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Exploring Digital Pill Technology for ART Adherence in Postpartum and Pregnant Women with HIV in South Africa: Insights from a Qualitative Study

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Abstract

In South Africa, nearly one-quarter of cisgender women aged 15–49 are living with HIV, and among them, a significant proportion are pregnant. Maintaining adherence to antiretroviral therapy (ART) during pregnancy and postpartum is crucial for preventing HIV transmission from mother to child. However, women often face multiple challenges that hinder consistent medication use, including pregnancy-related physical changes, mental health struggles, limited social support, and systemic barriers. Digital pill systems (DPS)—medications embedded with ingestible sensors that track adherence—have been implemented in the United States to monitor pre-exposure prophylaxis (PrEP) use among men who have sex with men. While such technology could potentially enhance ART adherence and reduce the risk of mother-to-child transmission in South Africa, its acceptability among pregnant and postpartum women has yet to be explored. Thirty women living with HIV, including 15 who were pregnant and 15 who were postpartum, and who had reported difficulties with ART adherence, were exposed to digital pill systems (DPS) and subsequently participated in qualitative interviews. The interview data were examined using a rapid qualitative analysis method. In the past 30 days, participants reported missing an average of 3.0 (SD = 2.1) doses of ART. Most women found the concept of the digital pill system (DPS) and its elements acceptable, including ingesting a radiofrequency-enabled pill and wearing the accompanying digital Reader, which transmits adherence data to a smartphone app via a lanyard. They felt that DPS could support better adherence and foster accountability, potentially reducing the risk of HIV transmission to their infants. Those who had shared their HIV status with close friends or family generally considered wearing the Reader for a few minutes daily acceptable and appreciated that providers could access their adherence information. The linked smartphone app was also viewed as a helpful reminder for ART collection and ingestion. However, both pregnant and postpartum participants highlighted that the main concern limiting their use—or recommending DPS to others—was the possibility of unintended disclosure of their HIV status due to the visible Reader. Future studies should investigate optimal digital pill Reader designs that enhance usability for this population in South Africa, particularly for individuals reporting suboptimal ART adherence or presenting to antenatal care with unsuppressed HIV RNA.

Keywords: HIV, Digital pill technology, Pregnancy, ART, South Africa, Postpartum

Introduction

In southern Africa, cisgender women—especially those who are pregnant or recently gave birth—bear a disproportionate share of new HIV infections, accounting for 63% of cases among cisgender girls and women [1]. In South Africa, nearly one-third of pregnant women attending public antenatal clinics are living with HIV [1]. Adherence to antiretroviral therapy (ART) during pregnancy and postpartum is crucial for preventing mother-to-child transmission (MTCT). However, adherence often declines after delivery. While adherence during pregnancy tends to be higher, postpartum women frequently face competing demands such as newborn care, financial pressures, and reduced focus on their own health, even though the risk of HIV transmission through breastfeeding remains high [2]. Data indicate that about

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73.5% of pregnant women maintain ART adherence, but this drops to around 53% after childbirth [3], contributing to suboptimal viral suppression and increased MTCT risk [4]. These patterns underscore the need for improved adherence monitoring and support strategies for women during the peripartum period in South Africa.

Several individual, interpersonal, and structural factors can interfere with ART adherence during this period. At the individual level, common pregnancy-related symptoms, ART side effects, and mental health issues pose challenges [5–8]. Nausea and vomiting, affecting 70–85% of pregnant women, can be worsened by ART and lead to missed doses [3, 4]. Mental health conditions, particularly depression, are prevalent in up to 47% of peripartum women in South Africa [9], often fueled by poverty, unplanned pregnancies, and intimate partner violence (IPV) [10, 11]. Depression can reduce problem-solving skills, promote social isolation, and weaken hope, all of which undermine adherence [8, 12, 13]. IPV, reported by 18–63% of pregnant women living with HIV in southern Africa, also disrupts adherence by increasing posttraumatic stress, discouraging disclosure of HIV status, and causing missed clinic visits [14, 15].

Structural and systemic factors further complicate adherence. In many low- and middle-income countries (LMICs), limited job opportunities force individuals to prioritize work over clinic appointments, negatively affecting ART adherence [16, 17]. Healthcare-related stigma can also be a barrier. Practices such as separate waiting areas for people living with HIV or distinctively colored medical folders can inadvertently reveal a patient's HIV status, discouraging engagement with care and adherence to ART [8, 18].

Various approaches have been applied to measure and support adherence. Indirect methods, including self-reports, pill counts, and pharmacy refill data, may not accurately reflect actual pill-taking behavior, which is especially important in the peripartum period when MTCT risk is high [19]. Viral load testing is a critical tool, but delays in processing and clinical response in LMICs can hinder timely interventions. Technology-assisted methods—such as electronic pillboxes, smart pill bottles, and blister-pack trackers—can monitor pill access but cannot confirm ingestion [20]. As a result, direct adherence measurement strategies beyond directly observed or video-observed therapy remain rare in LMICs.

In the United States, digital pill systems (DPS) have been used for over 16 years to objectively track medication adherence and have proven effective for monitoring preexposure prophylaxis (PrEP) and ART in research settings. DPS use ingestible radiofrequency (RF) sensors embedded in gelatin capsules that over-encapsulate medication [21]. Once swallowed, the stomach acid activates the sensor, sending a signal to a wearable Reader (a necklace device) that confirms ingestion **(Figure 1).** The Reader then transmits data via Bluetooth to a linked smartphone app, providing real-time adherence feedback to patients and healthcare teams. Among men who have sex with men (MSM) with substance use disorders, DPS was found to be feasible and acceptable, with participants successfully integrating it into daily routines [22]. For people living with HIV in the US, DPS use has been linked to lower HIV RNA viral loads [23]. Introducing DPS in South Africa could provide a direct, real-time method to monitor and address poor ART adherence during the peripartum period, helping reduce MTCT. The DPS (ID-Cap System; etectRx) has received regulatory approval for clinical use.

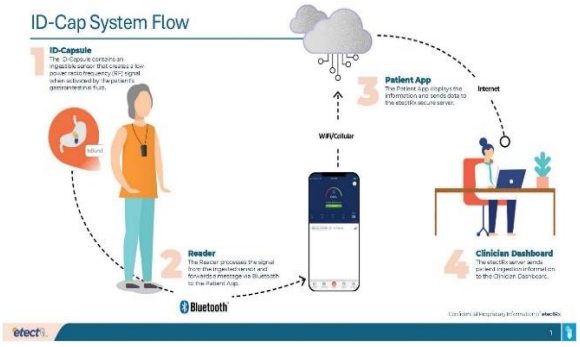

Figure 1. Shows a flowchart of the ID-Cap System, outlining the sequence of events in the digital pill system from the time the pill is swallowed until the clinician receives an alert.

Perceptions of digital pill systems (DPS) have not been studied in South Africa to date. Examining these perceptions in pregnant and postpartum women who report inconsistent antiretroviral therapy (ART) adherence could offer valuable insights into whether they would be open to using DPS to help prevent HIV transmission to their babies. For this reason, the study aimed to assess the acceptability and practicality of using DPS technology to track ART adherence in pregnant and postpartum women with HIV in South Africa.

Materials and Methods

Study procedures

Participants living with HIV during pregnancy and the postpartum period were enrolled from two antenatal clinics located within larger community health facilities in Khayelitsha, a peri-urban area near Cape Town, South Africa, where the research team already had established connections with clinic staff. The research investigated the acceptability of digital pill systems (DPS) for tracking and offering feedback on antiretroviral therapy (ART) adherence throughout these life stages.

Research assistants responsible for recruitment and conducting interviews underwent a two-day in-person training delivered by project staff from the United States and South Africa. This training covered the study materials (including the protocol, informed consent document, questionnaire, and interview guide) and involved role-playing simulated study visits with principal investigators, supervisors, and peers.

Study research assistants approached potential participants while they waited in line at the clinic. Clinic personnel were also briefed on the inclusion criteria to enable them to refer suitable patients. Individuals who showed interest were invited to undergo eligibility screening by a research assistant in a private area within the clinic.

For pregnant participants, inclusion criteria included: (1) confirmed HIV-positive status and current pregnancy (any gestational age), verified through medical records; (2) age 18 years or older; (3) currently on HIV treatment; (4) self-reported ART non-adherence (any missed doses within the previous 30 days); and (5) ability to complete study activities in isiXhosa or English. Postpartum participants met the same criteria, except they had delivered within the last six months and were breastfeeding at the time.

Eligible individuals could choose to proceed with informed consent and study participation on the same day or schedule a return visit. Consent was conducted in the private clinic space, where the research assistant explained the consent form, obtained written agreement from those who wished to join, and gave participants a copy for their own records.

The study received ethical approval from the institutional review boards at Massachusetts General Hospital (ethics reference #2023P000088) and the University of Cape Town (UCT) (HREC REF: 007/2023). A formal collaboration agreement was additionally set up between UCT and Boston University.

In total, 48 pregnant and postpartum women underwent eligibility screening; 21 pregnant and 20 postpartum individuals satisfied the criteria. Among the 41 eligible persons, 30 participated in a short questionnaire and in-depth qualitative interview conducted in a private area at their recruitment clinic. The questionnaire collected basic sociodemographic details, pregnancy-related information, self-reported ART adherence, and readiness to adopt DPS [adapted from System Usability Scale [24]. A semi-structured interview guide, created following the recommendations of Miles and Huberman [25], was used to examine: (1) views on digital pill technology; (2) practicality and acceptability of DPS use during pregnancy and postpartum; (3) perspectives on DPS privacy measures and data sharing; and (4) suggestions for future DPS improvements. In the interviews, participants viewed an educational video explaining how the system tracks ART adherence and protects user safety. Physical samples of the digital pills, gelatin capsules, and readers were shown, allowing participants to handle the components and even disassemble the capsule to examine the radiofrequency emitter.

Analysis Interviews were audio-recorded, transcribed, and—if conducted in isiXhosa—translated into English by South Africa-based research assistants (YT, MN). A rapid qualitative analysis (RQA) method was employed for the qualitative data. Prior to data collection, the second author (JSL) designed a matrix template to structure key domains and subdomains based on the interview guide. Relevant transcript sections were summarized and placed into the appropriate matrix cells using Microsoft Excel. JSL began coding the first seven transcripts, after which the first author (MRF) reviewed additional transcripts and expanded the framework by incorporating new subdomains for better coverage. The team convened biweekly to review emerging themes and maintain consistent data interpretation between South African research assistants and analysts. All co-authors examined, debated, and reached consensus on the final themes and sub-themes before preparing the manuscript. The overall synthesis emphasized patterns across domains and connected results to wider research priorities and prior studies.

Results and Discussion

The sample comprised 30 women, with an equal split between those who were pregnant (n = 15) and those in the postpartum period (n = 15). Participants had a mean

age of 31 years (SD = 6.2). Among the pregnant women, the average gestational age was 23.3 weeks (SD = 11.3), whereas postpartum women were, on average, 11.3 weeks past delivery (SD = 9.1). Over the preceding 30 days, participants reported missing an average of three ART doses (SD = 2.1). Notably, 28 participants (93.3%) indicated that they did not conceal their HIV medication from others. Comprehensive demographic information is summarized in **Table 1**. Most participants viewed the DPS as highly beneficial and expressed strong interest in using it to support adherence to ART. Complete quantitative findings regarding willingness to use the DPS are provided in **Table 2.**

Table 1. Participant demographics

Characteristic	**Value**
Age (Mean SD)	31.0 (6.2)
Weeks postpartum Mean (SD)	11.3 (9.1)
Gestational age (weeks) (Mean SD)	23.3 (11.7)
Gestational age at presentation for antenatal care (weeks) (Mean SD)	10.0 (5.5)
Total lifetime pregnancies (Mean SD)	2.5 (1.3)
Missed medication doses in the past 30 days (Mean SD)	3.0 (2.1)
Total live births (Mean SD)	1.9 (1.2)
Highest Education Level	(n, %)
Grade 12 / Standard 10	9 (30.0%)
Grade 11 / Standard 9	13 (43.3%)
Grade 10 / Standard 8	2 (6.7%)
Grade 9 / Standard 7	4 (13.3%)
Vocational training	2 (6.7%)
Hides HIV medication	(n, %)
No	28 (93.3%)

Table 2. Participants' willingness to use DPS**.**

Item	**Strongly disagree**	**Disagree**	**Neither agree nor disagree**	**Agree**	**Strongly agree**
I find the system likely to be user-friendly.	1 (3.3)	2 (6.7)	1 (3.3)	23 (76.7)	3 (10)
I feel the system might be more complicated than necessary.	2 (6.7)	12 (40)	1 (3.3)	14 (46.7)	1 (3.3)
I believe the system's features are well-connected.	1 (3.4)	0	1 (3.4)	25 (86.2)	2 (6.9)[1]
I think I might require help from a technical expert to use this system.	0	10 (33.3)	1 (3.3)	17 (56.7)	2 (6.7)
I feel the system is rather inconsistent.	1 (3.3)	20 (66.7)	4 (13.3)	4 (13.3)	0
I think using the system would be quite awkward or inefficient.	1 (3.3)	26 (86.7)	1 (3.3)	2 (6.7)	0
I expect most people would pick up how to use this system quickly.	1 (3.3)	1 (3.3)	0	23 (76.7)	5 (16.7)
I need considerable learning before I can begin using the system.	0	7 (23.3)	0	19 (63.3)	4 (13.3)
I would feel confident using the system if it were provided to me.	1 (3.3)	0	0	25 (83.3)	4 (13.3)

I believe I would use this system often.	0	0	0	25 (83.3)	5 (16.7)
	Not at all useful	Slightly Useful	Moderately useful	Very useful	Extremely useful
Helping you stay accountable for taking your ART.	0	0	0	26 (86.7)	4 (13.3)
Guiding a beginner in consistently taking their ART medication.	0	0	0	26 (86.7)	4 (13.3)
Supporting you in following your ART regimen. .	0	0	0	26 (86.7)	4 (13.3)
Assisting healthcare providers in tracking your ART adherence.	0	0	0	25 (83.3)	5 (16.7)
Allowing you to view your previous ART adherence on your phone	0	0	0	26 (86.7)	4 (13.3)
	Not at all trusting	Slightly trusting	Moderately trusting	Very trusting	Extremely trusting
To what extent do you believe the digital pill system can reliably report your daily ART adherence?	0	2 (6.9)	0	26 (86.7)	2 (6.9)
	Not at all willing	Slightly willing	Moderately willing	Very willing	Extremely willing
Sending messages to ask about anything that makes taking ART difficult.	1 (3.3)	0	0	26 (86.7)	3 (10)
Collecting phone information, including location, battery status, messaging, and app usage related to the digital pill system.	0	0	1 (3.3)	26 (86.7)	3 (10)
Sending messages about your daily routines and places you visit.	0	0	0	27 (90)	3 (10)
Making phone calls to talk about challenges in taking ART.	1 (3.3)	1 (3.3)	0	25 (83.3)	3 (10)
Based on what you know, how willing would you be to use digital pills to monitor your ART use?	0	0	2 (6.9)	24 (80)	4 (13.3)
Making phone calls to learn about your everyday activities and locations.	1 (3.3)	0	0	26 (86.7)	3 (10)
Using a wearable device (like a smartwatch) alongside the digital pill to track your body signals—such as heart rate, breathing, oxygen level, and temperature—when taking ART.	0	0	2 (6.9)	25 (83.3)	3 (10)

[1]One participant refused to answer

Our qualitative findings shed light on participants' views of the DPS, revealing both its potential to support ART adherence and obstacles that could limit its use. Participants felt that the DPS could help them stay on track with their medication and increase accountability, particularly in preventing HIV transmission to their infants. Most found it acceptable to wear the DPS reader for several minutes each day and to share adherence data with healthcare providers to promote transparency and receive support. A companion smartphone app was seen as a useful tool for reminders to collect and take ART. The main concern, however, was that the visible reader could inadvertently reveal their HIV status, which participants identified as the key barrier to consistent use.

Theme 1: DPS as a tool to enhance ART adherence and accountability to prevent HIV transmission to infants

Pregnant and postpartum participants considered the DPS a valuable tool not only for tracking their own ART adherence but also for protecting their infants from HIV. One postpartum participant emphasized how the technology could motivate her during breastfeeding, explaining, "There are times when it's really important to stay on track because the baby relies on me. I have to take my medication to protect the baby, so while breastfeeding, I would feel highly motivated to use the digital pill technology" (postpartum, age 40). Similarly, a pregnant participant described how the DPS could help ensure her baby's safety, saying, "It would be very helpful, especially during breastfeeding … it ensures the child gets protection and nothing harms them" (pregnant, age 24).

Several participants highlighted that seeing adherence data could further encourage consistent ART use. One pregnant participant explained how tracking her medication intake would motivate her while reassuring her about her baby's health:

"I think it would be very helpful because it shows whether I have taken my pill. I like that it tracks my daily and weekly progress, which helps me take my medication on time and also ensures my baby stays healthy … it motivates me because I want to see the results" (pregnant, age 28).

For women lacking social support for ART adherence, the DPS was seen as a potential source of guidance and encouragement. A postpartum participant shared her optimism about the device's ability to fill this gap during high-risk periods:

"I think fewer people would miss doses because the device can show whether someone has taken their medication … I like that it motivates and reminds you to take your pills, especially for those who don't have anyone to encourage or remind them, or who live alone" (postpartum, age 33).

Overall, participants found the DPS acceptable and motivating, suggesting that integrating it into routine clinical care could help reduce missed doses and improve adherence outcomes.

Subtheme 1: Acceptability of wearing the DPS reader among participants who disclosed their HIV status

Pregnant and postpartum women who had shared their HIV status with close friends and family generally reported that wearing the DPS Reader around their neck was manageable and acceptable. They saw short daily use after taking ART as a practical way to support adherence. One postpartum participant reflected, "I don't mind using it, even if others notice, because I understand the benefit it gives me" (postpartum, age 42).

Participants suggested that stigma in their immediate or wider social circles would not discourage them from using the Reader. A pregnant participant explained,

"I would wear it openly in front of them. If they tease me, it's their problem—I'm not trying to hide anything" (pregnant, age 29).

Several women noted that they would feel comfortable explaining the Reader's purpose to others. One pregnant participant said,

"I would wear the Reader without hesitation. Since I'm open about my status at home, I'd tell anyone who asks exactly what it's for" (pregnant, age 28).

In general, participants who had disclosed their HIV status found wearing the Reader acceptable and were confident in discussing it with others if asked.

Subtheme 2: Sharing adherence data with healthcare providers is acceptable to promote transparency and support

Participants generally saw value in allowing healthcare providers to access their DPS adherence data. They believed that sharing this information could improve transparency, help providers monitor their ART use, and enable timely guidance if doses were missed. A pregnant participant reflected on the reassurance this could provide: "It would be good because they would know I'm taking my medication properly. I don't skip any doses" (pregnant, age 24). Some participants highlighted that provider access could serve as a helpful reminder system. One postpartum participant explained, "I like that the doctor can see how I take my medication and would be able to remind me if I missed a dose" (postpartum, age 35). Others appreciated the idea of providers offering feedback when adherence might be slipping: "I have no problem with them seeing my adherence data. That way, they can let me know when I'm not doing well, in case I don't notice it myself" (pregnant, age 36). Several participants described provider engagement as motivating, encouraging them to stick to their ART regimen. A postpartum participant said, "It would make me want to take my medication and follow the treatment properly" (postpartum, age 18). Overall, participants viewed sharing adherence data with healthcare providers as a beneficial feature of the DPS, noting that it both reinforced their accountability and offered an additional layer of support to protect their babies.

Theme 2: The linked smartphone app as a tool for reminders to take ART and attend appointments

Most participants expressed interest in the smartphone app, particularly because they sometimes forgot to take their ART or missed clinic visits. They felt that the app could reduce uncertainty about whether they had taken their medication, lowering stress and improving adherence. One postpartum participant reflected,

"I think that would be very helpful, because we can be forgetful. Sometimes I wonder if I've taken my pill or not, and it's confusing. So having this would really help" (postpartum, age 40).

Similarly, another participant emphasized the sense of relief and satisfaction the app could provide when doses were taken on time:

"It would make me happy because I wouldn't feel stressed knowing I've taken my medication, and if I take it consistently for a month without forgetting, it makes me feel good" (postpartum, age 42).

Participants also valued the app's potential to link clinic appointments—both antenatal and HIV-related—to an in-app calendar, helping them attend visits on schedule and collect ART punctually. One pregnant participant said, "That would be very helpful because it lets me know the exact dates of my appointments, so I don't forget" (pregnant, age 32). A postpartum participant echoed this, noting, "Yes, that would be great, because I would always know when to go get my medication and wouldn't forget" (postpartum, age 33). In addition to reminders for scheduled doses, participants expressed interest in receiving notifications when a pill had been missed. One participant explained, "I would like to get a notification after I've taken my pill, and also one if I happen to forget it" (postpartum, age 31). Although some participants shared a smartphone with partners or family members, most were not concerned about others seeing the notifications. Overall, participants were highly receptive to the linked smartphone app, viewing it as a practical tool to stay on track with ART, reduce missed doses or appointments, and alleviate stress related to adherence.

Theme 3: Fear of revealing HIV status through the visible reader as a barrier to DPS use

Participants who had shared their HIV status did not express concern about wearing the DPS Reader. However, those who had not disclosed their status reported hesitation about using a device that could make their HIV status obvious. One pregnant participant noted the challenge of concealing the Reader at home: "The hardest part is that it might be tricky to keep it hidden at home because the reader is somewhat large" (pregnant, age 25). Several participants identified the device's visibility as a major obstacle, as it could force explanations to partners or family and potentially expose them to stigma. A pregnant participant explained,

"People who are keeping their status private would struggle with the reader because they would need to tell their partners and family why they're wearing it, and others would have questions about what they're doing" (pregnant, age 40).

Wearing the Reader could also heighten feelings of internalized stigma, particularly for those still coming to terms with their HIV status. A postpartum participant said, "I think someone who hasn't accepted their status would have the hardest time wearing the reader on their neck" (postpartum, age 31). In settings with high HIV-related stigma, the Reader's visibility could evoke shame. One participant reflected,

"The reader itself is fine, but because it's noticeable when you wear it, I think some people would feel embarrassed or uneasy, even though I wouldn't" (postpartum, age 31).

Some participants described how questions from others about the Reader could cause discomfort. A pregnant participant shared, "People might ask me what's around my neck… they might feel embarrassed wearing it if others are watching" (pregnant, age 32). Such situations could interfere with adherence and increase the risk of mother-to-child transmission. One participant highlighted a practical consequence: "For people hiding their status, it would be hard to wear the reader around others and take medication. They would likely wait until they have privacy before putting it on" (pregnant, age 36). While most participants responded positively to the DPS overall, some acknowledged that wearing the Reader and taking ART in front of others could delay doses, as they might prefer to wait until alone.

This study qualitatively explored the early acceptability and potential feasibility of using the Digital Pill System (DPS) to monitor ART adherence among pregnant and postpartum women in South Africa. Overall, participants responded positively to the technology, recognizing that it could strengthen their adherence and enhance accountability to prevent HIV transmission to their infants. Beyond supporting adherence, participants viewed the DPS as a tool that could motivate them and facilitate communication with healthcare providers. Nonetheless, concerns regarding the Reader's visibility and the risk of inadvertently disclosing HIV status

emerged as significant barriers. These findings underscore the need for future pilot testing of the DPS in South Africa and highlight important design considerations for implementing the system in this population.

Women described how the DPS could reinforce adherence behaviors during the peripartum period, often linking their primary motivation to the desire to protect their infants from HIV. Prior studies suggest that access to real-time adherence data, such as that provided by DPS, can increase accountability and foster the development of long-term medication-taking habits [26]. By allowing individuals to observe their ART intake, the system promotes awareness of adherence patterns, strengthens daily routines, and helps maintain adherence even in non-standard circumstances, such as staying at a friend's house [27]. Similar evidence from Uganda demonstrates that digital adherence technologies improved TB medication adherence by enabling participants to demonstrate commitment to their treatment [28]. In line with this, participants in our study expressed that sharing adherence data with healthcare providers could validate their consistency and facilitate productive feedback. Additionally, for women without strong social support networks, the DPS offered a form of instrumental support, providing reminders to collect and take ART. Previous research has indicated that the ability to demonstrate commitment to treatment enhances a sense of purpose, which the DPS may similarly cultivate [29, 30].

Real-time monitoring may be particularly valuable during the postpartum period, when adherence often declines due to fatigue, structural barriers, and stigma. Fear of mother-to-child transmission motivates ART adherence, yet adherence commonly decreases after delivery [31]. Participants highlighted that the DPS could reduce their anxiety about inadvertently transmitting HIV to their infants by allowing them to track their ART use in real time. Future app features could further support adherence by consolidating upcoming clinic appointments for both mother and child and providing reminders to take ART consistently. Consistent with prior digital adherence interventions [32], participants expressed interest in a linked smartphone app to supplement support for medication adherence and appointment attendance.

Despite the generally favorable reception, participants identified stigma and the risk of unintentional HIV disclosure as barriers to sustained DPS use. While most participants had disclosed their HIV status to close friends or family, they noted that women who have not disclosed may experience challenges wearing the Reader due to potential questions, judgment, or discrimination. Although smartphone sharing with family members was generally acceptable, some participants expressed hesitancy about friends accessing adherence data due to perceived social judgment. In South Africa, visibility at clinics remains a barrier to HIV care, and the use of visible ART-related devices in public could exacerbate concerns [33]. Participants echoed previous findings that a smaller, discreet Reader that can be easily incorporated into daily routines would improve acceptability [34]. Future iterations might include wrist-worn or other compact devices currently being developed in the U.S. [35]. These findings highlight the importance of user guidance, discretion, and privacy measures, including masking medications (e.g., using gelatin capsules) and implementing secure smartphone app features (e.g., passwords or deidentified data) to prevent unintended disclosure.

Effective DPS implementation among pregnant and postpartum women will likely require it to function both as a tool for adherence and a platform for patient-provider communication. Customizable app features, discreet device designs, and tailored messaging could reduce disclosure risks, lower MTCT, and improve maternal and infant health outcomes. Engagement from healthcare providers is essential, as participants valued provider access to adherence data to increase transparency, foster trust, and support ART adherence, potentially strengthening provider-patient relationships, which have previously been shown to be weak in South Africa [36, 37]. During high-risk periods, providers could leverage DPS to support patients struggling with adherence or viral suppression. However, prior studies reveal mixed provider perspectives, including concerns about privacy, increased workload, and potential disruptions to the provider-patient relationship when relying on DPS data instead of self-report [38, 39]. Conversely, other research suggests that providers can use DPS data to inform medication adjustments and counseling [40]. Future research should explore South African antenatal provider perspectives. Given likely costs for large-scale rollout, targeting women with low adherence or unsuppressed viral loads may be the most feasible approach, though further research is needed to examine logistical and financial barriers to implementation.

Future directions include pilot testing the DPS among pregnant and postpartum women to evaluate real-world feasibility, assess impacts on adherence and viral suppression, and integrate patient and provider input to adapt the technology to this context. Redesigning the DPS to enhance acceptability in high-stigma settings will also be important.

This study has limitations. First, participants provided perspectives on hypothetical DPS use rather than actual experience, limiting conclusions about real-world acceptability and feasibility. The sample may reflect selection bias, as participants willing to disclose or accept their HIV status may have been more likely to participate. Additionally, as interviews were conducted in isiXhosa and translated to English, some cultural nuances may have been lost despite efforts by the South African research team to ensure accurate interpretation.

Despite these limitations, the study adds to the growing evidence supporting digital adherence technologies, particularly for individuals with low ART adherence or unsuppressed viral loads during the peripartum period. When paired with a smartphone app and provider access, the DPS may enhance adherence through motivation, reminders, and accountability, especially during periods of fatigue, forgetfulness, or limited social support. Concerns regarding device visibility and unintentional disclosure highlight the need for stigma-informed implementation and more discreet designs. Overall, the DPS shows promise as a tool to support ART adherence and prevent MTCT, but future research should focus on piloting the system in real-world settings and optimizing design to improve usability and acceptability among pregnant and postpartum women.

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