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Antiretroviral therapy adherence among people living with HIV in Vietnam using a multi-method tool: A cross-sectional study

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ABSTRACT

Objective: To assess antiretroviral therapy (ART) adherence rates and associated factors among people living with HIV in Vietnam.

Methods: A cross-sectional study was conducted at the Hospital for Tropical Diseases, Ho Chi Minh City from June to August 2022. Data were collected from 347 people living with HIV using structured questionnaires assessing sociodemographics, substance use, drug side effects, treatment beliefs, treatment satisfaction, and depression. ART adherence was evaluated using a multi-method tool, including self-report, pill count, the Provider Interview Tool, and the Visual Analog Scale. Participants were classified as having high adherence only if they met all four criteria across these methods. Multivariable logistic regression was used to identify factors influencing adherence, with significance set at $P < 0.05$.

Results: High ART adherence was observed in 69.5% of the participants. Adherence was significantly lower among tobacco users (OR 0.49, 95% CI 0.30–0.83, $P=0.007$), those with higher depression scores (per 1-point increase) (OR 0.89, 95% CI 0.84–0.95, $P < 0.001$), frequent substance users (OR 0.50, 95% CI 0.30–0.83, $P=0.007$), and those experiencing more severe drug side effects (per level increase) (OR 0.64, 95% CI 0.45–0.92, $P=0.016$). Participants able to afford treatment had nearly three times higher odds of adherence than those unable to pay (OR 2.85, 95% CI 1.48–5.47, $P=0.002$).

Conclusions: ART adherence among people living with HIV in Vietnam remains suboptimal. Interventions should target substance use, drug side effects, financial barriers, and depression screening to improve adherence.

KEYWORDS: HIV; Antiretroviral therapy adherence; Tobacco; Side effects; Substance use; Depression; Treatment costs

Summary

Question: What is the level of antiretroviral therapy adherence, and what factors are related to treatment adherence among people living with HIV in Vietnam?

Findings: In this cross-sectional study of 347 people living with HIV, 69.5% exhibited high ART adherence, assessed using a multi-method tool. Adherence was significantly lower among tobacco users, frequent substance users, individuals with higher depression scores, and those experiencing more severe drug side effects. Participants who could afford treatment had nearly three times higher odds of adherence than those who could not.

Meaning: ART adherence among people living with HIV in Vietnam remains suboptimal, highlighting the need for targeted interventions to address substance use, drug side effects, financial barriers, and depression screening to improve adherence.

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1. Introduction

Human immunodeficiency virus (HIV) remains a major global public health challenge, affecting communities worldwide. In 2023, the World Health Organization estimated that approximately 39 million people were living with HIV (PLWH), with 1.3 million being new infections and 630 000 deaths[1]. The Global Health Sector Strategies on HIV, viral hepatitis, and sexually transmitted infections (2022-2030) provide a strategic framework to end HIV and other sexually transmitted infections by 2030. One of the key targets is to ensure highly effective treatment among PLWH to achieve viral suppression[2].

In Vietnam, there are over 249 000 PLWH in 2023 with a prevalence rate of 0.3% (95% *CI* 0.3-0.4). This rate is lower than some neighboring countries, such as Cambodia (0.5%), Indonesia (0.4%), Laos (0.4%), and Thailand (1.1%), but higher than Singapore (0.1%)[3]. In 2023, Vietnam reported over 13 000 new diagnoses and 1 625 deaths[4]. The landscape of HIV high-risk groups in Vietnam has shifted in recent years. While infection rates have declined among sex workers, people who inject drugs, individuals with HIV-positive partners, and new infections among men who have sex with men have surged[4,5]. This shift presents a challenge for targeted prevention and treatment strategies aimed at ending HIV in Vietnam.

The advent of antiretroviral therapy (ART) marked a pivotal shift in the HIV pandemic, transforming it from a fatal disease into a manageable chronic infection condition[1]. ART effectively reduces mortality, prevents opportunistic infections, limits virus transmission, and extends the life expectancy of PLWH[1,6]. However, its success depends on patient adherence, with guidelines recommending a minimum adherence rate of 95% to maintain viral suppression and prevent drug resistance[7,8]. Strengthening adherence strategies is crucial not only for improving individual health but also for reducing HIV transmission at the population level through sustained viral load suppression[1]. Despite its importance, adherence rates in many countries fall short of the target of 95%. Reported rates include 77% in India[9], 80.2% in China[10], 74% in the United States[11], 87.4% in Nepal[12], 86.5% in Cambodia[13], and a range of 45.5% to 88.5% in Vietnam[14-16]. These disparities underscore the urgent need for targeted interventions to improve ART adherence and optimize treatment outcomes.

Adherence to ART is influenced by multiple factors, which can be categorized into four main groups[17]. (1) Intrapersonal factors include personal characteristics such as knowledge of ART, sex,

marital status, education level, substance abuse, psychosocial elements, personal beliefs, and health status, all of which play a crucial role in treatment commitment[9,12,14,15,18]. (2) Interpersonal factors, such as stigma and discrimination from family and community, can create barriers that discourage individuals from seeking or maintaining treatment[19,20]. (3) Healthcare and system-related factors, including the quality of healthcare services, provider communication, treatment costs, and distance to medical facilities, also affect adherence by shaping the overall patient experience and access to care[17]. (4) Lastly, medication-related factors, such as side effects, pill burden, and regimen complexity, can make adherence challenging, especially for individuals struggling with multiple medications or adverse effects[14]. However, these factors can vary across different populations and periods, emphasizing the need for tailored strategies to improve ART adherence[21].

In Vietnam, previous studies have linked ART adherence to several factors, such as marital status, living situation (whether living with family), substance abuse, general knowledge of ART, discontinuation after symptom improvement, distance to the hospital, smoking, sex, and residence[14-16]. However, some important factors, such as medication-related issues, ability to pay for treatment, and psychological status, remain underexplored and warrant further investigation.

Several indirect measurement tools are commonly used to assess ART adherence in Vietnam and other developing countries. These include self-reporting[14,15] and the Visual Analog Scale (VAS)[13,16]. However, relying on a single assessment method for a complex behavior such as ART adherence may overestimate adherence rates[9,22]. For instance, self-reported adherence is prone to social desirability bias, as patients may report what they believe is expected rather than their actual adherence[23]. To improve accuracy, a multi-method tool is recommended. Combining self-reports with pill counts, the Provider Interview Tool (PIT), and the VAS can enhance measurement reliability[23,24]. By cross-checking pill counts with self-reported data, researchers can obtain a more comprehensive evaluation of adherence among people living with HIV. Therefore, this study aims to assess ART adherence among adults living with HIV using a multi-method tool to explore factors influencing adherence, including sociodemographics, substance use, drug side effects, treatment beliefs, treatment satisfaction, and depression. The findings will provide valuable insights for improving ART adherence among PLWH in Vietnam.

2. Methods

2.1. Study design and setting

A cross-sectional study was conducted at the Hospital for Tropical Diseases (HTD) in Ho Chi Minh City, Vietnam, between June and August 2022. This hospital, a tertiary referral center, specializes in the treatment of infectious diseases, including HIV/AIDS. Data were collected through face-to-face interviews using a structured questionnaire. This questionnaire was developed based on the multi-method tool to measure ART Adherence by Gavin Steel *et al.* in 2007[24] and the Patient Health Questionnaire-9 (PHQ-9)[25]. The study's inclusion criteria were individuals aged 18 years and older living with HIV who were currently receiving ART at HTD (outpatient). PLWH who had received ART for less than one year were excluded to focus specifically on factors associated with long-term adherence, minimizing potential confounding effects related to the initial treatment period. Additionally, individuals with severe cognitive impairments or significant reading comprehension difficulties were excluded to ensure accurate understanding and reliable participation in the study (Supplementary Figure 1).

2.2. Sample size and sampling procedure

A single population proportion formula was utilized to estimate the ART adherence rate among the participants. The calculation was based on a 95% confidence interval ($Z_{\alpha/2}=1.96$), a 5% margin of error, and an assumed population proportion ($P=0.66$), that reflects the estimated ART adherence rate among PLWH as reported by Nguyen *et al.*[14]. After substituting the values into the formula, the minimum sample size was calculated to be 347 participants.

A convenience sampling method was employed to select participants for this study. Over a period of three months, the research team recruited PLWH who were receiving ART at the HIV ward during the time of data collection.

2.2. Instrument

The questionnaire consisted of four sections with 51 questions to gather comprehensive data on sociodemographic, influencing factors, and ART adherence levels.

The first section included 11 questions covering sociodemographic information such as age, sex, income, living area, education level, marital status, tobacco and alcohol use (indicated as “yes” if participants were using during treatment), occupation, ability to pay

for treatment, and distance from their home to the hospital.

The second section comprised 18 questions assessed using a 5-point Likert scale to examine factors influencing ART adherence[26]. These included the frequency of substances use (methamphetamine, ketamine, cocaine, *etc.*), drug side effects, patient beliefs about treatment effects, and satisfaction with treatment services, with average scores calculated for each subcategory to explore their association with ART adherence.

The third section consisted of seven questions assessing ART adherence using the multi-method tool developed by Gavin Steel *et al.* in 2007[24]. This tool combines multiple indirect adherence measures, including self-reporting, pill count, PIT, and VAS, to overcome the limitations of individual methods and provide a more comprehensive assessment of adherence among PLWH. It includes four components: (1) Self-reporting: Participants answered four questions about their medication-taking behavior, such as difficulties in taking medication or instances of missed doses, with adherence indicated by negative responses; (2) VAS: A 0-10 scale measuring adherence over the past four days; (3) PIT: An evaluation of patients' knowledge of their medications, including names, dosages, timing, and instructions; and (4) Pill Count Scale: A measure of adherence based on the percentage of pills consumed. Participants were asked to provide their medication container, allowing researchers to count the remaining pills and calculate adherence. High adherence was defined as meeting all of the following criteria: no reported lapses in adherence on the self-report, a VAS score of $\geq 9.5/10$ points, correct responses on the PIT, and a pill count adherence of $\geq 95\%$. Participants who failed to meet any of these criteria were classified as having low adherence.

The fourth section employed the 9-item PHQ-9 scale, which has been validated in its Vietnamese version to assess participants' depression levels[25,27]. The scale consists of nine questions, each scored on a scale of 0 to 3, with a maximum possible score of 27.

2.3. Data collection

Data collection involved face-to-face interviews conducted by trained researchers. To prevent duplication and safeguard personal information, participants were identified using patient IDs assigned from medical records. Each interview lasted approximately 20 to 25 minutes.

2.4. Data analysis

The data were entered using Microsoft Excel and analyzed

with STATA version 17[28]. Descriptive statistics, including the mean, standard deviation, median, quartile, maximum, minimum, percentages (%), and frequency (*n*), were calculated. The dependent variable, ART adherence, was categorized into two groups: high adherence and low adherence.

Independent variables included socio-demographic factors (sex, age, income, residential area, education, tobacco use, marital status, employment status, alcohol use, medical expenses, and distance to the hospital), and factors influencing adherence (substances use, drug side effects, patient beliefs about treatment effects, treatment satisfaction, and depression). Univariate analysis was performed using a univariate logistic model and *Chi*-square tests to identify potential variables for multivariate analysis. Variables with a *P*-value <0.05 were selected for further evaluation. Multivariate logistic regression was then conducted, with results presented as odds ratios (*OR*) and 95% confidence intervals (*CI*). Statistical significance was set at *P*<0.05.

2.5. Ethical approval

The study was approved by the Ethics Committee for Biomedical Research at the Hospital for Tropical Diseases (HTD) in Ho Chi Minh City, Vietnam (Approval No. 1951/QD_BVBND, dated June 14, 2022). Before participation, all individuals received detailed information about the study's objectives and procedures. Those who agreed to take part in the study provided a written consent form. Participants had the right to withdraw from the study at any time or skip specific questions without any consequences. All participants received a transportation allowance of 200 000 VND (approximately 8 dollars). Individuals identified as having low adherence were counseled by physicians after completing the survey; they were provided with personalized guidance to address adherence challenges and improve their adherence to ART. The questionnaire used in the study did not gather any personally identifiable information.

3. Results

A total of 347 individuals living with HIV participated in the study, with 86.2% identifying as male and 13.8% as female. 52.5% of the participants aged 35 or older, with a mean age of (35.2± 8.3) years. 42.1% lived in urban areas, while 57.9% resided in rural regions. 32.8% were using tobacco, and 36.9% were using alcohol during treatment. The high-income group earning ≥400 dollars per month made up 17% of the sample, while 83% were in the medium- or low-income categories, earning <400 dollars per month. 85.6% had completed at least high school, and 59.7% of participants were married. 82.7% of the participants could pay for treatment (Table 1).

Based on the adherence assessment scales, the high adherence rates among participants were 88.8% for the self-report scale, 81.8% for VAS, 89.0% for PIT, and 87.6% for the pill count scale. When combining the results from all four scales, the overall high treatment adherence rate was 69.5% (Table 2).

Table 1. Sociodemographic characteristics of the participants (*n*=347).

Characteristics	<i>n</i> (%)
Sex	
Female	48 (13.8)
Male	299 (86.2)
Living area	
Rural	201 (57.9)
Urban	146 (42.1)
Academic level	
≤High school	297 (85.6)
>High school	50 (14.4)
Marital status	
Single	207 (59.7)
Married	115 (33.1)
Divorced/separated/widow	25 (7.2)
Income	
Medium and low (<400 dollars per month)	288 (83.0)
High (≥400 dollars per month)	59 (17.0)
Whether he/she has a job?	
No	37 (10.7)
Yes	310 (89.3)
Ability to pay for treatment	
No	60 (17.3)
Yes	287 (82.7)
Using tobacco [#]	
No	233 (67.2)
Yes	114 (32.8)
Consuming alcohol [#]	
No	219 (63.1)
Yes	128 (36.9)
Age, years	
>35	182 (52.5)
≤35	165 (47.5)
Distance to hospital* (km)	
	10 (10-20)

[#]Tobacco/alcohol use were defined as "yes" if participants were using during treatment. *Data are expressed as median (quartile).

Table 2. Adherence rate to antiretroviral therapy adherence among participants according to different measures tools (*n*=347).

No.	Content	Adherence level, <i>n</i> (%)	
		High	Low
1	Patient self-report	308 (88.8)	39 (11.2)
2	VAS	284 (81.8)	63 (18.2)
3	PIT	309 (89.0)	38 (11.0)
4	Pill count	304 (87.6)	43 (12.4)
Overall adherence		241 (69.5)	106 (30.5)

VAS: Visual Analog Scale; PIT: Provider Interview Tool.

Table 3. Differences in scores related factors and depression, social support according to the degree of treatment adherence ($n=347$).

Content	Overall adherence		P
	Low ($n=106$)	High ($n=241$)	
Frequency of substance use	2 (1-2)	1 (1-2)	<0.001
Drug side effects	2 (1.0-2.3)	1.3 (1.0-2.0)	<0.001
Beliefs about treatment effect	4.1 (4-4.75)	4.5 (4.1-4.7)	0.002
Treatment satisfaction service	4.3 (4.0-5.0)	4.6 (4.0-5.0)	0.029
Depression	7 (5-10)	5 (2-7)	<0.001

P-value was calculated using a univariate Logistic model. Data are expressed as median (quartile). High adherence was defined as meeting all criteria: no reported lapses in adherence on the self-report, a VAS score 9.5/10, correct PIT responses, and pill count adherence 95%. Failing any criterion indicated low adherence.

In examining factors relating to ART adherence, the median scores for beliefs about treatment effect [4.5 (4.1-4.7) vs. 4.1 (4-4.75), on a 5-point scale, $P=0.002$], and treatment satisfaction service [4.6 (4-5) vs. 4.3 (4-5), on a 5-point scale, $P=0.029$] were significantly higher in the high adherence group compared to the low adherence group.

However, the median scores for the frequency of substances use [2 (1-2) vs. 1 (1-2), $P<0.001$, on a 5-point scale], drug side effects [2 (1-2.3) vs. 1.3 (1-2), $P<0.001$, on a 5-point scale], and depression [7 (5-10) vs. 5 (2-7), $P<0.001$, measured by the PHQ-9 scale, ranging from 0 to 27] were higher in the low adherence group (Table 3).

The univariate analysis results indicated a significant association between ART adherence among PLWH and factors such as income ($P=0.002$), employment status ($P=0.031$), ability to pay for treatment ($P<0.001$), consuming alcohol ($P=0.017$), using tobacco ($P<0.001$), and age ($P=0.003$). However, no significant correlation was found between ART adherence and variables such as sex ($P=0.575$), living area ($P=0.202$), marital status ($P=0.103$), distance to hospital ($P=0.730$), and education ($P=0.277$) (Table 4).

In the multivariable analysis, a significant association was found between ART adherence among PLWH and factors such as tobacco use, depression, stimulant use, ability to pay for treatment, and drug side effects. Participants who used tobacco had 0.49 times lower

Table 4. Univariate analysis of the association between sociodemographic characteristics with high antiretroviral therapy adherence among people living with HIV ($n=347$).

Characteristics	Low ($n=106$)	High ($n=241$)	P-value
Sex			
Female	13 (27.1)	35 (72.9)	0.575 ^a
Male	93 (31.1)	206 (68.9)	
Living area			
Rural	56 (27.9)	145 (72.1)	0.202 ^a
Urban	50 (34.3)	96 (65.7)	
Academic level			
≤High school	94 (31.6)	203 (68.4)	0.277 ^a
>High school	12 (24.0)	38 (76.0)	
Marital status			
Single	67 (32.4)	140 (67.6)	0.103 ^a
Married	28 (24.4)	87 (75.6)	
Divorce/widow	11 (44.0)	14 (56.0)	
Income			
High (≥400 dollars per month)	8 (13.6)	51 (86.4)	0.002 ^a
Medium and low (<400 dollars per month)	98 (34.0)	190 (66.0)	
Whether he/she has a job?			
No	17 (45.9)	20 (54.1)	0.031 ^a
Yes	89 (28.7)	221 (71.3)	
Ability to pay for treatment			
No	33 (55.0)	27 (45.0)	<0.001 ^a
Yes	73 (25.4)	214 (74.6)	
Using tobacco			
No	55 (23.6)	178 (76.4)	<0.001 ^a
Yes	51 (44.7)	63 (55.3)	
Consuming alcohol			
No	57 (26.0)	162 (74.0)	0.017 ^a
Yes	49 (38.3)	79 (61.7)	
Age group, years			
≤35	63 (38.2)	102 (61.8)	0.003 ^a
>35	43 (23.6)	139 (76.4)	
Distance to hospital ^b	10 (8-20)	12 (10-20)	0.730 ^b

Data are expressed as n (%). ^aChi-square test; ^bA univariate logistic model; ^cData are expressed as median (quartile).

Table 5. Multivariable analysis of associated factors with high ART adherence among people living with HIV ($n=347$).

Independent variables	OR	95% CI		P
		Lower	Upper	
Using tobacco (ref: No)				
Yes	0.49	0.28	0.83	0.009
Scores for frequency of addictive substance use	0.50	0.30	0.83	0.007
Scores for drug side effect	0.64	0.45	0.92	0.016
Scores for depression	0.89	0.84	0.95	<0.001
Ability to pay for treatment (ref: No)				
Yes	2.85	1.48	5.47	0.002

ref: Reference group; P -value was calculated using multivariate logistic regression. Only variables significantly associated with adherence ($P<0.05$) are presented in this table.

odds of high ART adherence compared to non-users (OR 0.49, 95% CI 0.28-0.83, $P=0.009$). For an increase in depression, the odds of high ART adherence decreased by 11% (OR 0.89, 95% CI 0.84-0.95, $P<0.001$). Similarly, an increase in the frequency of addictive substance use was associated with a 50% reduction in the odds of high ART adherence (OR 0.50, 95% CI 0.30-0.83, $P=0.007$). Compared to the group that could not afford treatment, the odds of adherence were 2.85 times higher in the group that could pay (OR 2.85, 95% CI 1.48-5.47, $P=0.002$). Lastly, an increase in the drug side effects corresponded to a 36% decrease in the odds of high ART adherence (OR 0.64, 95% CI 0.45-0.92, $P=0.016$) (Table 5).

4. Discussion

This cross-sectional study assessed antiretroviral therapy adherence rates among PLWH and examined factors associated with high adherence. The results showed that 69.5% of participants demonstrated high adherence to ART. Significant associations were found between adherence levels and factors such as tobacco use, depression, stimulant use, ability to pay for treatment, and drug side effects.

Our findings revealed a lower ART adherence rate among participants, as measured by a multi-method tool, compared to previous studies conducted in Vietnam by Phuong MN *et al.* (75.7%)[14] and Phuong ML *et al.* (88.5%)[15]. However, our adherence rate was higher than that reported by Hue TM *et al.* (45.5%) in northern Vietnam[16]. Notably, when assessing self-reported adherence alone, the differences between studies were not significant.

Overall, most studies indicated that ART adherence rates among people living with HIV fall short of the recommended target of at least 95%. These variations in adherence rates across studies may be attributed to differences in demographic factors, such as marital status and education level, both of which have been shown to influence adherence[14,15]. Another key factor is the variation in adherence assessment methods. Phuong MN *et al.*[14] and Phuong

ML *et al.*[15] relied solely on self-report questionnaires, while Hue TM *et al.*[16] used VAS. However, our study used a multi-method tool that integrating self-report, VAS, PIT, and pill counts providing a more comprehensive assessment of adherence from participants.

Relying on a single assessment method for a complex behavior like ART adherence may lead to overestimated adherence rates[9,22]. A combined indirect measurement approach helps mitigate the limitations of individual methods, enhancing reliability[23]. However, indirect measures may not fully align with direct adherence assessments such as the Medication Event Monitoring System or biomarker-based methods. Nevertheless, a multi-method tool offers practical and cost-effective alternatives, especially in resource-limited settings like Vietnam, where laboratory-based adherence assessments are often financially inaccessible. Given these advantages, we strongly recommend that clinicians adopt a multi-method tool in clinical settings to better assess and understand ART adherence among PLWH, ultimately improving treatment outcomes.

There was a notable correlation between tobacco use and ART adherence. People who did not smoke demonstrated higher adherence rates compared to those who used tobacco. These findings are consistent with previous research[16,29-31]. One study examining ART adherence among PLWH who smoke revealed that nicotine dependence, along with other risk behaviors such as alcohol consumption, illicit drug use, and advancing age, significantly reduced adherence levels[30]. Additionally, tobacco use in PLWH with compromised immune systems may increase their risk of opportunistic pulmonary infections and lung cancer[32]. In Vietnam, tobacco use remains prevalent among PLWH, with rates ranging from 32.8% to 47.6%[16]. This high prevalence may contribute to suboptimal ART adherence and an increased risk of adverse health outcomes. To improve adherence and reduce pulmonary comorbidities, healthcare providers should actively support smoking cessation efforts through counseling, education, and evidence-based interventions.

Our findings also indicated that substance use is negatively associated with ART adherence, aligning with previous studies that have shown a link between substance use and decreased adherence among PLWH[12,14,31]. Frequent substance use can impair cognitive function and diminish the motivation to adhere to medication schedules, leading to missed doses and inconsistent adherence[31]. Additionally, this factor has been associated with lower rates of viral suppression, even among individuals receiving ART, which can contribute to treatment failure and drug resistance[33]. In Vietnam, drug abuse remains prevalent among PLWH, affecting more than 69% of this population[14]. This high rate of substance use is likely one of the significant factors contributing to poor adherence. Addressing risky behaviors, particularly stimulant use, should be a key component of HIV treatment strategies to improve adherence and enhance overall treatment outcomes.

In our study, we observed that participants experiencing a greater number of side effects exhibited lower adherence to ART. This finding aligns with results from previous research[12,18,31,34]. This could be because PLWHs are required to use ART for a lifetime. However, persistent side effects can significantly impact the quality of life for PLWH, potentially leading to treatment discontinuation. The early reports showed that over 90% of participants experienced side effects, with a higher prevalence noted among younger individuals, women, those from lower socioeconomic backgrounds, and patients newly initiated on ART[35,36]. These findings underscore that side effects are a prevalent issue in clinical practice, posing a significant barrier to adherence among PLWH. Despite the significant impact of side effects on adherence, previous studies in Vietnam have not extensively examined this factor[14–16]. Given its critical role, our results recommend that healthcare providers proactively discuss potential side effects with patients, particularly those newly beginning ART. Educating patients on how to manage side effects may help mitigate their impact, support sustained adherence, and ultimately improve treatment outcomes.

The analysis showed that higher levels of depression were linked to lower adherence to antiretroviral therapy. This finding aligns with existing literature that identifies depression as a barrier to adherence among PLWH[13,31,34,37]. There is a bidirectional relationship between depression and HIV management. On one hand, factors such as stigma and discrimination associated with living with HIV increase the likelihood of depression in patients[20,38]. On the other hand, depression contributes to poor ART adherence, leading to treatment failure and worse health outcomes in people living with HIV[31,37]. Depression is a prevalent mental health issue affecting approximately 12%–35% of PLWH[34,38], with similar rates reported in Vietnam[39]. Given its impact on adherence, routine depression screening in clinical settings is essential. Healthcare providers can use the Patient Health

Questionnaire-2 as an initial screening tool, with individuals scoring three or higher requiring further evaluation using the PHQ-9[25]. Implementing this two-step approach ensures efficient use of clinical time while reducing the risk of undiagnosed depression, ultimately supporting better mental health and ART adherence.

Our findings reveal a significant association between financial capacity and ART adherence among participants. PLWH who can afford treatment demonstrate higher adherence rates than those who cannot. However, research on this relationship in Vietnam remains limited[14–16]. Notably, a study in Cambodia reported an inverse trend, where individuals with higher incomes exhibited poorer adherence than those with lower incomes[13]. This discrepancy may be attributed to differences in health systems: Cambodia provides ART free of charge, prioritizing access for lower-income, vulnerable populations, whereas in Vietnam, ART is not entirely free[4,13]. Beyond medication costs, PLWH in Vietnam must also pay for check-ups and laboratory tests, making treatment affordability a challenge, especially given that over 83% of participants earn less than \$400 per month. Although medical insurance reduces treatment costs more than fortyfold, 7% of PLWH still do not utilize it[4]. To improve adherence and ensure equitable access to treatment, expanding universal insurance coverage for PLWH in Vietnam should be a priority.

One of the strengths of this study is the use of a multi-method tool to assess ART adherence among people living with HIV. This tool provides a more comprehensive measure of adherence. Additionally, the study identifies ART adherence rates and associated factors, such as tobacco use, depression, substance use, ability to pay for treatment, and drug side effects, which can be applied in clinical practice to improve patient adherence.

Several limitations should be noted. First, the cross-sectional design limits the ability to infer causality, necessitating prospective cohort studies to establish causal relationships. Second, convenience sampling was used to recruit PLWH, which may lead to a lack of generalizability.

ART adherence among people living with HIV in Vietnam has been found to be significantly low and far below the targeted levels. Risk behaviors, including tobacco use, substance use, ART-related side effects, financial barriers, and depression, were identified as key factors contributing to poor adherence. To improve adherence, interventions aimed at reducing these risk behaviors, increasing the use of medical insurance for treatment, managing ART-related side effects, and screening for depression are essential. Implementing such measures could enhance treatment outcomes for PLWH in Vietnam.

Conflict of interest statement

The authors declare that there is no conflict of interest.

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Authors' contributions

All authors contributed substantially to drafting, revising, and approving the article's final version. LTV and GH contributed to the conception and design of the study and acquisition of the data. DQP, BVKQ, and LTV cleared and analyzed the data. DPQ, AG, HTNN, HTMN, LYV, and GH were the contributors to the interpretation of the data.

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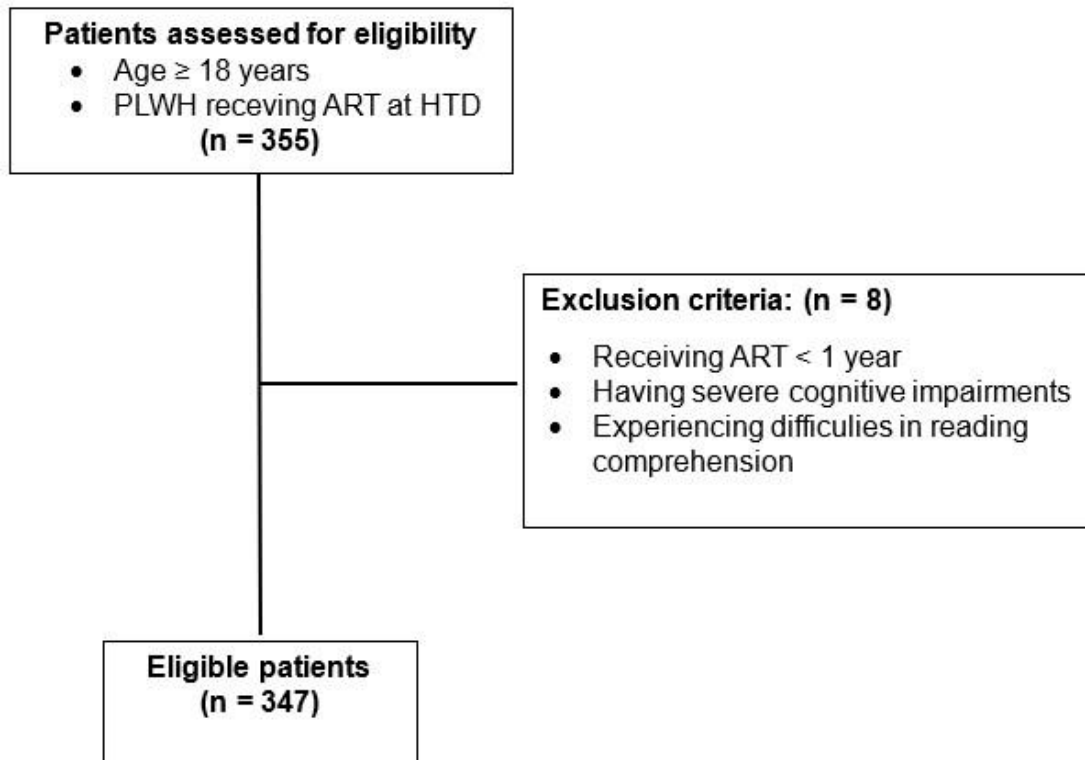
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Supplementary Figure 1. Flowchart of participant selection process in the study.