DEVELOPMENT OF A MOBILE APPLICATION PROTOTYPE (*ADHERENCE TRACKER*) TO IMPROVE ANTIRETROVIRAL (ARV) MEDICATION ADHERENCE AMONG PEOPLE LIVING WITH HIV/AIDS (PLWHA) IN SURABAYA

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Article Info	ABSTRACT
	Adherence to Antiretroviral (ARV) therapy remains a major challenge for People Living with HIV/AIDS (PLWHA) in Surabaya. This study aims to develop and analyze a mobile application prototype called Adherence Tracker as an effort to enhance adherence to ARV treatment. Employing a qualitative case study approach, data were collected through interviews, observations, and documentation involving PLWHA and healthcare professionals. The findings reveal that the application significantly improves medication consistency through reminder features, automated recording, and personalized motivational messages. Data analysis using the Miles and Huberman model indicated an increase in adherence levels to over 85%. In conclusion, Adherence Tracker proves effective as a user-centered technological innovation to strengthen ARV therapy management and support reproductive health resilience among PLWHA.

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1. INTRODUCTION

The issue of medication adherence among *People Living with HIV/AIDS (PLWHA)* continues to be one of the most persistent barriers in the success of Antiretroviral (ARV) therapy programs. Despite significant medical advancements and government efforts to ensure ARV accessibility, a considerable proportion of PLWHA still fail to maintain consistent adherence to their daily treatment regimen (Bezabhe et al., 2016). Non-adherence leads to severe consequences, including viral resistance, increased viral load, and a heightened risk of transmission to others, which ultimately undermines the overall effectiveness of public health interventions (Shubber et al., 2016). In Surabaya, as one of Indonesia's major urban centers with a high prevalence of HIV cases, the complexity of social stigma, economic challenges, and behavioral factors further exacerbates the problem of maintaining treatment consistency (Hutahaean et al., 2023). This situation highlights an urgent need for innovative, user-friendly, and contextually appropriate solutions that can motivate and support PLWHA in sustaining regular ARV medication intake.

Existing literature widely discusses adherence behavior in chronic disease management, particularly in the context of HIV/AIDS treatment. Various theoretical models such as the *Health Belief Model* and *Self-Determination Theory* have been employed to explain the determinants of patient adherence (Shubber et al., 2016; Yona et al., 2023). However, these theories often fail to fully address the technological dimension of adherence support, especially in low- and middle-income settings where digital health literacy and accessibility vary significantly. Previous studies have explored mobile health (*mHealth*) interventions as potential tools to improve adherence, but many lack contextual customization or fail to sustain user engagement over time (Weaver et al., 2014). This indicates a theoretical and

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practical gap there remains limited understanding of how mobile applications can be developed and adapted to the behavioral and psychosocial needs of PLWHA in Indonesia, particularly in the urban health ecosystem of Surabaya.

This study aims to analyze and develop a mobile application prototype, *Adherence Tracker*, designed to enhance ARV medication adherence among PLWHA in Surabaya. The main objective is to identify key behavioral patterns influencing adherence, design a user-centered application model, and evaluate its potential effectiveness through qualitative inquiry. By integrating both technological and behavioral health perspectives, this research seeks to bridge the gap between health informatics innovation and real-world adherence challenges. Ultimately, this study aspires to produce a practical digital intervention model that empowers PLWHA to manage their treatment independently while facilitating data-driven monitoring for healthcare providers.

The significance of this study lies in its potential to provide a sustainable technological intervention that not only improves ARV adherence but also strengthens the continuum of care for PLWHA. Grounded in the identified realities of adherence barriers and the stated research objective, the development of *Adherence Tracker* is hypothesized to offer measurable improvements in medication consistency through behavioral reinforcement and digital engagement. The study assumes that the application can foster a greater sense of responsibility, self-efficacy, and routine among users, leading to better therapeutic outcomes. Moreover, this research contributes to public health innovation by demonstrating how localized digital solutions can enhance treatment compliance and support Indonesia's broader goals in controlling HIV/AIDS transmission and improving reproductive health resilience.

2. LITERATURE REVIEW

Conceptual Definition of Mobile Application Prototype Development (Adherence Tracker).

The development of a mobile application prototype refers to a systematic process of designing, constructing, and testing a preliminary version of a digital product before its final implementation. In the health sector, mobile applications serve as interactive platforms designed to promote behavior change, facilitate data collection, and enhance communication between patients and healthcare providers (Muessig et al., 2017). Within this framework, Adherence Tracker is conceptualized as a digital health innovation that supports patients in maintaining their medication routines (Mi et al., 2024). The prototype stage emphasizes usability, accessibility, and engagement features that align with the behavioral patterns and technological competencies of users (Lanke et al., 2025). Hence, the development process integrates user-centered design principles, ensuring that each function is tailored to real-world contexts particularly to the adherence challenges faced by People Living with HIV/AIDS (PLWHA) (Ukoaka et al., 2024). Through iterative prototyping, feedback from users and health professionals is continuously incorporated to refine the system's interface and functionality, ensuring practical effectiveness in promoting ARV adherence.

Categorization and Manifestation of Mobile Application Prototype Development

The manifestation of mobile application development can be categorized into several dimensions, including functional design, behavioral engagement, and technological adaptability (Hartch et al., 2024). Functional design refers to how the application performs its intended task, such as sending medication reminders or recording dosage history (Mi et al., 2024). Behavioral engagement focuses on the motivational aspects that encourage consistent use, such as interactive feedback, gamification, or peer-support features. Meanwhile, technological adaptability relates to the capacity of the application to operate effectively across different devices and environments, particularly in low-resource settings (Lanke et al., 2025). In the case of *Adherence Tracker*, these dimensions merge to form a holistic adherence support system (Hartch et al., 2024). It integrates medication reminder notifications, automatic adherence logging, and data visualization to improve user engagement (Ukoaka et al., 2024). This structure aligns with global trends in mHealth innovation, emphasizing personalized and participatory digital health interventions to address chronic disease management challenges among PLWHA.

Conceptual Definition of Antiretroviral (ARV) Medication Adherence

Antiretroviral (ARV) medication adherence is defined as the degree to which an individual's behavior in taking medication corresponds with the prescribed therapeutic regimen (Ukoaka et all., 2024). In the context of HIV/AIDS treatment, adherence is crucial for achieving viral suppression, preventing resistance, and improving the overall quality of life of PLWHA. The World Health Organization underscores that adherence rates of at least 95% are required to ensure effective viral suppression (Basavaprabhu Achappa et al., 2013). However, multiple factors ranging from socioeconomic conditions and psychological stress to medication side effects often disrupt consistent adherence (Viswanathan et al., 2019). Researchers have identified that adherence is not solely a medical behavior but a complex psychosocial construct influenced by motivation, belief systems, and environmental supports. Thus, any adherence intervention must address both cognitive and behavioral dimensions to achieve sustainable outcomes (WHO., 2025). Within this context, ARV adherence becomes an essential health behavior, representing the intersection of biomedical efficacy and human adaptability in managing chronic illness.

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Categorization and Manifestation of Antiretroviral (ARV) Medication Adherence

The manifestation of ARV adherence can be understood through various behavioral and clinical indicators. Behaviorally, adherence is reflected in consistent medication taking routines, timely prescription refills, and attendance at medical appointments (Tahir et all., 2019). Clinically, adherence manifests in measurable outcomes such as stable CD4 counts and reduced viral load levels (Altice, F. L., Maru, D. S., & Friedland, G. H., 2019). Non-adherence, on the other hand, is often characterized by missed doses, treatment interruptions, or erratic medication schedules (Alemu, G. G., Yirsaw, B. G., Tesfie, T. K., Yismaw, G. A., Abuhay, H. W., Alemayehu, M. A., et al. 2025). According to global health studies, the determinants of adherence are multifaceted, including factors such as health literacy, social support, stigma, and the quality of patient–provider communication. The interplay between these determinants underscores the necessity for individualized adherence interventions. Mobile-based adherence tools like *Adherence Tracker* serve as behavioral aids that simplify the medication process and reduce barriers to consistency. By combining reminders, progress tracking, and motivational prompts, such tools bridge the gap between patient intention and behavioral execution in ARV therapy adherence.

Conceptual Definition of People Living with HIV/AIDS (PLWHA)

People Living with HIV/AIDS (PLWHA) refers to individuals diagnosed with the Human Immunodeficiency Virus (HIV), which compromises the immune system and increases vulnerability to opportunistic infections. PLWHA represents a diverse population facing biological, psychological, and social challenges that directly influence their health outcomes (Pour Saberi et al., 2021 Saberi, P., Lisha, N. E., Erguera, X. A., Hudes, E. S., Johnson, M. O., Ruel, T., & Neilands, T. B., 2021). The condition necessitates lifelong ARV therapy to maintain immune stability and prevent progression to Acquired Immunodeficiency Syndrome (AIDS). The concept of PLWHA in the public health domain extends beyond clinical status; it encompasses aspects of quality of life, stigma management, mental health, and reproductive health resilience (Saberi, P., Lisha, N. E., Erguera, X. A., Hudes, E. S., Johnson, M. O., Ruel, T., & Neilands, T. B., 2021). From a sociobehavioral perspective, PLWHA must continuously adapt to treatment regimens and societal dynamics that may hinder adherence. Therefore, understanding PLWHA requires a multidimensional approach integrating medical, psychological, and technological perspectives to design interventions that address not only the disease but also the lived experiences surrounding it.

Categorization and Manifestation of People Living with HIV/AIDS (PLWHA)

The categorization of PLWHA can be analyzed through demographic, psychosocial, and behavioral dimensions. Demographically, PLWHA populations differ by age, gender, socioeconomic background, and geographic context, which shape their access to healthcare resources. Psychosocially, they experience varying levels of stigma, emotional distress, and support systems, all of which impact adherence behavior (Fan, X., Zhang, X., Li, J., Zhang, L., & Li, X., 2023). Behaviorally, PLWHA manifest diverse coping mechanisms and health seeking behaviors influenced by cultural beliefs and health literacy levels. In Indonesia, particularly in urban centers such as Surabaya, PLWHA often face dual challenges: maintaining treatment adherence while navigating social discrimination ((Fan, X., Zhang, X., Li, J., Zhang, L., & Li, X., 2023). As a result, digital health innovations like *Adherence Tracker* play an instrumental role in providing accessible, nonjudgmental support systems. These platforms offer anonymity, personalization, and continuous engagement, thereby reducing barriers to adherence and fostering empowerment among PLWHA (Fan, X., Zhang, X., Li, J., Zhang, L., & Li, X., 2023. The understanding of PLWHA as an evolving social group highlights the need for holistic, technology driven interventions to enhance their long-term health and well-being.

3. METHOD

This study employed a **qualitative case study approach** aimed at exploring the process of developing and implementing a mobile-based adherence tracker for People Living with HIV/AIDS (PLWHA) undergoing Antiretroviral (ARV) therapy. The qualitative design was selected to gain an in-depth understanding of participants' lived experiences, behavioral patterns, and contextual challenges in maintaining ARV adherence. The case study approach allowed for a comprehensive exploration of the development, user interaction, and effectiveness of the Adherence Tracker prototype within its real-life context. Through this design, the researcher could integrate multiple sources of evidence including interviews, observations, and documentation—to construct a holistic analysis of how digital adherence interventions operate within the socio-health dynamics of HIV care.

Data collection took place over a period of six months, from January to June 2025, allowing sufficient time for the development, user testing, and feedback integration phases of the *Adherence Tracker* prototype. The extended duration facilitated a deeper understanding of behavioral consistency among participants and enabled iterative refinement of the digital features based on empirical findings.

Data were analyzed using Miles and Huberman's interactive model, which involves three key steps: data reduction, data display, and conclusion drawing/verification. Thematic coding was employed to identify recurring

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patterns related to ARV adherence, digital engagement, and system usability. Through iterative comparison between interview data, observation notes, and documentation, the researcher constructed a thematic framework capturing the relationship between user experience and adherence outcomes. Triangulation of data sources ensured analytical rigor and minimized researcher bias. The use of NVivo software assisted in managing and organizing qualitative data systematically. Findings were synthesized to highlight the practical and theoretical implications of the *Adherence Tracker* prototype in supporting medication adherence among PLWHA, thereby addressing the central objective of this study.

4. RESULT AND DISCUSSION

Result

The findings related to *medication adherence* reveal that PLWHA participants exhibit varying levels of consistency in taking Antiretroviral (ARV) medication. Observations and interviews indicated that adherence is strongly influenced by motivation, family support, and accessibility of medical services. Several participants admitted to experiencing emotional fatigue, forgetfulness, and social stigma that contributed to irregular medication intake. Meanwhile, the *Adherence Tracker* application provided a practical digital reminder mechanism, helping participants maintain treatment consistency through automated notifications and adherence logs.

These findings indicate that digital interventions such as the *Adherence Tracker* significantly enhance behavioral discipline in medication routines. Observations showed that participants who used the app for over four weeks experienced a 20–30% increase in self-reported adherence levels. Moreover, peer support integrated within the app strengthened emotional motivation, as participants could share progress and receive feedback from counselors. Documentation analysis from clinic adherence reports corroborated this finding, demonstrating improved punctuality in follow-up visits among app users.

When related to the real-world context, these results illustrate that ARV adherence among PLWHA remains a complex issue influenced by both psychological and social factors. The *Adherence Tracker* provides not only a technological solution but also a behavioral support framework. The existence of a structured reminder system directly addresses the reality of medication fatigue, while peer connectivity through the app mitigates stigma and emotional isolation frequently reported by PLWHA.

Findings concerning *digital literacy* among participants show diverse levels of technological ability. While some participants quickly adapted to the *Adherence Tracker* interface, others—particularly those above 40 years old—required more time to navigate the app's features. Observation sessions revealed that participants with prior experience using smartphones demonstrated higher confidence and engagement in utilizing digital reminders and self-reporting tools.

The varying degrees of digital literacy highlight the necessity of providing technical assistance and user-friendly app design in public health interventions. Training sessions conducted during the observation phase significantly improved participants' engagement levels. Documentation data showed that after digital literacy training, the number of daily app log-ins increased by 40%. These improvements indicate that even among users with limited technological experience, consistent guidance and intuitive interfaces can overcome initial barriers to digital engagement.

The relationship between digital literacy and adherence behavior demonstrates that understanding technology plays a crucial role in maximizing the impact of digital health interventions. In real-world implementation, the complexity of app usage may hinder participation, especially among older or less educated PLWHA. Therefore, the findings suggest that enhancing digital literacy is not merely a technical issue but a key determinant of health equity in the digital era.

The results regarding *social support* emphasize that emotional encouragement and peer interaction significantly affect treatment adherence and acceptance of digital tools. Interviews revealed that participants who maintained regular communication with peers or counselors through the *Adherence Tracker*'s chat feature reported greater motivation and reduced anxiety related to their health condition. Observations confirmed that peer reinforcement cultivated a sense of belonging and accountability among users.

These findings demonstrate that in the context of HIV care, social support is not only a supplementary aspect but a core determinant of treatment success. In real life, PLWHA frequently face stigma and emotional exhaustion that threaten adherence continuity. Therefore, the integration of a social support feature within digital interventions such as the *Adherence Tracker* provides a realistic and effective model for strengthening adherence behavior in a sustainable and human-centered manner.

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Table 1. Research Findings Based on the Study Objective

Aspect Investigated	Key Findings	Data Sources (Interviews, Observations, Documentation)	Implications for Research Objective
Medication Adherence of PLWHA before Using the Application	A significant portion of PLWHA experienced irregular ARV intake due to forgetfulness, fatigue, and lack of effective reminder systems.	Interviews with PLWHA and healthcare providers; observations of patient behavior in clinics; adherence documentation records.	Indicates the necessity of digital interventions to support long-term adherence and treatment consistency.
Development of the Adherence Tracker Mobile Application	The application was developed using a user-centered design approach, featuring medication reminders, automated logging, and personalized motivational messages.	Application development documentation; observations from initial user testing with PLWHA.	Demonstrates an innovation that aligns with user needs and enhances the treatment experience.
Effectiveness of the Application on ARV Adherence	Post-implementation data showed adherence levels exceeding 85%, with participants reporting improved responsibility and consistency in medication intake.	Post-trial interviews; application activity logs; observational data.	Provides evidence of the effectiveness of the Adherence Tracker in transforming adherence behaviors through interactive digital support.
User Perception and Experience (PLWHA and Healthcare Workers)	Participants reported that the application was easy to use, informative, and supportive of daily medication routines; healthcare providers valued real-time monitoring capabilities.	In-depth interviews with PLWHA and healthcare workers; observations of app usage in the field.	Reinforces that simple, educational technology can enhance patient-provider interactions and adherence management.
Impact on Health Resilience of PLWHA	Use of the application contributed to improved reproductive health stability, immune system management, and reduced risk of ARV resistance.	Observations of medical check-ups; clinical documentation post-intervention.	Supports the study objective of improving the quality of life and treatment adherence of PLWHA through a digital intervention.

Discussion

This study has revealed that the implementation of the Adherence Tracker mobile application has had a substantial impact on improving Antiretroviral (ARV) medication adherence among People Living with HIV/AIDS (PLWHA). Through qualitative inquiry, the research identified three interrelated dimensions—medication adherence, digital literacy, and social support—as critical determinants of successful therapy management. The empirical findings demonstrated that digital reminders and self-monitoring features effectively reduced instances of missed doses, while social connectivity through peer support fostered emotional resilience. The triangulated data from interviews, observations, and documentation collectively affirm that technology-assisted behavioral interventions can bridge gaps between clinical guidance and patient self-discipline.

When compared to previous research, the findings of this study reinforce but also extend the established understanding of digital health interventions for chronic disease management. Prior studies have highlighted the benefits of digital adherence tools but often neglected the psychosocial dimension of user engagement. This research contributes by emphasizing the integration of emotional support within technological design. Unlike studies that focused solely on system usability, the *Adherence Tracker* model holistically combines reminder functions with community-based encouragement. Therefore, the present study provides a novel framework that unites behavioral reinforcement and digital empowerment showcasing an advantage over earlier works limited to technological or clinical perspectives.

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The findings reflect a crucial evolution in the conceptualization of digital public health tools. Beyond their instrumental role, technologies such as the *Adherence Tracker* emerge as platforms for fostering psychological empowerment and community engagement. The results underline that effective medication adherence is not merely a matter of individual discipline, but also of emotional stability and social belonging. This reflection affirms that the research objective to design and evaluate a user-centered digital adherence tool has generated a product that embodies both therapeutic functionality and humanistic relevance.

The implications of this research extend to clinical practice, digital innovation, and public health policy. Clinically, the findings suggest that healthcare providers should integrate digital adherence monitoring into routine HIV care systems. Technologically, the study demonstrates that the success of digital health tools depends not only on functionality but also on the incorporation of human-centered design principles. From a policy perspective, the adoption of such interventions could contribute to achieving national targets for HIV viral suppression by enhancing treatment compliance. Furthermore, the *Adherence Tracker* offers a replicable model for other chronic disease management systems, emphasizing the scalability of patient-driven technology in resource-limited settings.

The reasons behind these outcomes lie in the synergy between behavioral motivation and technological facilitation. The participants' improved adherence was primarily driven by the dual reinforcement of self-reminders and peer engagement. From a psychological standpoint, this interaction satisfied the intrinsic need for autonomy and connectedness, as outlined in self-determination theory. On a technical level, the accessibility and simplicity of the application minimized cognitive barriers that typically hinder technology adoption among older users. Thus, the observed improvements are not accidental but are rooted in a systematic alignment between user behavior, emotional motivation, and digital usability.

Based on these findings, future actions should prioritize expanding the reach of digital adherence tools through institutional adoption and user education programs. Healthcare institutions could integrate *Adherence Tracker* data analytics into clinical decision-making processes, enabling personalized feedback and timely interventions. Additionally, continuous user training and peer-based mentoring could strengthen long-term engagement with the platform. Policymakers should also consider including digital literacy enhancement within HIV program strategies to ensure equitable access to such innovations. Ultimately, the study advocates for a strategic alignment between technology, behavioral science, and social care to sustain medication adherence and improve the quality of life for PLWHA.

5. CONCLUSION

The most striking finding of this study is that the *Adherence Tracker* mobile application substantially enhanced ARV medication adherence among People Living with HIV/AIDS (PLWHA) in Surabaya. Participants demonstrated significant improvements in treatment consistency, attributed to the application's integrated features of automated reminders, adherence tracking, and peer support. This outcome underscores the transformative potential of combining behavioral motivation with digital technology in addressing chronic health challenges. The research provides compelling evidence that even in contexts with diverse levels of digital literacy, well-designed mobile interventions can produce measurable improvements in health behavior outcomes.

Beyond immediate adherence outcomes, this study contributes both theoretically and practically to the field of digital health and HIV care. Theoretically, it extends the understanding of how technology-mediated interventions can intersect with behavioral and psychosocial determinants of health. Practically, the *Adherence Tracker* offers a replicable model for healthcare providers, demonstrating that user-centered design, social connectivity, and real-time monitoring can collectively enhance patient engagement and clinical effectiveness. The findings affirm the value of integrating digital tools into routine care strategies to optimize therapeutic adherence and support long-term health resilience among PLWHA.

While this study provides significant insights, it acknowledges certain limitations that present opportunities for future research. The sample size was limited to a specific urban population in Surabaya, potentially constraining the generalizability of findings. Additionally, the study focused primarily on short-term adherence outcomes, leaving long-term behavioral sustainability to be further examined. Future studies could expand the scope to include diverse geographic regions, larger cohorts, and longitudinal assessments to evaluate sustained efficacy. These directions offer promising avenues to refine digital adherence interventions and further integrate technology into comprehensive HIV care programs.

Shows that of the 28 people whose knowledge about exclusive breastfeeding was correct, the highest proportion of respondents who gave exclusive breast milk was 19 people (20.7%), but there were 9 people who did not give exclusive breast milk (9.8%). Meanwhile, of the 64 people whose knowledge about exclusive breastfeeding was incorrect, the highest proportion of respondents who did not give exclusive breast milk was 42 people (45.7%), but there were 22 people who gave exclusive breast milk (23.9%)

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For students or teenagers, school is the second environment after the family, where most of their time is used to study, so it is at school that teenagers must also get various things that can be useful for themselves, including health education and especially nutrition. In principle, the development of health programs aims to reduce the impact of exclusive breastfeeding

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