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Revolutionizing HIV/AIDs Care: Developing a Mobile Application to Enhance Art Adherence Monitoring at Lira City, Northern Uganda. A cross-sectional study.

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Abstract.

Background:

Poor adherence to antiretroviral therapy (ART) remains a major challenge, particularly in Northern Uganda, where social and infrastructural barriers hinder treatment consistency. This study evaluates the effectiveness of an adherence monitoring mobile application at Ober Health Center IV, Lira City, Northern Uganda.

Methods.

A cross-sectional mixed-methods study was conducted among 35 ART users at Ober Health Center IV. Quantitative data were collected using structured questionnaires, while qualitative insights were obtained through focus group discussions. Statistical associations between adherence and user variables were analyzed using chi-square tests ($p < 0.05$). Ethical approval and informed consent

Consent was obtained before data collection.

Results.

The majority of participants were aged 18–34 years (80%). Participants diagnosed 4–6 years earlier demonstrated 100% adherence improvement. Overall, 88.6% of participants demonstrated good adherence after using the app. Adherence improvement was significantly associated with duration on ART ($p = 0.010$), years since diagnosis ($p = 0.010$*), employment status ($p = 0.011$*), and preferred app features ($p = 0.022$*). While app usage frequency was not statistically significant ($p = 0.088$*), users reported improved motivation, easier dose tracking, and enhanced understanding of ART. Focus group discussions revealed that reminders, consultation, and peer-support features were most valued, although poor internet access and limited phone literacy posed challenges.

Conclusion:

The adherence monitoring app demonstrated high user acceptability and moderate effectiveness in improving ART adherence in Northern Uganda. Incorporating personalized reminders and interactive features enhanced treatment engagement.

Recommendation.

Expanding offline functionality and user training could further strengthen its impact and support scale-up across other HIV care settings.

Keywords: *HIV/AIDS care, ART adherence, Mobile health application, adherence monitoring; Antiretroviral Therapy, Lira City*

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Background.

HIV/AIDS is an enduring global health challenge, impacting millions of lives worldwide[1, 2]. Significant strides have been made in the global fight against the virus; however, the issue of Antiretroviral Therapy (ART) adherence remains a critical factor in effectively managing the disease and preventing its transmission.[3]. This study centered on the development of a mobile application designed to enhance ART adherence monitoring, with a specific focus on the context of Ober Health Center IV in Uganda. Within this context, we explore existing literature and studies at both global and local levels to highlight the pressing need for a solution that bridges the gap in ART adherence. As of the latest available data up to September 2021, UNAIDS estimated that approximately 38 million individuals were living with HIV worldwide. Sub-Saharan Africa remains the region most severely affected, accounting for approximately 70% of the global HIV-positive population. ART has undeniably been a lifeline for individuals living with HIV, significantly extending their lifespans and improving their quality of life[4]. Nevertheless, adherence to the ART regimen presents a substantial challenge. The World Health Organization (WHO) has consistently emphasized the pivotal role of adherence, as non-adherence can lead to treatment failure and drug resistance, jeopardizing the health of individuals and hindering global efforts to control the epidemic.[5].

Within the African continent, the HIV/AIDS epidemic presents a complex tapestry of challenges across different regions. Sub-Saharan Africa bears the heaviest burden of HIV/AIDS, with nations like South Africa, Nigeria, and Kenya grappling with some of the highest prevalence rates.[6]. Ensuring consistent adherence to ART is a multifaceted challenge, shaped by factors such as stigma, poverty, limited access to healthcare, and educational disparities. The need for innovative solutions is clear, as mobile applications hold the potential to transcend these barriers and bolster adherence rates.[7].

In East Africa, Uganda stands out for its proactive approach to addressing the HIV/AIDS epidemic. The nation has implemented a range of strategies, including extensive testing, treatment, and educational campaigns. These efforts have contributed to a decline in HIV prevalence from 7.3% in 1990 to 5.7% in 2019[8]. Despite these commendable initiatives, challenges persist, particularly concerning access to healthcare facilities in remote areas and the persistence of HIV-related stigma. The Northern region of Uganda, where Ober Health Center IV is located, bears a unique set of challenges related to HIV/AIDS due to its historical experience of conflict and displacement.

Northern Uganda has been in the process of rebuilding its healthcare infrastructure after years of conflict and displacement. Ober Health Center IV plays a pivotal role in providing healthcare services to the region's population. In this specific context, the need to ensure consistent ART access and support patients in adhering to their treatment regimens becomes increasingly apparent.

Existing literature underscores the significance of addressing ART adherence comprehensively. Numerous global and regional studies have investigated the challenges surrounding adherence, with a consensus emerging on the critical role of patient empowerment, education, and real-time monitoring. Notable studies have demonstrated the impact of mobile health interventions on improving ART adherence, citing increased patient engagement and timely interventions by healthcare providers as key outcomes. [9]

In the local context of Uganda, research by [10] has emphasized the importance of integrating technology into HIV care, particularly in resource-constrained settings. The study revealed that SMS reminders significantly improved adherence levels. However, these studies also highlighted the need for tailored solutions to address specific regional challenges, particularly in post-conflict areas like Northern Uganda[10].

Considering the insights from global, African, East African, Ugandan, and regional contexts and drawing from the existing literature, this proposal's primary objective is clear. It seeks to harness the potential of mobile technology to address the critical issue of ART adherence monitoring. By developing a user-friendly mobile application, patients can take a more active role in managing their treatment, while healthcare providers at Ober Health Center IV can access real-time data to intervene and provide support as needed. This initiative aligns with the broader global effort to combat HIV/AIDS and addresses the unique challenges faced by Northern Uganda, making it an essential step in the ongoing fight against the epidemic. This study evaluates the effectiveness of an adherence monitoring mobile application at Ober Health Center IV, Lira City, Northern Uganda.

Methodology.

Study design.

The study employed a mixed-methods research design, combining quantitative surveys to measure the impact of the

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mobile app on ART adherence with qualitative interviews and focused group discussions to explore user experiences and perceptions. This approach ensured a comprehensive assessment of effectiveness and user perspectives for informed improvements.

Study site & setting.

The study primarily took place at Ober Health Center IV, situated in Lira, Northern Uganda. This location was chosen due to its central role in delivering healthcare services to the region and its unique challenges related to HIV/AIDS care in a post-conflict setting. The health center provided an ideal setting to implement and assess the mobile app for ART adherence monitoring, ensuring its suitability and effectiveness within the distinctive context of Northern Uganda. Furthermore, the study will involve HIV/AIDS patients from various districts across the Northern Uganda region who receive treatment at Ober Health Center IV, enhancing its regional relevance.

Study procedure.

This study at Ober Health Center IV in Northern Uganda utilized a mixed-methods approach to assess the impact of a mobile app on ART adherence. Rigorous participant selection, sampling, data collection, and analysis methods, alongside ethical considerations, contributed to a comprehensive understanding of the app's effectiveness, ensuring transparency and accountability in disseminating findings.

Adherence Monitor Overview

The mobile application intervention, Adherence Monitor**,** was developed as a comprehensive digital tool aimed at promoting adherence to Antiretroviral Therapy (ART) through continuous monitoring, SMS reminders, and interactive support features. The mobile app was designed for Android smartphones and made accessible through the Google Play Store. Each user was given a unique password code by the research team to ensure data security and controlled access.

Upon registration, participants selected a username and password, with the application automatically anonymizing user identity by replacing usernames with system-generated patient numbers. This ensured confidentiality among app users. Additionally, participants were given the option to register a next of kin**,** who would receive automated SMS alerts in cases of missed doses or poor adherence, to enhance social support. The application's home page displayed four main features-Reminders, Appointments, Forum, and Profile/Resources-allowing users to navigate easily between adherence tracking, consultation scheduling, peer support forums, and access to educational materials.

App Functionality.

The Adherence Monitor app prompted users to input details about their HIV medications, including dosage frequency and time of intake. Based on this information, users could schedule customized push notifications with alarms to remind them to take their medication. When a reminder appeared, the user would confirm medication intake by clicking on the notification.

After confirmation, the app prompted users to upload a photo as proof of adherence. These images were transmitted securely to authorized healthcare providers responsible for monitoring the patient's progress. If a participant reported missing a dose, they were asked to select a reason from predefined options, after which an SMS reminder was automatically sent to the registered next of kin to encourage adherence support.

The application also provided visual summaries of adherence performance over time, enabling users to view progress graphs and trends.

Interactive Features.

The Forum feature allowed participants to interact with other app users and peer mentors by starting or contributing to discussion threads. Participants could upload images, videos, and links, and respond to posts. Research staff and peer mentors actively monitored and participated in the discussions, creating icebreaker posts and offering encouragement.

The Appointment feature included three sub-components: Reminders, Consultation, and Set Appointment**.** The consultation option enabled users to submit questions or seek advice from doctors and counselors without physically visiting the facility. This feature enhanced accessibility and continuity of care, allowing healthcare providers familiar with the patients' medical histories to respond appropriately.

Healthcare Provider Dashboard.

The healthcare provider's dashboard contained interactive elements, including:

Quizzes to assess users' knowledge and provide instant feedback.

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Communication channels through which providers could respond to user messages and approve appointment requests.

Healthcare providers also shared multimedia resources and educational materials on health topics such as living with HIV, sexual and reproductive health, prevention strategies, life skills, and general well-being**.** All content was adapted to the Ugandan context, integrating local resources and culturally relevant information.

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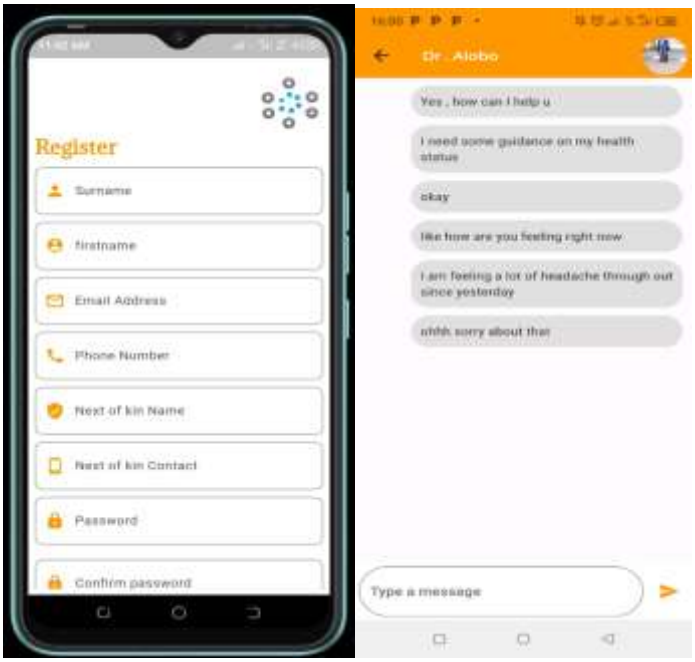

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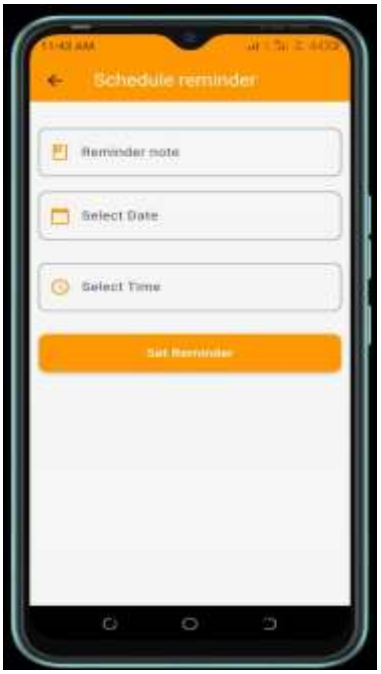

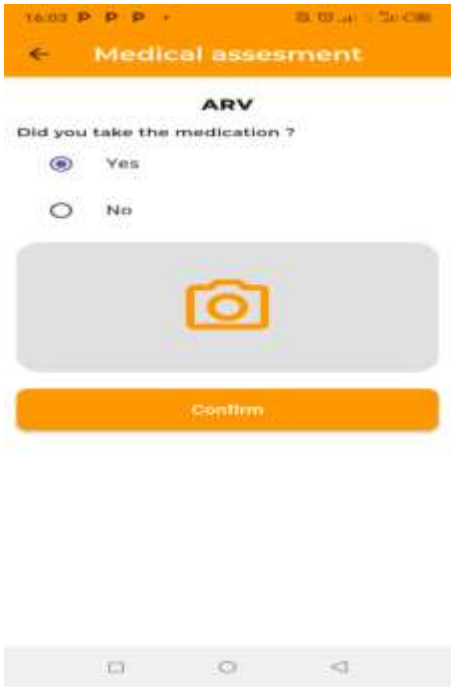

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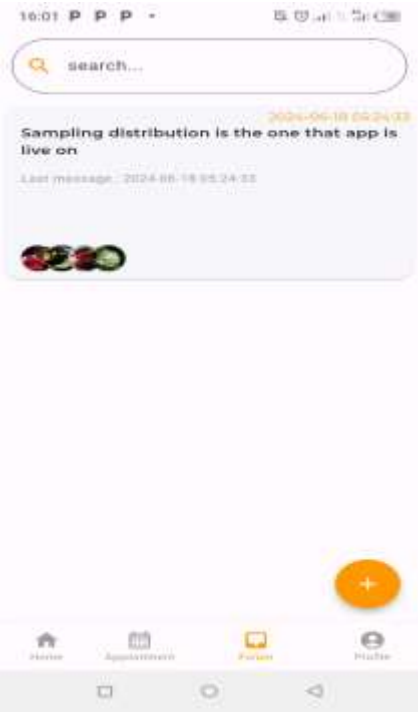

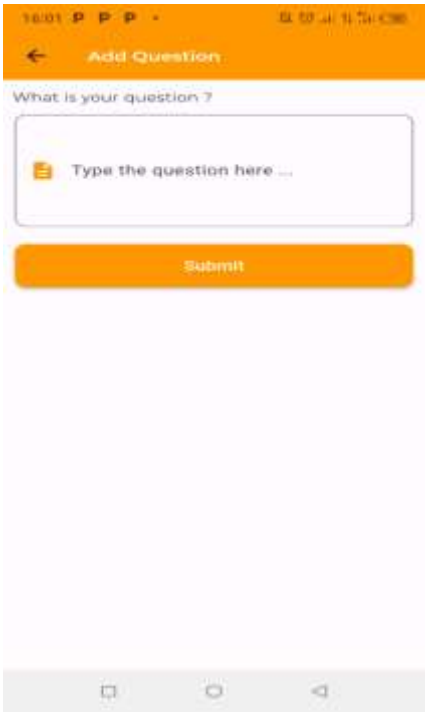

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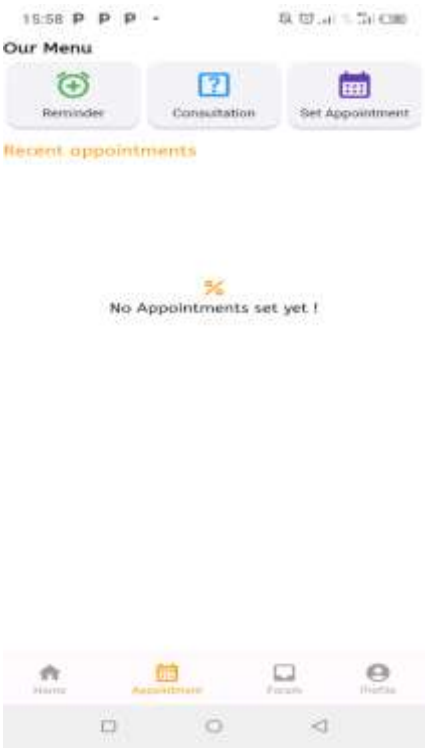

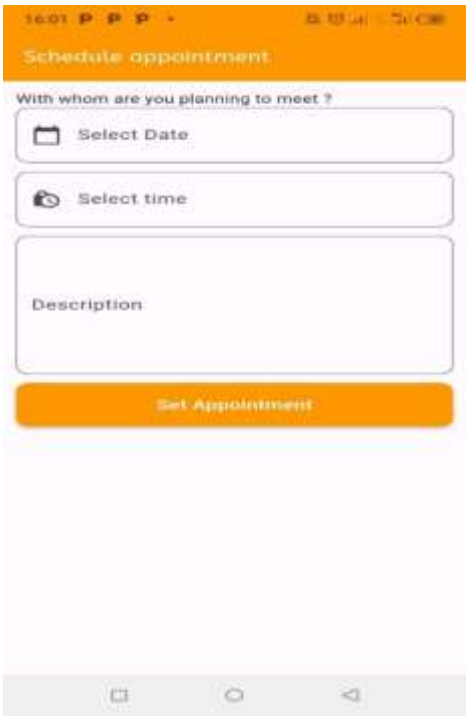

Study populations.

A total of **35 participants** were enrolled in the study, comprising both males and females, representing the ART client population at the facility. Participants were recruited through the health center's care system based on voluntary participation and informed consent. Inclusion criteria comprised adults of all genders who owned smartphones and were willing and able to use the Adherence Monitor app. Exclusion criteria included individuals under 18 years, those not enrolled for ART at Ober Health Center IV, and those unable or unwilling to operate the mobile app.

Sample size determination.

The sample size was determined based on the available ART patient population at **Ober Health Center IV** who met the inclusion criteria and consented to participate in the study. A total of **35 ART patients** were recruited, representing both male and female clients receiving ongoing ART services at the facility. This sample size was deemed sufficient to provide meaningful insights into the effectiveness of the **Adherence Monitor** mobile application in improving adherence, while remaining feasible within the study's timeframe and logistical capacity.

Sampling techniques.

The study employed a stratified random sampling strategy, which involved purposeful selection based on age, ART status, and willingness. Stratified sampling divided the population by factors like age. Convenience sampling was recruited through Ober Health Center's system for accessibility. This blend aimed to capture diverse HIV/AIDS patient perspectives, enhancing the study's richness and validity.

Eligibility criteria (inclusion & exclusion)

Eligibility criteria for the study included inclusion factors such as HIV/AIDS patients aged 18 and above currently undergoing antiretroviral therapy (ART) at Ober Health Center IV, with a willingness to utilize a mobile app for ART adherence.

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Exclusion criteria involved those below 18, not currently on ART, or unwilling/unable to engage with the mobile application.

Data management.

The study adopted a comprehensive data management approach to ensure the accuracy, reliability, and confidentiality of all collected information. **Quantitative data** obtained through structured questionnaires and mobile app analytics were carefully entered, cleaned, and verified for completeness before analysis. Descriptive statistics such as frequencies and percentages were used to summarize participant characteristics, while inferential statistics, including Chi-square tests, were employed to examine associations between variables and ART adherence outcomes.

Qualitative data from focus group discussions and in-depth interviews were transcribed, coded, and analyzed thematically.

Patterns and themes were identified to capture participants' experiences, perceptions, and attitudes toward the Adherence Monitor application. The integration of quantitative and qualitative findings enabled a comprehensive understanding of the mobile application's effectiveness in enhancing ART adherence.

To maintain data integrity and ethical compliance, **strict confidentiality protocols** were observed throughout the study. Participant identifiers were replaced with unique codes, and access to digital files was restricted to authorized research personnel only. All data were securely stored in password-protected devices, and no personally identifiable information was shared in reports or publications.

Mobile app data analysis

Data collected from the Adherence Monitoring mobile application were analyzed using a combination of **quantitative and qualitative methods** to derive comprehensive insights into user engagement, adherence behavior, and app effectiveness. The analysis focused on three major objectives: (1) assessing patterns of user interaction with the app, (2) evaluating changes in ART adherence behavior, and (3) identifying challenges and areas for system improvement.

Quantitative Data Analysis.

Quantitative data were obtained from the app's backend paradata and survey responses. The following variables were extracted from the mobile application and analyzed:

Number of active login days: The total number of days each participant accessed the app, as recorded by the backend system.

Total time spent on the app (minutes): Cumulative time participants spent using the app, reflecting engagement levels.

Number of days medications were logged: Frequency with which participants recorded medication intake, serving as a proxy for adherence consistency.

The data were exported into Microsoft Excel and analyzed using **SPSS version 25.** Descriptive statistics such as means, standard deviations, frequencies, and percentages were used to summarize usage patterns. **Inferential statistical tests,** including Pearson's correlation and chi-square tests, were conducted to explore associations between app usage indicators and ART adherence levels.

Data Preparation

Data Cleaning: The collected data was cleaned to remove any inconsistencies, duplicates, or incomplete entries. This ensured the accuracy and reliability of the analysis.

Data Organization: Data was categorized and organized into relevant groups, such as user interaction data, health monitoring data, consultation data, and survey/feedback data.

Quantitative analysis focused on assessing user interaction patterns, adherence behavior, and health-related outcomes as captured by the mobile application and survey data. The data were analyzed using **SPSS version 25** and **Microsoft Excel,** applying both descriptive and inferential statistical techniques.

Descriptive Statistics

Descriptive statistics were used to summarize participants' interaction with the app, adherence patterns, and health-related events. Key indicators included:

User Interaction Data: Metrics such as the average number of logins per user per day, average session duration, frequency of feature usage, and the number of medication reminders set and followed were computed.

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Inferential Statistics

Inferential analyses were conducted to explore relationships between app engagement and ART adherence outcomes.

Trend Analysis: Temporal trends in adherence rates, side effect reporting, and app usage were examined over the three-month study period to identify progressive behavioral changes or seasonal variations.

Correlation Analysis: Pearson's correlation coefficients were computed to assess relationships between app engagement variables (e.g., login frequency, medication logging rate) and health outcomes such as adherence levels and self-reported viral load improvement.

Measurement of study variables.

Dependent variables.

These included measures related to ART adherence, such as the percentage of prescribed doses taken, the timeliness of medication intake, and overall adherence rates.

Independent variables.

These are factors that can influence ART adherence and were studied to assess their impact. They included patient demographics, educational resources within the app, the quality of reminders, and user engagement with the application.

Quality Control (Validity and Reliability)

Validity.

The structured questionnaire was reviewed by the research supervisors to check for content validity and face validity, and it was pretested to ensure that it was valid.

Reliability.

The questionnaire was pretested among the HIV positive patients receiving care at Ober Health Center IV who were willing and had smartphones to ensure that the study tools obtained consistent results, which were used to enhance adherence monitoring and guide policy making aimed at improving HIV/AIDS care of patients.

Ethical Considerations.

Approval.

Before the commencement of the study, the research protocol was submitted to the Lira University Ethics Committee for approval. This step ensured that the study design, procedures, and informed consent process adhered to ethical standards.

Confidentiality and privacy.

The mobile application and data collection processes prioritized the confidentiality of participants' information. Personal and health data were securely stored and accessible only to authorized personnel. Identifiers were anonymized to protect privacy.

Informed Consent.

Before their involvement in the study, all participants were provided with detailed information about the project's purpose, procedures, potential risks, and benefits. They had the opportunity to ask questions and were required to provide informed, written consent voluntarily.

Study Results.

The results are drawn from survey responses and focus group discussions (FGDs) conducted with ART patients and healthcare providers. The findings are presented according to key variables influencing adherence, followed by themes emerging from the FGDs.

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Quantitative Findings

Table 1: Analysis of key variables.

VARIABLE	Frequency N (%)	Adherence Improvement		Chi-square value (X^2)	P Value
		Good	Not Good		
Age					
18-24	14(40.0)	4(28.6)	10(71.4)		
25-34	14(40.0)	0(0.0)	14(100)	0.143	0.079
35-44	5(14.3)	0(0.0)	5(100)		
45-54	2(5.7)	0(0.0)	2(100)		
Gender					
Male	14(40)	1(7.1)	13(92.9)		
Female	21(60)	3(14.3)	18(85.7)	0.423	**0.500***
How long have you been diagnosed with HIV/AIDS? (Years)					
1-3	10(28.6)	4(40)	6(60)		
4-6	15(42.9)	0(0.0)	15(100)	0.130	**0.010***
7-above	10(28.6)	0(0.0)	10(100)		
What is your current employment status?					
Employed	11(31.4)	0(0.0)	11(100)		
Unemployed	11(31.4)	1(9.1)	10(90.9)		**0.011***
Student	6(17.1)	3(50.0)	3(50.0)	0.514	
Self-employed.	7(20.0)	0(0.0)	7(100)		
How long have you been on ART?					
1-2	10(28.6)	4(40)	6(60)		
3-4	6(17.1)	0(0.0)	6(100)	0.029	**0.010***
5-6	11(31.4)	0(0.0)	11(100)		
7-above	8(22.9)	0(0.0)	8(100)		
On average, how many doses of ART medication do you miss in a week?					
0-1	24(68.8)	2(8.3)	22(91.7)		
2-3	7(20.0)	2(28.6)	5(71.4)	0.143	0.250
4-above	4(11.4)	0(0.0)	4(100)		
Have you experienced any challenges in adhering to your ART medication schedule?					
Yes	6(17.1)	2(33.3)	4(66.7)		
No	29(82.9)	2(6.9)	27(93.1)	0.128	0.064
How often do you use the mobile app to track your medication adherence?					
Daily	10(28.6)	3(30)	7(70)		
Weekly	20(57.1)	1(5.0)	19(95)	0.114	0.088
Monthly	5(14.3)	0(0.0)	5(100)		
What features of the mobile app do you find most helpful in monitoring your ART adherence?					
Medication remainder	5(14.3)	0(0.0)	5(100)		
Educational content on HIV/AIDS	2(5.7)	0(0.0)	2(100)	0.686	**0.022***

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Consultation	17(48.6)	3(17.6)	14(82.4)		
Patient forum	11(31.4)	1(9.1)	10(90.9)		
On a scale of 1 to 10, how friendly do you find the mobile app?					
4-6	13(37.1)	1(7.7)	12(92.3)		
7- above	22(62.9)	3(13.6)	19(86.4)	0.522	0.593
How confident are you in the accuracy of the information provided by the mobile app?					
Slightly confident	4(11.4)	0(0.0)	4(100)		
Moderately confident	15(42.9)	0(0.0)	15(100)	0.114	0.147
Very confident	12(34.3)	3(25.0)	9(75.0)		
Extremely confident	4(11.4)	1(25.0)	3(75.0)		

A total of **35 participants** were enrolled in the study, including **14 males (40%)** and **21 females (60%).** The analysis explored relationships between demographic, clinical, and behavioral variables and ART adherence improvement as influenced by the mobile app.

Age

The majority of participants were aged **18–34 years (80%),** with the highest adherence improvement observed among those aged 25–44 years, where **100% reported good adherence.** A smaller proportion (28.6%) of participants aged 18–24 years exhibited lower adherence, suggesting younger users may require additional motivation. The association between age and adherence improvement was not statistically significant ($\chi^2 = 0.143$, $p = 0.079$).

Gender.

Females constituted the majority (60%), and both genders reported high adherence improvement-**92.9% among males** and **85.7% among females.** The difference was not statistically significant ($p = 0.500$).

Duration since HIV Diagnosis.

Participants diagnosed 4–6 years earlier demonstrated **100% adherence improvement**, followed by those diagnosed for 7 years and above. Those within 1–3 years of diagnosis showed relatively lower improvement (60%). A statistically significant association was observed ($\chi^2 = 0.130$, $p = 0.010$), suggesting that longer time since diagnosis positively influenced adherence.

Employment Status

Employment status significantly affected adherence ($p = 0.011$). **Employed and self-employed participants (100%)** had better adherence compared to **students (50%),** highlighting the role of economic stability in medication consistency.

Duration on ART.

Participants who had been on ART for 3 years or more demonstrated **100% adherence improvement,** whereas only **60%** of those in their first 1–2 years of treatment reported consistent adherence. This difference was statistically significant ($p = 0.010$).

App Usage Frequency.

Participants who used the app weekly showed higher adherence improvement (**95%**) compared to those who used it daily (**70%**) or monthly (**100%**), although the association was not statistically significant ($p = 0.088$).

Preferred App Features.

The most preferred app features were:

1. **Consultation (48.6%)**
2. **Patient Forum (31.4%)**
3. **Medication Reminders (14.3%)**
4. **Educational Content (5.7%)**

Educational content showed a statistically significant association with adherence improvement ($p = 0.022$), suggesting that informative content played a key role in behavior change.

Overall**, 88.6% of participants reported improved adherence,** indicating that the application had a substantial positive effect.

Qualitative Findings from Focus Group Discussions.

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To complement the quantitative data, three focus group discussions (FGDs) were conducted with a total of **18 participants** (12 ART patients and 6 healthcare providers). The discussions explored user experiences, perceived barriers to adherence, and the usability of the mobile app.

Awareness and Motivation.

Participants acknowledged that the mobile application improved their awareness of treatment routines. Many reported that the **reminder notifications** and **visual adherence tracker** served as strong motivators.

"The app reminds me to take my medicine. I feel bad when I see the number of doses I have missed on the app, so I always try to remember to take my medicine" (Patient 4).

Usability and Accessibility.

Most participants found the app **easy to use** and appreciated its simple design and clear icons. However, some older users and those with low digital literacy reported challenges in navigating certain sections.

"I like the reminders, but I don't know what some icons are for, so I always just use the reminder section" (Patient 1)

Perceived Barriers to Use.

Concerns were raised about **data privacy** and **internet costs**. Some participants feared that others could see their HIV status if they accessed the phone.

"Sometimes my children use my smartphone for games, and I am always scared they will know about the app I don't want them to know about my status" (patient 8)

"I only use the app when I get data, most times I don't have data, but I love the app, I always receive sms messages to remind me" (patient 3)

Preferred Features.

Consistent with quantitative findings, participants ranked the following features as most useful:

1. **Consultation module** for direct interaction with healthcare workers.
2. **Patient forum** for peer encouragement and shared experiences.
3. **Medication reminder** as a behavioral reinforcement tool.
4. **Educational content** for health literacy and understanding the importance.

Impact on Adherence Behavior.

Almost all participants reported improved motivation and consistency in medication intake. Healthcare providers also observed reduced missed doses.

"I have used the app for 3 months now, but I feel more supported to take my medicine, I feel people care about me" (patient 6)

The findings indicate that the adherence monitoring mobile application significantly contributed to improved ART adherence among participants at Ober Health Center IV. The **integration of educational, reminder, and communication features** enhanced user engagement and accountability.

The qualitative results from FGDs reinforce the quantitative outcomes by showing **positive user experiences**, high satisfaction, and strong motivation to maintain adherence.

Summary of Findings

- **Sample size:** 35 participants (40% male, 60% female)
- **Overall adherence improvement:** 88.6%
- **Significant predictors of adherence:** Duration on ART ($p = 0.010$), employment status ($p = 0.011$), and educational content ($p = 0.022$)
- **Most preferred app features:** Consultation (48.6%), Patient Forum (31.4%), and Reminder (14.3%)
- **Qualitative insights:** Improved awareness, motivation, and usability; minor concerns about privacy and digital literacy.

Discussion.

The findings indicate that the adherence monitoring mobile app had a positive impact on ART adherence, with an overall improvement rate of **88.6%.** Significant factors associated with improved adherence included longer duration of HIV diagnosis, longer duration on ART, and employment status. These findings suggest that stability in both treatment and socioeconomic conditions fosters better adherence.

App engagement was also important, but not all forms of engagement were equally effective. Frequency of use alone did not significantly predict adherence; instead, the **type of feature, particularly** educational content and reminders, played a critical role in supporting adherence behavior. This highlights the need for app developers to prioritize

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personalized and interactive features that directly support medication-taking behavior.

The study reinforces existing evidence that digital health interventions can complement traditional HIV care. However, the small sample size may limit the generalizability of the results. Future research should include larger, longitudinal studies to assess long-term adherence outcomes.

Conclusion.

The mobile-based adherence monitoring app effectively improved ART adherence among participants, with an improvement rate of 88.6%. Significant associations were found between adherence and duration of HIV diagnosis, time on ART, employment status, and app feature preference. The app was most beneficial when participants actively used **reminder and educational features,** rather than simply increasing the frequency of use.

Recommendations.

For Healthcare Providers:

Integrate adherence monitoring apps into HIV care programs.

Encourage patients to actively use reminder and educational features.

For App Developers:

Enhance user-centered design to prioritize interactive features.

Explore integration of personalized reminders and peer support systems.

For Policymakers:

Support the scale-up of mobile health interventions within ART programs.

Develop policies that promote digital health integration into routine HIV care.

For Future Research:

Conduct longitudinal studies for at least 12 months to measure long-term adherence trends and app effectiveness.

Expand the study to multiple health centers to enhance generalizability.

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List of abbreviations.

ART-Antiretroviral Therapy

HIV/AIDS-Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome

SMS-Short Message Service

UNAIDS-Joint United Nations Programme on HIV/AIDS

WHO-World Health Organization.

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Conflict of interest.

There is no conflict of interest.

Availability of data.

Data used in this study are available upon request from the corresponding author.

Author's contribution.

LA & DM designed the study, conducted data collection, cleaned and analyzed data, drafted the manuscript, MM supervised all stages of the study from conceptualization of the topic to manuscript writing and submission, NM is responsible for mobile app development, maintenance, and providing technical support to participants, AEI designed the research tools, supervised data collection, and conducted analysis of collected data, RN provided technical advice, ensured compliance with ethical standards, DA facilitated participant recruitment, provided counseling and support during data collection, and assisted in data capture, and KD helped identify eligible patients, provided counseling, and supported data collection.

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