

Available online at : <https://ejurnal.upnb.ac.id/index.php/JKPN>

Jurnal Kesehatan

| ISSN (Print) 2085-7098 | ISSN (Online) 2657-1366 |



Determinants Of Antiretroviral Therapy Adherence Among PLHIV: A Hospital-Based Study In North Sumatera, Indonesia

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ARTICLE INFORMATION

Received: 10 March 2026
Revised: 06 June 2026
Accepted: 29 June 2026
Available online: 30 July 2026

KEYWORDS

Adherence, Antiretroviral Therapy, HIV, Indonesia

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ABSTRACT

Background: Human Immunodeficiency Virus (HIV) remains a major public health challenge worldwide. In North Sumatra, the rising number of HIV cases highlights the importance of sustained adherence to antiretroviral therapy (ART) to achieve viral suppression and reduce HIV-related morbidity and transmission. However, suboptimal adherence remains a persistent barrier to optimal treatment outcomes, underscoring the need to identify factors influencing ART adherence among people living with HIV.

Aims: This study aimed to explore the primary predictors of adherence to antiretroviral therapy (ART) among people living with HIV (PLHIV) in North Sumatra, Indonesia.

Aims: This study aimed to examine the key determinants influencing ART adherence among people living with HIV (PLHIV) in North Sumatra, Indonesia.
Methods: A quantitative cross-sectional study was conducted at Dr. Ferdinand Lumbantobing General Hospital in Sibolga City, Indonesia, from April to December 2024. Using a total sampling approach, all 88 PLHIV receiving ART during the study period were recruited. Data were collected through structured questionnaires and analyzed using univariate analysis, chi-square tests, and multivariate logistic regression.

Results: Among the 88 participants, 53.4% demonstrated adequate adherence to antiretroviral therapy (ART). ART adherence was significantly associated with treatment-related knowledge, family support, healthcare provider support, and access to healthcare facilities ($p < 0.05$). Multivariate logistic regression analysis revealed that treatment-related knowledge was the strongest predictor of ART adherence (aOR = 7.845; 95% CI: 2.116–29.081), followed by family support (aOR = 7.347; 95% CI: 2.109–25.590), healthcare provider support (aOR = 7.129; 95% CI: 1.971–25.787), and access to healthcare facilities (aOR = 3.713; 95% CI: 1.134–12.156).

Conclusion: Treatment-related knowledge, family support, healthcare provider support, and access to healthcare facilities were significantly associated with ART adherence among PLHIV. Treatment-related knowledge emerged as the strongest predictor of adherence. These findings underscore the importance of strengthening patient education, family involvement, and healthcare support systems to improve adherence to HIV treatment regimens in similar healthcare settings.

INTRODUCTION

Despite advances in prevention and treatment, HIV infection remains a major global public health challenge, adversely affecting population productivity and placing a substantial long-term socioeconomic burden on individuals, families, and healthcare systems worldwide [1, 2]. Although the widespread availability of ART has transformed HIV into a manageable chronic disease, sustained adherence to ART remains critical for achieving viral suppression, preventing drug resistance, reducing HIV-related morbidity and mortality, and minimizing onward transmission [4].

Indonesia is home to an estimated 526,841 PLHIV, with the number of reported cases continuing to rise in North Sumatra [3]. Despite ongoing efforts to expand ART coverage, retention in care remains a major challenge, as evidenced by persistent rates of loss to follow-up (LTFU). In Sibolga, the number of newly diagnosed HIV cases increased from 103 in 2022 to 165 in 2023. However, only slightly more than half of patients receiving ART achieved the recommended adherence level of $\geq 95\%$. Dr. Ferdinand Lumbantobing General Hospital serves as the primary HIV referral center for the western coastal region of North Sumatra, providing care to patients from a wide geographic area, including remote coastal communities where access to healthcare services may be limited. These circumstances highlight the need for context-specific evidence to identify factors influencing ART adherence and to inform interventions aimed at improving treatment outcomes among PLHIV in this setting.

Previous research has shown that ART adherence is influenced by various factors, such as knowledge, perceptions, access to healthcare services, adherence counseling, and social support from healthcare providers, family members, and the community [5,10,11]. These findings align with the behavioural frameworks developed by Lawrence Green and Snehandu B. Kar, which underscore the influence of predisposing, enabling, reinforcing, and social support factors on health-related behaviours [13]. Moreover, adherence is shaped by a range of psychological determinants, including stigma, perceived treatment effectiveness, and concerns about medication-related adverse effects, all of which have been consistently associated with patients' adherence behaviour [16–18].

Despite the substantial body of international and national evidence on ART adherence, empirical studies from North Sumatra remain limited. Moreover, findings from other settings may not be directly applicable to Sibolga due to differences in geographical accessibility, healthcare utilization patterns, and sociodemographic characteristics. To the best of our knowledge, no previous study in North Sumatra has applied multivariate logistic regression to identify the key determinants of ART adherence among PLHIV based on the behavioral frameworks proposed by Green and Kar. Therefore, this study aimed to examine the factors associated with ART adherence among PLHIV receiving care at Dr. Ferdinand Lumbantobing General Hospital in Sibolga, North Sumatra, and to identify the strongest predictor of adherence behavior. The findings are expected to provide evidence for the development of targeted and sustainable interventions to improve ART adherence.

Study Design and Setting

An analytical cross-sectional study was conducted between April and December 2024 at Dr. Ferdinand Lumbantobing General Hospital in Sibolga, North Sumatra, Indonesia. As the principal referral center for HIV care in the region, the hospital provides comprehensive services for PLHIV. This study aimed to identify the independent predictors of adherence to ART among PLHIV attending outpatient HIV care services.

Study Population and Sampling

The study population consisted of PLHIV residing in Sibolga and receiving ART at Dr. Ferdinand Lumbantobing General Hospital. Using a total sampling strategy, all eligible patients who met the study criteria during the study period were invited to participate, resulting in a final sample of 88 participants. Eligibility criteria included receiving ART for at least one month and willingness to complete the

questionnaire and participate in an interview. Pregnant women and individuals younger than 14 years were excluded from the study.

Data Collection

Data were collected using a structured questionnaire comprising closed-ended items developed from an extensive review of the literature. The instrument was adapted to reflect the study variables, participant characteristics, and the local healthcare setting. Content validity was established through expert review by professionals with expertise in HIV care and public health research. To complement the primary data, secondary data were extracted from clinic attendance records and other relevant documents obtained from the VCT Clinic of Dr Ferdinand Lumbantobing General Hospital, Sibolga.

Data Analysis

The required sample size was estimated through a priori power analysis using a 95% confidence level and 80% statistical power. The independent variables examined were treatment awareness, perceptions of ART, availability of healthcare facilities, adherence counselling, support from healthcare providers, family support, and community support. Adherence to antiretroviral medication was considered the dependent variable. Data were analysed using SPSS version 18.0. Descriptive statistics were used for univariate analysis, while associations between variables were assessed using the chi-square test. Variables meeting the selection criteria were subsequently entered into a multivariate logistic regression model to identify independent determinants of ART adherence.

Ethical Considerations

This study was approved by the Ethics Committee of the University of North Sumatra (No. 1314/KEPK/USU/2024); dated November 12, 2024 and was implemented with the Declaration of Helsinki

RESULT DISCUSSION

1.1 Overview of Respondent Characteristics

The overall adherence rate to antiretroviral therapy (ART) among people living with HIV (PLHIV) in Sibolga was 53.4%. Of the 88 participants included in the study, 47 (53.4%) were classified as adherent to ART, whereas 41 (46.6%) were classified as non-adherent.

The majority of participants were aged 30 years or older, and males constituted a slightly larger proportion of the study population than females. Most participants were employed, while approximately half were married. A substantial proportion also reported experiencing side effects associated with ART. Detailed demographic and clinical characteristics of the participants are presented in Table 1.

Table 1. Characteristics of Respondents

Characteristic	n	%
Age		
< 30 years	29	33
≥ 30 years	59	67
Total	88	100
Marital Status		
Married	45	51.5
Unmarried/separated	43	48.9
Total	88	100
Gender		
Male	53	60.2
Female	35	39.8
Total	88	100

Employment status		
Unemployed	32	36.4
Employed	56	63.6
Total	88	100
Side effects history		
Never	36	40.9
Ever	52	59.1
Total	88	100

1.2 Bivariate analysis

Bivariate analysis showed that several individual, healthcare-related, and social support factors were significantly associated with ART adherence. These factors included treatment-related knowledge, perceptions of ART, healthcare facility quality, adherence counseling, healthcare provider support, and family support. Participants with better treatment-related knowledge, more favorable perceptions of ART, and greater support from healthcare providers and family members were more likely to adhere to ART. Similarly, higher perceived quality of healthcare facilities and receipt of adherence counseling were significantly associated with adherence. Detailed results of the bivariate analysis are presented in Table 2. Although community support showed a positive association with ART adherence, the relationship did not reach statistical significance. Nevertheless, these findings suggest that ART adherence is influenced by multiple interrelated factors, including individual, healthcare-related, and social support determinants. This highlights the importance of addressing both personal and environmental factors when developing interventions to promote sustained treatment adherence among PLHIV.

Table 2. Respondent Characteristics Based on Measured Variables (n=88)

Table 2: Respondent Characteristics Based on Measured Variables (n=66)						
Characteristic	Adherence to ARV treatment				P value	OR (95% CI)
	Obedient		Disobedient			
	n	%	n	%		
Treatment Knowledge						
Good	32	65.3	17	34.7	0.018	3.012 (1.258-7.211)
Poor	15	38.5	24	61.5		
Perception of ARV						
Positive	35	62.5	21	37.5	0.028	2.778 (1.133-6.813)
Negative	12	37.5	20	62.5		
Healthcare Facilities						
Satisfactory	37	67.3	18	32.7	0.001	4.728 (1.862-12.005)
Unsatisfactory	10	30.3	23	69.7		
Adherence Counseling						
Received	28	66.7	14	33.3	0.020	2.842 (1.191-6.781)
Not received	19	41.3	27	58.7		
Health Worker Support						
Strong	34	68	16	32	0.002	4.087 (1.669-10.008)
Weak	13	34.2	25	65.8		
Family Support						
Strong	33	68.8	15	31.3	0.003	4.086 (1.675-9.963)
Weak	14	35	26	65		
Community Support						
Strong	23	63.9	13	36.1	0.130	2.064 (0.863-4.935)
Weak	24	46.2	28	53.8		

*Chi-square test, two-tailed

1.3 Multivariate analysis

Multivariate logistic regression analysis identified treatment-related knowledge, family support, healthcare provider support, and healthcare facility quality as independent predictors of ART adherence. Treatment-related knowledge emerged as the strongest predictor, suggesting that a better understanding of treatment may play a pivotal role in promoting consistent adherence to ART among PLHIV.

The persistence of family support and healthcare provider support as significant predictors underscores the importance of a supportive care environment in promoting ART adherence. These findings suggest that

both familial involvement and positive interactions with healthcare providers may contribute to sustained treatment engagement among PLHIV. Furthermore, the significant association between healthcare facility quality and adherence highlights the need for accessible, responsive, and patient-centered services as integral components of effective HIV care.

Notably, perceptions of ART and adherence counseling were no longer significantly associated with adherence after adjustment for other variables in the multivariate model. This attenuation suggests that their influence may operate indirectly through more proximal determinants, particularly treatment-related knowledge and social support mechanisms. In contrast, treatment-related knowledge, family support, healthcare provider support, and healthcare facility quality remained independently associated with adherence, underscoring their central role in shaping treatment behavior. Collectively, these findings indicate that sustained ART adherence is driven not only by patients' understanding of their treatment but also by the availability of supportive interpersonal relationships and responsive healthcare services. Strengthening these interconnected domains may therefore be critical for improving long-term adherence among people living with HIV.

Table 3. Logistic Regression Test Results

Variabel	B	P value	aOR	95% CI	
				Lower	Upper
Treatment Knowledge	2.060	0.002	7.845	2.116	29.081
Healthcare facilities	1.312	0.030	3.713	1.134	12.156
Health Worker Support	1.964	0.003	7.129	1.971	25.787
Family Support	1.994	0.002	7.347	2.109	25.590
Perception of ARV	0.106	0.862	1.112	0.336	3.681
Adherence Counseling	1.116	0.073	3.052	0.903	10.316

DISCUSSION

This study investigated the determinants of ART adherence among PLHIV in Sibolga, Indonesia, and demonstrated the complex interaction of predisposing, enabling, and reinforcing factors in influencing adherence behavior. The predominance of participants aged 30 years and older is consistent with UNAIDS data showing that the majority of PLHIV in the Asia–Pacific region fall within the 25–49-year age group, which represents the most economically productive segment of the population [6]. Furthermore, the gender distribution observed in this study reflects national HIV epidemiological trends in Indonesia [9]. Despite these similarities, previous research suggests that adherence behaviors may vary by sex, as men and women often face distinct psychosocial, economic, and healthcare-related barriers to sustained treatment adherence [7,8].

Among the determinants identified, treatment-related knowledge emerged as the most influential predictor of ART adherence, corroborating evidence from previous studies [10–12]. Within Lawrence Green's behavioral framework, knowledge is regarded as a key predisposing factor that shapes an individual's motivation and readiness to adopt health-promoting behaviors. Patients with a clear understanding of the benefits of ART, the consequences of treatment interruption, and the risk of viral rebound are more likely to sustain long-term adherence. The Health Belief Model offers a complementary explanation, suggesting that increased knowledge may strengthen perceptions of vulnerability to HIV-related complications and the potential severity of poor treatment outcomes, thereby reinforcing adherence behavior [13]. Nevertheless, the findings revealed that knowledge alone was insufficient to guarantee adherence. Despite being aware of the importance of regular medication intake, many participants reported missing doses due to routine disruptions, competing daily demands, or travel-related challenges. This discrepancy between knowledge and practice has been consistently observed across adherence studies and highlights the need for interventions that address both cognitive and behavioral barriers to sustained ART use.

A gap between knowledge and practice was evident in this study. Some participants with adequate knowledge of ART still reported missed doses due to travel commitments and disruptions to their daily routines, consistent with previous reports [12, 14]. Knowledge alone may not be sufficient to sustain adherence. Medication reminder systems, self-management strategies, and ongoing behavioral support may help patients integrate treatment into everyday life and overcome practical barriers to adherence [15].

Family support emerged as a key determinant of ART adherence in this study. Previous research has demonstrated that emotional encouragement, practical assistance, and treatment monitoring provided by family members can strengthen adherence behaviours and enhance continuity of care [27,28]. This finding may be particularly relevant in the Sumatran context, where strong family networks often play a central role in health-related decision-making and caregiving practices [30]. However, the effectiveness of family support may be constrained by caregivers' limited knowledge of HIV management and the absence of formal training, which can affect their ability to provide consistent and informed support throughout the treatment process [29].

Healthcare provider support emerged as a significant predictor of ART adherence, highlighting the pivotal role of therapeutic relationships in HIV care [24–26]. Trustworthy and supportive interactions with healthcare providers may promote adherence by encouraging open communication, addressing treatment-related concerns, and enhancing patients' self-efficacy in managing lifelong therapy. These findings are consistent with previous evidence demonstrating that positive patient–provider relationships contribute to improved treatment engagement and adherence outcomes. Consequently, efforts to strengthen communication skills, continuity of care, and patient-centered service delivery may represent important strategies for improving long-term ART adherence among people living with HIV.

Access to healthcare emerged as a key enabling factor associated with ART adherence. Accessible healthcare services, flexible appointment systems, and continuity of care facilitate treatment retention and sustained adherence [19]. ART is available free of charge in Indonesia [20, 21]. Transportation costs, food expenses, and other indirect expenditures continue to burden patients, particularly those residing in geographically dispersed or resource-constrained settings. Persistent structural barriers may reduce access to care and undermine adherence. Improving healthcare accessibility remains essential for optimizing HIV treatment outcomes.

Adherence counseling did not remain a significant predictor of ART adherence after adjustment for other variables ($p = 0.073$). The significant association observed in the bivariate analysis was attenuated in the multivariable model, suggesting that the influence of counseling may be partly mediated through treatment-related knowledge and patients' understanding of ART. This interpretation is supported by the finding that treatment-related knowledge was the strongest predictor of adherence in the final model. Limited variability in counseling exposure may also have contributed to the lack of an independent association, as most participants reported receiving counseling regularly. In addition, routine counseling may not have been sufficiently individualized or reinforced through ongoing follow-up to effectively address the diverse barriers faced by patients. These factors may have reduced the independent effect of counseling on adherence after adjustment for other determinants [22, 23].

The findings of this study align with previous research from North Sumatra and other regions of Sumatra, which has consistently highlighted the importance of treatment-related knowledge and family support in promoting ART adherence. A notable difference, however, concerns the relative importance of the predictors identified. Earlier local studies reported healthcare availability as the primary determinant of adherence, whereas the present study found that cognitive and interpersonal factors exerted a stronger influence. This discrepancy may reflect contextual differences in healthcare delivery systems, improvements in patient education, and variations in the availability and quality of family support across populations and study settings.

A major strength of this study is its application of Lawrence Green's behavioral framework to examine ART adherence through an integrated lens. Previous studies in Indonesia have often focused on isolated

determinants, such as treatment knowledge, stigma, or family support, without considering the combined influence of predisposing, enabling, and reinforcing factors. By incorporating these dimensions into a single multivariable model, the present study provides a more comprehensive evaluation of the factors shaping adherence behavior among people living with HIV in North Sumatra. The findings indicate that treatment-related knowledge, family support, healthcare provider support, and healthcare accessibility each contribute to adherence, highlighting the multifactorial nature of treatment behavior. This broader perspective may help guide the design of more effective and contextually appropriate adherence interventions, particularly in resource-constrained settings.

ART adherence is influenced by a dynamic interaction of cognitive, social, and structural determinants. The findings of this study highlight the importance of treatment-related knowledge and family support as key drivers of adherence, underscoring the need for multifaceted intervention approaches. Efforts to improve adherence should extend beyond the provision of medication and encompass continuous patient education, family-centred support mechanisms, strong patient–provider partnerships, and equitable access to healthcare services. Such integrated strategies may be critical for promoting sustained treatment engagement and improving long-term health outcomes among people living with HIV.

Conclusion

This study demonstrated that treatment-related knowledge and family support were the most influential determinants of ART adherence among people living with HIV in Sibolga, Indonesia, with healthcare accessibility and healthcare provider support also contributing significantly to adherence behavior. The findings underscore the importance of adopting comprehensive adherence strategies that combine patient education, family-centered support, and high-quality healthcare services. Such approaches may strengthen long-term treatment engagement and improve HIV-related health outcomes. Future longitudinal and intervention studies are needed to clarify causal pathways and identify effective strategies for sustaining ART adherence in comparable resource-constrained settings.

LIMITATIONS

Several limitations should be acknowledged. The cross-sectional nature of the study limits the ability to establish causal relationships between the identified determinants and ART adherence. Adherence was measured using self-reported data, which may be affected by recall and social desirability biases. As a result, adherence levels may have been overestimated, potentially influencing the magnitude of the observed associations. The study was also conducted at a single referral hospital and included a relatively small sample, which may restrict the generalizability of the findings beyond the study setting. Future research should employ longitudinal and multicenter designs and incorporate objective adherence measures, such as pharmacy refill records or viral load monitoring, to provide more robust evidence on the determinants of ART adherence among people living with HIV.

Author Contributions

LOH, TW, and RRL conceived and designed the study. IIF verified the data and contributed to conceptual validation. LOH conducted the survey, performed data collection and analysis, and prepared the first draft of the manuscript. TW, RRL, MI, and IIF supervised the study and critically reviewed the manuscript. All authors contributed to manuscript revision and approved the final version for publication.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the support of the Master's Program in Tropical Medicine, University of North Sumatra, and Dr. Ferdinand Lumbantobing General Hospital, Sibolga, for facilitating this study. The authors also thank their supervisors and examiners for their valuable guidance, insightful comments, and continued support throughout the research process.

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