was not conducted owing to relatively numerous exploratory independent variables compared with the small sample size. Perceived influence of clinic visit barriers on selected healthcare uptake variables was assessed first with a chi-squared distribution test and, if significant, followed by a binary log binomial regression model for the interaction term. Non-overlapping 95% CIs were used to indicate significant prevalence ratios in the log binomial regression analysis. We determined whether the risk of VHT changed during the peak COVID-19 lockdown period by calculating the prevalence

of high-risk status at both baseline (pre-COVID data) and COVID-19 lockdown time points using data from the same participants who were enrolled at baseline and subsequently participated in the telephonic survey during COVID-19 lockdown. High-risk status was defined based on three concurrent conditions: (i) ongoing breastfeeding; (ii) absence of PNP; and (iii) maternal VL $\geq 1\ 000$ copies/mL or unknown VL. The prevalence of high-risk status was calculated as a proportion (number of high-risk infants divided by total number of HIV-exposed children) at each timepoint, expressed as a percentage. We created binary variables for each risk criterion and then combined all three to determine overall high-risk status using logical operations.

A post-hoc power analysis was conducted to determine the statistical power of the achieved sample size in measuring a difference in breastfeeding prevalence between two groups (i.e. for children on PNP v. those not on PNP). The power was calculated using the observed breastfeeding prevalence in the achieved sample size assuming a standard deviation of 5%.

Ethics

Ethics approval was obtained from the SA Medical Research Council ethics committee (ref. no. EC021-6/2020) and the Regional Committee for Medical and Health Research Ethics West, Norway (REK-Vest ref. no. 2019/773). During the baseline study, the consent process included permission to contact participants for future studies and only participants who agreed were contacted for participation in the follow-up telephonic survey. The telephonic survey involved a verbal telephonic consent process which was recorded before commencing each interview.

Results

Reliability of the achieved sample size

Contact details for telephonic follow-up were available for 655 of 667 WLHIV, including those who had progressed from the third trimester of pregnancy during baseline recruitment to postpartum during peak COVID-19 lockdown. Of these, 43.5% ($n/N=290/667$) were not contactable, 35 interviews were unsuccessful (interviews with no consent, participants no longer interested in taking part and incomplete surveys) and 8 interviews were interrupted, resulting in a final sample of 322 (48.3%) with complete interviews. In the post-hoc power analysis, the sample size of 322 with an observed breastfeeding prevalence of 30% using 95% CI and an assumed standard deviation of 5%, had 100% power to detect a 5% difference in breastfeeding prevalence between two groups. The 95% CI for the reported breastfeeding estimate was 25.3 - 35.4%, with a standard error of 8.55%, indicating a reasonably precise estimate. Therefore, this sample is considered reliable for the observed differences (all $>5\%$) in breastfeeding prevalence between age groups and between HIV status groups.

Summary of participant characteristics

The analysed sample of participants was biased towards those with desirable antenatal care practices and improved health-seeking behaviour ([Supplementary File 1](#)). In comparison to WLHIV who could not be reached nor interviewed, fewer of the women who participated in this telephonic survey were in their third trimester during baseline study enrolment (38.8% (95% CI 32.0 - 46.1) v. 61.2% (95% CI 53.9 - 68.0)) ($p=0.007$), had an unplanned pregnancy (44.4% (95% CI 39.3 - 49.7) v. 55.6% (95% CI 50.3 - 60.7), $p=0.009$), or attended the first antenatal care visit after 20 weeks' gestation (36.6% (95% CI 26.3 - 48.4) v. 63.4% (95% CI 51.6 - 73.7) ($p=0.007$).

The characteristics of the interviewed sample are summarised in Table 1. Among the 322 WLHIV interviewed telephonically, maternal age ranged between 19 and 46 years during the peak

lockdown period. Many households (69%) had no one with an active income during the study period besides receiving the COVID-19 government relief grant (93.5%). Just over half (55.9%) of the women reported not facing barriers to visiting the clinic during the peak lockdown period. The cited clinic barriers in the remainder 44.1% ($n/N=142/322$) included fear of getting the coronavirus, long clinic queues, closed clinics, fear of visiting distant clinics owing to the lock-down enforcement. Most women (96.3%) were on first-line ART regimen and had disclosed their HIV status to someone (92%). Less than 30% of women with VL test done in the past 6 months had a VL $\geq 1\ 000$ copies/mL and most (63.7%) had no VL test done. During this peak lockdown period, about 6% of the women ran out of ART, with less than 2% going without treatment for more than a week, and among these 70% ($n/N=14/20$) were women who reported facing barriers to visiting the clinic during peak lockdown period. We explored a potential relationship between clinic visit barriers and selected factors ([Supplementary File 2](#)). The distribution of clinic visits barriers varied significantly by infant HIV and treatment status and mother's VL ($p<0.001$). Regarding antiretroviral access, all mothers who reported their infants running out of medication cited fear of COVID-19 infection as a barrier, while 57.1% of those who never ran out reported no barriers ($p=0.001$).

Nearly half of the 322 children included in this telephonic survey were 12 months old or younger (49.4%), 39.8% were aged >12 to 24 months and the remainder (10.9%) were between 24 and 36 months old. A total of 18 (5.6%) were CLHIV and on ART. These 18 CLHIV contributed 6.3% of the ≤ 12 months age group, 3.1% of the >12 - 24 months age group, and 8.6% of the 24 - 36 months age group. All children were older than 12 weeks during the study period for the telephonic survey, therefore, all those who were receiving PNP were on extended PNP. Most ($n/N=304/322$) children were HEUs and 300 of these were eligible for extended PNP. Of the HEUs eligible for extended PNP, 47.7% were on extended PNP, and the rest were not. About 29% ($n/N=87/304$) of HEUs were breastfeeding, and more than half of those (62.1%) were on extended PNP. Nearly all HIV-exposed children who had been prescribed routine extended PNP or where on ART never ran out of extended PNP or ART (97.8%) during peak lockdown period. However, of the few who did, 1.2% did not take extended PNP or ART for over a week. The number of infants classified as being at high-risk of HIV acquisition increased dramatically from 11 (3.4%) at baseline (with no observed HIV infections in this sample at that time point) to 174 (54.0%) during the COVID-19 peak period. Among those classified as high-risk during the COVID-19 period, 6 (95% CI 5.64-6.38) HIV infections were observed.

Prevalence of infant feeding practices during the COVID-19 pandemic

Overall, 30.1% and 64.3% of participants reported breastfeeding and formula/fresh milk feeding during the peak lockdown, respectively. The summary of feeding practices is shown in Table 2. Breastfeeding during peak lockdown was highest among the ≤ 12 -months age group (41.5%), compared with older age groups (>12 to 24 months (23.4%) and >24 to 36 months (2.9%), respectively ($p<0.001$)). Overall, 37.8% of HEUs on extended PNP were breastfeeding compared with 21.0% of those eligible but not on extended PNP ($p<0.001$). Breastfeeding was comparably higher among CLHIV (53.3%; $p<0.001$). Feeding formula/fresh milk was more prevalent among those HEUs who were eligible but not on extended PNP (73.2%) compared with 57.3% on extended PNP ($p<0.001$). The prevalence of feeding on solids was at least 80% in all infant groups.

Table 1. Characteristics of the study participants

Variable		<i>n</i> (%)
Child age groups (months)	4 - 12	159 (49.4)
	>12 - 24	128 (39.8)
	>24 - 33	35 (10.9)
Child HIV status	Negative (HEUs)	304 (94.4)
	CLHIV	18 (5.6)
HEUs still breastfeeding	Yes	87 (28.6)
	No	217 (71.4)
Breastfeeding HEUs on extended-PNP	Yes	54 (62.1)
	No	33 (37.9)
Maternal age (years)	19 - 28	107 (33.2)
	29 - 38	177 (55.0)
	39 - 46	38 (11.8)
Education at baseline	≤Grade 12	200 (62.1)
	>Grade 12	122 (37.9)
Disclosed HIV status	No	26 (8.1)
	Yes	296 (91.9)
Baseline high-risk for VHT	No	311 (96.6)
	Yes	11 (3.4)
Peak COVID-19 high-risk for VHT	No	148 (46.0)
	Yes	174 (54.0)
During peak lockdown Receiving government grant	No	21 (6.5)
	Yes	301 (93.5)
Income source	Self	40 (12.4)
	Partner/spouse	43 (13.4)
	Parent/relative	16 (5.0)
	No one had income	223 (69.3)
Child ever goes without food for whole day	No	315 (97.8)
	Yes	7 (2.2)
Clinic visits barriers	Did not face problems	180 (55.9)
	Afraid of getting infected with coronavirus	107 (33.2)
	Other	35 (10.9)
Maternal ART regimen	First-line*	310 (96.3)
	Second-line [†]	10 (3.1)
	Third-line [‡]	2 (0.6)
Maternal VL if known	Yes VL done, ≥1 000 copies/mL	67 (20.8)
	Yes VL done, do not recall actual VL (13.7%) (includes those who reported <1 000 (1.9%))	50 (15.6)
	VL not done	205 (63.7)
Ran out of ART and for how long	Yes, a few days	14 (4.4)
	Yes, >1 week	3 (0.9)
	Yes, >1 month	3 (0.9)
	Never	302 (93.8)
CLHIV on ART	On ART	18 (100)
HEUs eligible for extended PNP	No	4 (1.3)
	Yes eligible	300 (98.7)
Extended PNP in eligible HEUs	Eligible HEUs on extended PNP	143 (47.7)
	Eligible HEUs not on extended PNP	157 (52.3)
Infant ran out of ART and for how long	Yes, a few days	3 (0.9)
	Yes, >1 week	2 (0.6)
	Yes, >1 month	2 (0.6)
	Never	315 (97.8)

HEU = HIV-exposed uninfected; PNP = postnatal prophylaxis; VHT = vertical HIV transmission; ART = antiretroviral therapy;

VL = viral load; CLHIV = children living with HIV.

*First-line: AZT/TDF + 3TC/FTC + EFV/DTG.

[†]Second-line: AZT/TDF + 3TC + LPV/r .

[‡]Third-line: DRV/r + RAL + optimised NRTIs.

Table 2. Proportion of breastfeeding practises during the peak COVID-19

	Any breastfeeding			Formula/fresh milk			Solids		
	n	Yes % (95% CI)	No % (95% CI)	n	Yes % (95% CI)	No % (95% CI)	n	Yes % (95% CI)	No % (95% CI)
Overall	322	30.1	69.9	322	64.3	35.7	316	91.1	8.9
Child age groups (months)***									
4 - 12	159	41.5 (34.1 - 49.3)	58.5 (50.7 - 65.9)	159	64.2 (56.4 - 71.2)	35.8 (28.8 - 43.6)	159	83.0 (76.3 - 88.1)	17.0 (11.9 - 23.7)
>12 - 24	128	23.4 (16.9 - 31.6)	76.6 (68.4 - 83.1)	128	66.4 (57.8 - 74.1)	33.6 (25.9 - 42.2)	123	99.2 (94.4 - 99.9)	0.8 (0.1 - 5.6)
>24 - 33	35	2.9 (0.1 - 17.8)	97.1 (82.2 - 99.6)	35	57.1 (40.5 - 72.3)	42.9 (27.7 - 59.5)	34	100	0
Infant HIV and treatment status*									
Eligible HEU not on extended PNP	157	21.0 (15.3 - 28.1)	79.0 (71.9 - 84.7)	157	73.2 (65.8 - 79.6)	26.8 (20.4 - 34.2)	156	89.1 (83.1 - 93.3)	10.9 (6.9 - 16.9)
Non-eligible HEUs not on extended PNP	4	0	100	4	100.0	0	4	100	0
Eligible HEU on extended PNP	143	37.8 (30.2 - 46.0)	62.2 (54.0 - 69.8)	143	57.3 (49.1 - 65.2)	42.7 (34.8 - 50.9)	138	94.2 (88.8 - 97.1)	5.8 (2.9 - 11.2)
CLHIV (all on ART)	18	55.6 (33.0 - 76.1)	44.4 (23.9 - 67.0)	18	33.3 (15.8 - 57.2)	66.7 (42.8 - 84.2)	18	83.3 (59.0 - 94.6)	16.7 (5.4 - 41.0)
WLHIV ART interruption									
Yes	20	6.2 (2.8 - 13.2)	93.8 (86.8 - 97.2)	20	6.8 (4.0 - 11.1)	93.2 (88.9 - 96.0)	20	6.3 (4.0 - 9.7)	93.8 (90.3 - 96.0)
No	302	6.2 (3.7 - 10.2)	93.8 (89.8 - 96.3)	302	5.2 (2.4 - 11.2)	94.8 (88.8 - 97.6)	296	7.1 (1.8 - 24.6)	92.9 (75.4 - 98.2)

CI = confidence interval; HEU = HIV-exposed uninfected; PNP = postnatal antiretroviral prophylaxis; CLHIV = children living with HIV; ART = antiretroviral therapy; WLHIV = women living with HIV. **p*<0.001 (Chi-squared).

Factors associated with breastfeeding during the COVID-19 pandemic peak lockdown period

In log binomial regression analysis, child age and HIV status combined with treatment status were significantly associated with breastfeeding (Table 3). Breastfeeding was less likely among HIV-exposed children aged >12 - 24 months (prevalence ratio (PR) 0.6 (95% CI 0.4 - 0.8)) and those aged >24 - 36 months (PR 0.1 (95% CI 0.0-0.5)) compared with younger infants. HEUs who were still on extended PNP and CLHIV (all on ART) had a significantly increased likelihood of breastfeeding (PR 1.8 (95% CI 1.2 - 2.6), and PR 2.6 (95% CI 1.6 - 4.4), respectively) compared with eligible HEUs not on extended PNP. This significant relationship remained the same even in the context of clinic visit barriers, i.e. in the interaction model, HEUs on extended PNP and CLHIV (all on ART) were more likely to be breastfeeding (PR 4.3 (95% CI 1.8 - 10.6) and PR 5.2 (95% CI 1.5 - 18.1), respectively), even when faced with clinic visit barriers, compared with those who reported not facing barriers. Other factors perceived to be affected by clinic visit barriers (listed in [Supplementary File 2](#)) did not show significant interactions with this variable (results not shown).

Given that children on extended PNP or ART had significantly higher odds of breastfeeding compared with those eligible HEUs who were not on extended PNP, we investigated whether the proportion of children on extended PNP or ART were significantly younger than those not on extended PNP, thus contributing to the differences observed in breastfeeding. Using chi-squared statistics, there was a difference in the age distributions between CLHIV (all on ART), eligible HEUs on extended PNP and eligible HEUs not on extended PNP (*p*=0.024) ([Supplementary File 3](#)). Most of the eligible

HEUs not on extended PNP (56.7%) were ≤12 months old, while most HEUs on extended PNP were >12 - 24 months old (49.7%). This finding contrasts the assumption that younger age could be the reason for more prevalent breastfeeding among HEUs on extended PNP. Most CLHIV were aged 1 - 2 years.

Discussion

The present study assessed the prevalence of breastfeeding among HIV-exposed children during the COVID-19 pandemic peak lockdown period in a rural district of SA and explored association with antiretroviral coverage and other factors. Overall, only around 30% of HIV-exposed children were breastfed during this period. Breastfeeding prevalence varied significantly with age, with much higher rates among those 12 months or younger compared with older children, as expected. Differences were also observed based on HIV status combined with treatment status with and without COVID-19-related fear of access to care. Breastfeeding was more common among HEUs receiving extended PNP and CLHIV (all of whom were on ART) compared with eligible HEUs not taking antiretrovirals.

Breastfeeding prevalence was highest (41.5%) among infants ≤12 months, dropping to 23.4% in the 12 - 24-month age group. This decline in breastfeeding rates with increasing infant age is consistent with patterns observed in various settings including both low- and middle- and high-income countries such as Zambia and Norway,^[19,20] respectively, and highlights the need for continued support and education to promote sustained breastfeeding among WLHIV. The overall breastfeeding prevalence of 30% observed in this study is lower than the

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Table 3. Factors associated with practising any breastfeeding during the COVID-19 peak lockdown period (N=322)

Variables	PR (95% CI)
Child age groups (months)	
4 - 12	Ref
>12 - 24	0.6 (0.4 - 0.8)*
>24 - 33	0.1 (0.0 - 0.5)*
Maternal age (years)	
19 - 28	Ref
29 - 38	0.9 (0.6 - 1.3)
39 - 46	0.9 (0.5 - 1.6)
Infant HIV and treatment status	
Eligible HEU not on extended PNP	Ref
Eligible HEU on extended PNP	1.8 (1.2 - 2.6)*
CLHIV on ART	2.6 (1.6 - 4.4)*
Maternal VL if known	
Yes VL done, $\geq 1\ 000$ (20.8%)	Ref
Yes VL done, cannot recall actual VL (13.7%) (includes those who reported $< 1\ 000$ (1.9%))	1.3 (0.8 - 2.3)
VL not done (63.7%)	1.0 (0.7 - 1.6)
Infant ever run out of ART and duration	
Yes, a few days/more	Ref
Never	1.1 (0.3 - 3.4)
Mother ran out of ART and duration	
Yes, a few days/more	Ref
Never	1.0 (0.5 - 2.0)
Education at baseline	
\leq Grade 12	Ref
$>$ Grade 12	0.8 (0.5 - 1.1)
Disclosed HIV status	
No	Ref
Yes	1.1 (0.6 - 2.2)
Receiving government grant	
No	Ref
Yes	0.9 (0.5 - 1.7)
Income source	
Self	Ref
Partner/spouse	1.4 (0.7 - 2.9)
Parent/relative	1.1 (0.4 - 3.1)
No one had income	1.3 (0.7 - 2.4)
Clinic visits barriers	
No barriers	Ref
Afraid of getting infected with coronavirus	1.0 (0.7 - 1.4)
Other	0.8 (0.5 - 1.5)
Interaction with infant HIV and treatment status	
Afraid of getting infected with coronavirus [†]	4.3 (1.8 - 10.6)*
Other [†]	2.6 (0.8 - 8.1)
Afraid of getting infected with coronavirus [‡]	5.2 (1.5 - 18.1)*
Other [‡]	1.0
Child ever go without food the whole day	
No	Ref
Yes	0.9 (0.3 - 3.1)

PR = prevalence ratio; CI = confidence interval; HEU = HIV-exposed uninfected; PNP = postnatal antiretroviral prophylaxis; CLHIV = children living with HIV;

ART = antiretroviral therapy; VL = viral load.

* $p < 0.001$.

[†]HEU on extended PNP.

[‡]CLHIV on ART.

breastfeeding rate observed before the COVID-19 pandemic among the baseline cumulative sample of HIV-exposed children (57.3%) and around 6 months of age (45.5%),^[21,22] and rates reported in some other sub-Saharan African settings. For example, a study in Ethiopia found a breastfeeding rate of 90.7% among HIV-exposed children.^[23] This lower prevalence was likely due to weaning as children grew older during the 6 - 9 months period post recruitment in the baseline study in 2019. However, our findings are more consistent with previous SA studies,^[24,25] which have reported breastfeeding rates between 18 and 66.3% among HIV-exposed children. During this pandemic period of restricted access to services, we found higher prevalence of breastfeeding among CLHIV (55.6%) compared with HEUs (37.8%). This difference between CLHIV and HEUs is consistent with findings from other studies in similar settings, prior to the COVID-19 pandemic. For instance, a study^[26] in Kenya reported higher breastfeeding rates among CLHIV compared with HEUs. This pattern might be attributed to increased nutritional needs of CLHIV or differences in counselling provided to mothers of these children v. those of HEUs, and not necessarily owing to COVID-19-related factors. However, further research is needed to understand how mothers of CLHIV make breastfeeding decisions. The COVID-19 pandemic worsened food insecurity concerns,^[27,28] and given that most mothers in our study reported no personal income and depended on their partner's or spouse's income, these factors may have further necessitated breastfeeding as a feeding option. This indicates the role of breastmilk as an important source of food among those with a higher risk of food insecurity. Even though a significant interaction was observed between COVID-19-related barriers and breastfeeding practices, it did not have a negative impact on the practice of breastfeeding among mothers who reported COVID-19-related fear of access to care. These results suggest that mothers who had access to antiretroviral treatment felt more confident about continuing breastfeeding despite pandemic-related fears. These findings underscore the importance of ensuring continued access to treatment during health crises. In addition, the telephonic survey appeared to have a selection bias with more participation from WLHIV who were better at complying with healthcare service recommendations (i.e. planned pregnancy and early enrolment into antenatal care).

The WHO recommends breastfeeding for HIV-exposed children up to 24 months or beyond, provided the mother is on ART and fully adherent. In general, few WLHIV practised breastfeeding during the COVID-19 pandemic peak lockdown despite very high ART and extended PNP coverage. Breastfeeding was more prevalent among HEUs receiving extended PNP, suggesting good knowledge of transmission risk and that extended PNP may increase mothers' confidence in the safety of breastfeeding. This finding is noteworthy as this effect has not been directly studied. This finding highlights an important area for further investigation, as the impact of extended PNP on breastfeeding practices has not been adequately explored in existing literature. The differences observed in age distribution between infant HIV status groups confirmed that the significant differences observed in the prevalence of breastfeeding were not due to higher proportions of younger infants among HEUs on extended PNP or CLHIV on ART compared with HEUs who were not on extended PNP. Rather, there were fewer infants aged ≤ 12 months in the HEUs on extended PNP compared with those who were not on extended PNP, with equal proportions of infants aged ≤ 12 months between the HEUs not on extended PNP and CLHIV. Therefore, concluding that the significantly higher odds of breastfeeding among

HEUs on extended PNP compared with those not on extended PNP could be due to confidence in the reduced risk of HIV transmission provided by extended PNP.

The reason for most of the HEUs on extended PNP being older than 1 year likely reflect implementation of the extended PNP guideline for the duration of breastfeeding^[10] and that some mothers breastfeed while having elevated VL. This guideline to provide extended PNP until after cessation of breastfeeding, was introduced in 2019 in SA, and could increase breastfeeding prevalence for HEUs older than 1 year. A properly designed survey is needed to adequately measure progress in adoption of this guideline in practice. The observed higher extended PNP coverage among the HEUs who were being breastfed is worth noting and emphasises the need for addressing high VL in breastfeeding mothers. This finding is concerning because under the guidelines in place during our study, only children whose mothers had VL ≥ 1000 copies/mL, or had no VL test done, were eligible for extended PNP, potentially missing other at-risk children, as transmission still occurs with detectable VL. However, the 2023 guidelines adjusted the threshold for transmission risk from VL ≥ 1000 copies/mL to VL ≥ 50 copies/mL, reflecting a more cautious approach to preventing HIV transmission during breastfeeding. This relationship between extended PNP coverage and breastfeeding becomes even more critical when considering the substantial increase in high-risk for VHT that coincided with the COVID-19 peak lockdown period, suggesting potential disruptions in prevention of VHT services, changes in breastfeeding practices, or reduced support for maternal viral suppression. Implementation of universal coverage of extended PNP should be strengthened to ensure that prolonged breastfeeding remains a safe and optimal source of feeding, and this becomes extremely necessary during times of food insecurity.^[29]

Study strengths and limitations

The present study provides data from an important period during the COVID-19 pandemic that informs the performance of routine healthcare antiretroviral services in supporting WLHIV who practise breastfeeding. Our study had sufficient power to detect a difference as low as 5% points in breastfeeding prevalence. The study sample of 322 also provided a reasonably precise estimate of breastfeeding prevalence, with a relative standard error well below the commonly used 25% threshold for reliability. However, the 95% CI (25.3% - 35.4%) suggests that the true population prevalence could vary by up to 5 percentage points in either direction from our point estimate. This level of precision is adequate for the purposes of our study, but future research with larger sample sizes could provide even more precise estimates.

The final analysed sample of participants was observed to be biased towards those with desirable antenatal care practices and improved health-seeking behaviour, thus the results in this study may not reflect the broader population in the district. Although the external validity of the sample size was not confirmed, it is still useful in showing that breastfeeding prevalence among HIV-exposed children during the peak season of COVID-19 lockdown remained unchanged despite high coverage of extended PNP. The accuracy of determining extended PNP eligibility was significantly impacted by a major challenge: about 14% of mothers who had undergone VL testing in the past 6 months were unaware of their results. This lack of awareness greatly hindered the precision of our extended PNP eligibility assessment. The small sample size may also have limited the ability to identify other factors associated with breastfeeding practice. The feeding practices in this study were based on self-reported data, which can be susceptible to response bias.

Conclusion

Good antiretroviral coverage supported safe breastfeeding practices during the COVID-19 pandemic peak lockdown in this rural setting in SA. The findings indicate promising ongoing adoption of extended PNP for the duration of breastfeeding, and this might subsequently lead to increased confidence to breastfeed for longer.

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