Consistent ART Adherence Is Associated with Improved Quality of Life, CD4 Counts, and Reduced Hospital Costs in Central China

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Abstract

This study aimed to assess levels of ART adherence and to examine the relationship between adherence and treatment outcomes. A longitudinal study in Hunan and Hubei provinces used the CPCRA Antiretroviral Medication Self-Report and a 7-day Visual Analogue Scale to assess levels of adherence, while quality of life was evaluated using SF-36. CD4 cell count and the number, duration, and cost of hospitalizations were collected from participant medical records. Measurements were obtained at baseline, month 3, and month 6. A total of 113 participants enrolled and 98 completed the study. The mean level of adherence was 91%, 89%, and 88% at baseline and at 3 and 6 months, respectively. Of participants, 54/98 (58%) reported taking all doses at all three interviews and were classified as consistent adherers (CA). CAs had better physical function ($p=0.001$), general health ($p=0.009$), vitality ($p=0.016$), social functioning ($p=0.001$), and mental health ($p=0.023$), and presented a higher CD4 cell count ($p=0.028$). CAs also had fewer hospital admissions and readmissions ($p=0.005$), shorter hospital stays ($p=0.005$), and lower hospital expenses ($p=0.006$). Consistent adherence is associated with better outcomes including improved quality of life, higher CD4 counts, and lower health care costs.

Introduction

THE NUMBER OF HIV-INFECTED PEOPLE in China is increasing rapidly. Given the size of China's population (1.3 billion) the HIV epidemic has the potential to become a significant threat to public health in China. According to the Chinese Ministry of Health and UNAIDS, it was estimated that by the end of 2007 there were 700,000 people infected with HIV, including 85,000 living with AIDS in China.¹ In response to the growing HIV epidemic, the Chinese government initiated The China Comprehensive AIDS Response (China CARES) program in 2003, and began providing free access to antiretroviral therapy (ART) and related health care services to HIV-infected people.² The ART program initially focused on the people who contracted HIV through illicit blood and plasma donations as well as blood transfusion in the mid-1990s, and then scaled up to other HIV-infected populations, including drug users, commercial sex workers, pregnant women, and children.³ This program now covers low-income HIV/AIDS patients in urban areas and all patients in rural areas.⁴⁻⁶ As of late 2007, according to the Chi-

nese Ministry of Health, a cumulative total of 39,298 HIV-infected people had received ART.¹

It is widely accepted that adherence to therapy is crucial to successful outcomes of ART. Optimal adherence is essential for plasma viral suppression and immunological responses.⁷⁻⁹ For patients in poor regions in which viral load and CD4 cell counts are unavailable, clinical outcomes of ART can be measured indirectly by following weight, symptoms, and the ability to return to performing the activities of daily life. ART has also been associated with an improved quality of life in people infected with HIV.¹⁰ Other positive outcomes related to ART, including decreased hospital readmissions and reduced cost, have been described by some western studies.^{11,12}

Published literature regarding adherence to ART and treatment outcomes among Chinese HIV/AIDS patients is limited. Two current studies have assessed the levels of adherence to ART and associated factors in Chinese populations.^{13,14} Other reports simply describe adherence as the rate of discontinuation of ART by Chinese HIV/AIDS patients.^{15,16} ART treatment outcome is often evaluated solely by CD4 cell counts¹⁷ and few reports have examined other outcomes in China. This

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study was therefore designed to investigate the level of adherence to ART in Chinese HIV-infected people using structured methods; and to examine the relationship between adherence and treatment outcomes. The expected benefits of this study include generating evidence for the systematic monitoring of patients' adherence, evaluation of treatment outcomes in national ART programs, and providing baseline data supporting treatment strategies that would allow China to successfully implement its free ART policy.

Materials and Methods

Sample and setting

The target population for this study was HIV/AIDS patients participating in the China CARES program. People were eligible for this study if they met the following criteria: (1) a confirmed diagnosis of HIV infection; (2) 18 years or older; (3) had received ART for at least 1 month prior to commencement of this study, and were continuing their ART at study commencement; and (4) mentally competent to answer questions.

This study was conducted in HIV/AIDS treatment sites in Hunan and Hubei provinces. Hunan is located in the mid-south of China. The majority of patients in Hunan acquired HIV through drug injection or sexual contact. In Hunan, free ART started in 2004 and by the end of 2007 there were 620 HIV-infected people receiving free ART (Hunan CDC working information). Hubei is located in central China and has a long border with the province of Henan where many illegal blood banks existed in the 1990s and many people were infected with HIV due to improper blood collection techniques. Most HIV-infected people in Hubei are farmers and they contracted HIV by selling plasma in the 1990s. By the end of 2007 there were 1145 active ART patients in Hubei Province (Hubei CDC work summary). According to the documented data from treatment sites, around 80–90% of the HIV-infected people who receive care in the clinics and meet the requirements of initiation of ART were on ART.

Measurements

A two-part medication adherence questionnaire was used to measure the participant's adherence behavior to medication.

The Community Programs for Clinical Research on AIDS (CPCRA) Antiretroviral Medication Self-Report has been used with reliability in over 1000 HIV-infected people by Mannheimer *et al.* in AIDS clinical trials.¹⁸ This questionnaire uses a global 7-day recall and asks subjects to recall whether they took "all (100%), most (80%), about half (50%), very few (20%), none" of their pills in the past 7 days. Ten common reasons for missing a dose are listed in the questionnaire. Subjects are allowed to check all reasons. Other information, including timing of doses, basic medication information, and side effects, was also included in the questionnaire.

A visual analogue scale (VAS) measuring the proportion of dose taken was the second measure of subjects' adherence to ART in the preceding 7 days. This scale has been validated in a low-income population.¹⁹ A 10-cm line is drawn and marked 0% at one end and 100% at the other end. Subjects are instructed to put a cross on the line at the point representing

their best guess of how much medication they had taken in the preceding week (0% = taking no medication, 100% = taking all medication). Results of the VAS are dichotomized as adherent (>90%) or nonadherent ($\leq 90\%$).^{20–22}

The two parts measuring medication adherence were adapted to reflect the local culture, but the changes were minimal. A general information sheet collected demographic data and clinical information. The questionnaire was compiled in English and evaluated by experts from Yale University who have expertise in AIDS care and who are familiar with the HIV/AIDS situation in China. The investigator translated the instrument into Chinese, and invited two other Chinese scholars to back translate. Five AIDS experts in China were invited to review the Chinese version of the questionnaire for face validity and readability. The questionnaire was pilot tested on 12 HIV-infected people in Hengyang, Hunan in October 2005.

Quality of life

Quality of life was measured with the Short Form 36 Health Survey Questionnaire (SF-36). It is a well-validated tool and has been used in testing HIV-positive populations.²³ SF-36 assesses the quality of life in eight domains: physical function (PF), role limitation due to physical problems (RP), bodily pain (BP), general health (GH), vitality (VT), social functioning (SF), role limitation due to emotional problems (RE), and mental health (MH). It has been shown to be useful in longitudinal survey assessments.²⁴ The SF-36 has been widely used in China and Chinese population norms have been established.²⁵

Clinical outcomes

The medical records for each subject were reviewed for the latest laboratory test results of CD4⁺ cell counts and occurrence of HIV/AIDS-related opportunistic infections (OIs).

Hospitalization and costs

During the study period the number of nontrauma hospitalizations and medical expenses of hospitalization and outpatient clinic care were obtained from participants' medical documents and related records from assigned hospitals.

Data collection

Data collection lasted from March 2006 to January 2007. A face-to-face interview was used to administer the questionnaires to obtain information about subjects' sociodemographic information and clinical characteristics, adherence, and quality of life. The investigator and trained research assistants interviewed the participants at baseline, month 3, and month 6 with the same instruments. The baseline assessment took 45 min, and both follow-up interviews lasted 30 min. All interviews were conducted in a private area of the treatment sites, which was out of earshot of clinic staff and other patients. Medical records were reviewed to obtain data about CD4 cell counts and OIs at the same time as the interviews. Medical documents in the assigned hospital were reviewed at baseline and 6 months to calculate the number of HIV/AIDS-related hospitalizations and the medical expenses of hospitalization and outpatient clinic care.

TABLE 1. SOCIODEMOGRAPHIC AND CLINICAL CHARACTERISTICS OF THE SAMPLE (N=113)

Characteristics	n (%)
Residence	
Rural	72 (63.7)
Urban	41 (36.3)
Sex	
Male	82 (72.6)
Female	31 (27.4)
Education	
Illiterate	8 (7.7)
Primary school	40 (35.4)
Middle school	40 (35.4)
High school or above	25 (22.1)
Marital status	
Married or being cohabitant	76 (67.3)
Single	25 (22.1)
Divorced	7 (6.2)
Widowed	5 (4.4)
Route of HIV infection	
Plasma selling	34 (30.1)
Sexual contact	27 (23.9)
Drug use	37 (32.7)
Blood transfusion	8 (7.0)
Unknown	7 (6.2)
HIV stage	
Asymptomatic	32 (28.4)
Symptomatic	81 (71.6)
Duration of therapy	
≤6 months	64 (56.5)
>6 months	49 (43.4)
Antiretroviral medication regimen	
3TC + NVP + D4T	58 (51.3)
AZT + NVP + DDI	19 (16.8)
AZT + 3TC + NVP	17 (15.0)
3TC + D4T + EFV	15 (13.3)
Other combinations	4 (3.6)
CD4 cell	
<200	53 (46.9)
200–500	48 (42.5)
>500	12 (10.6)

The study protocol was reviewed and approved by the Human Subject Research Review Committee of Yale University and Central South University. The participants were fully informed of the purpose, procedures, risks, and benefits of participating in this study. Each participant was assured that their responses would be kept confidential. A code was assigned for each subject and personal identifying information did not appear in the questionnaire. All data were locked and were accessed only by the researchers. Participants with poor adherence and inaccurate medication knowledge received immediate counseling and advice from the interviewers.

Data analysis

Data were entered with Epidata and analyzed with SPSS 13.0. Descriptive analyses, Friedman *M* test, Chi square analysis, repeat measures ANOVA, and *t* test were used as appropriate. Assumptions of normality and constant SD were met.

FIG. 1. The number of subjects at each data collection point.

Results

Sample characteristics

One hundred and thirteen subjects began the study with a consent rate of 90%: 66 from Hunan and 47 from Hubei. Table 1 describes the sample characteristics. Among 113 participants, 63.7% were farmers, with a mean age of 39.5 years (median = 39, range 22–73 years). Of the total participants, 67.3% were married or cohabitated with partners. On average, they had a very low income (mean yearly income per person = 1005 yuan, median = 333 yuan). Only 10 participants were employed or retired (therefore having a fixed income); the other participants were unemployed or farmers living in poor regions and therefore had low and erratic incomes. The main routes of HIV transmission were drug injection (32.7%), sale of plasma (30.1%), and sexual contact (23.9%). The mean duration of treatment was 13.7 ± 11.2 months (range 1–47). Forty-seven percent of the subjects had CD4 cell counts of less than 200 cells/ μ l.

One hundred and six participants were interviewed at month 3 and 98 completed the entire study. Figure 1 shows the number of subjects at each data collection point and the reasons for dropping out of the study.

Levels of adherence

At each time point 70% or more of the subjects reported taking all of their doses (Table 2). Using the VAS scores, the mean level of adherence was 91% at baseline, 89% at month 3, and 88% at month 6, showing a slight decrease over time, with an average total adherence of 89%. The Friedman *M* test showed no significant difference among these three measurements ($\chi^2 = 0.15$, $p = 0.56$). Twenty-nine percent (33/113) of participants reported missing doses at least once in the past 7 days at baseline, 26% (28/106) at month 3, and 29% (28/98) at month 6.

During the three interviews, missing doses or discontinuing treatment were reported 89 times. The four most common reasons for missing doses or discontinuing treatment were simple forgetfulness (45%), being away from home (44%), being too busy (33%), and side effects (30%).

Using the VAS score, adherence was dichotomized as adherent (greater than 90% of prescribed doses) and nonadherent

TABLE 2. CATEGORICAL LEVELS OF ADHERENCE OVER TIME (N = 98)

Interviews	Levels of adherence		
	All (100%)	Most (80% ~ 99%)	Half or less (0% ~ 79%)
Baseline	71 (72.4)	19 (19.4)	8 (8.2)
3 months	73 (74.5)	17 (17.3)	8 (8.2)
6 months	70 (71.4)	17 (17.3)	11 (11.2)

(90% or less of prescribed doses). Among the 98 participants who completed the study, 54 persons (57%) were rated as adherent to ART at all three interviews (consistent adherers) and 42 persons (43%) were classified as nonadherent in at least one interview (nonadherers).

Quality of life

The SF-36 scores of the participants showed improvement in eight domains within the 6-month period. One-sample *t* test was used to test the differences between the average scores of our sample and Chinese norms.²⁵ Significant differences were found in every domain (Table 3).

Adherence and quality of life

Repeat measures ANOVA (Table 4) was used to examine the effects of adherence (two levels) and time (three levels) on the SF-36 scores. Table 4 shows that there were significant differences in physical function ($p = 0.016$), role limitation due to physical problems ($p = 0.043$), bodily pain ($p = 0.013$), role limitation due to emotional problems ($p = 0.0001$), and mental health ($p = 0.001$) among the different time points. There was no significant difference in the scores of general health, vitality, and social functioning. Our results also indicated that consistent adherers had a better score in the dimensions of physical function ($p = 0.001$), general health ($p = 0.009$), vitality ($p = 0.016$), social function ($p = 0.001$), and mental health ($p = 0.023$) than nonadherers. Repeat measures ANOVA showed that adherence and time had no interaction effect on the quality of life.

Clinical outcomes

The mean CD4 cell counts was 254 cells/ μ l at baseline, 275 cells/ μ l at month 3, and 310 cells/ μ l at month 6, with an increase of 58 cells/ μ l over the 6 months ($p = 0.0001$). The mean growth of CD4 count was 72 cells/ μ l in consistent adherers and 27 cells/ μ l in nonadherers ($p = 0.03$) (Fig. 2).

During the 6 months, 49 participants (50%) had no OIs, 25 (26%) had OIs at one interview and 20 participants (20%) had OIs at two interviews, and four participants (4%) had OIs at all three interviews. Among consistent adherers, 36 (64%) of participants were free from OIs and only 13 (31%) nonadherent participants had no OIs. The χ^2 test showed that adherent participants were more likely to be free from OIs than nonadherent participants ($\chi^2 = 10.67$, $p = 0.001$, OR 1.8, 95% CI 1.24–2.62).

Hospitalization and costs

Thirty-one participants (32%) had been hospitalized at least once during the 6-month study period, with an average hospital stay of 46.9 ± 34.5 days and an average hospitalization cost of $14,534 \pm 1253$ RMB. The mean outpatient medical expense was 243 RMB. Consistent adherers had lower hospital expenses ($\chi^2 = 7.45$, $p = 0.006$) and shorter hospital stays ($\chi^2 = 7.91$, $p = 0.005$) compared to nonadherers. Consistent adherers were also less likely to be hospitalized or rehospitalized ($\chi^2 = 7.92$, $p = 0.005$) (Table 5).

Discussion

Adherence to ART

One hundred percent adherence to ART was reported by approximately 70% of participants at each interview. The mean level of adherence in this sample was 89%, and was slightly less than that reported in previous western studies,^{8,26–28} due to the longitudinal nature of the data. The level of adherence to ART of HIV-infected people enrolled in the China CARES program appears similar to levels reported in western countries. However, the large numbers of clients reported as nonadherent are of concern in view of the potential for nonnucleoside reverse transcriptase inhibitor (NNRTI) resistance developing, and the lack of protease inhibitor back-up regimens, which are currently unavailable in China.⁵

TABLE 3. COMPARISON OF SCORES OF SF-36 BETWEEN THE SAMPLE AND CHINESE NORMS ($\bar{X} \pm SD$)

Subscales	This sample (n = 98)			Norms ²⁵ (n = 2249)	t ^a
	Baseline	3 months	6 months		
Physical function	81.46 $\pm$ 15.94	85.31 $\pm$ 16.70	86.61 $\pm$ 16.52	90.62 $\pm$ 15.40	4.8*
Role limitation due to physical problems	23.44 $\pm$ 35.32	28.13 $\pm$ 39.45	35.94 $\pm$ 43.50	79.51 $\pm$ 34.70	17.7*
Bodily pain	65.07 $\pm$ 26.69	73.33 $\pm$ 27.17	71.09 $\pm$ 27.47	85.61 $\pm$ 18.37	7.5*
General health	37.71 $\pm$ 22.47	41.30 $\pm$ 25.37	41.88 $\pm$ 24.00	69.55 $\pm$ 21.32	14.7*
Vitality	48.65 $\pm$ 21.08	49.32 $\pm$ 20.69	52.60 $\pm$ 17.14	70.29 $\pm$ 17.07	12.2*
Social function	47.27 $\pm$ 31.53	47.01 $\pm$ 31.19	52.60 $\pm$ 31.04	86.85 $\pm$ 17.28	15.6*
Role limitation due to emotional problems	28.82 $\pm$ 40.06	46.88 $\pm$ 46.79	52.78 $\pm$ 47.31	76.45 $\pm$ 38.47	11.1*
Mental health	53.33 $\pm$ 18.98	55.54 $\pm$ 18.33	58.83 $\pm$ 17.59	72.65 $\pm$ 16.81	11.3*

^acomparison mean scores with norms.

* $p < 0.0001$.

TABLE 4. RESULTS OF REPEAT MEASURES ANOVA ANALYSIS

Domains	Intercept		Time effect		Adherence effect	
	F	P	F	P	F	P
PF	0.29	0.75	6.01	0.016	9.72	0.001
RP	0.97	0.38	4.19	0.043	2.33	0.10
BP	1.26	0.29	6.45	0.013	0.52	0.60
GH	1.28	0.28	1.70	0.19	4.99	0.009
VT	1.30	0.28	2.35	0.13	4.32	0.016
SF	0.092	0.91	1.45	0.23	7.78	0.001
RE	0.46	0.64	19.37	0.0001	0.15	0.86
MH	2.56	0.083	12.27	0.001	3.91	0.023

As a whole, the level of adherence was relatively stable during the 6 months, but this does not mean adherence is static. During the observation period, adherence improved in some participants and became worse in others. Although the nonadherence rate was less than 28% at each interview, 43% of the participants were rated as nonadherent at least once in the entire period of study. Therefore relying only on cross-sectional data to evaluate adherence would cause 15% of nonadherent clients to be classified as adherent. Medication adherence is a dynamic process and ART is a lifelong treatment. It is necessary to assess clients' adherent behavior periodically to understand fully the characteristics of ART adherence.²⁹

Simple forgetfulness, being away from home, being too busy, and side effects were reported as the most common reasons for missing doses in our study, which are similar to previous international findings.^{30,31} Our finding suggests that people receiving ART need to integrate taking medication into their daily routine, have individualized medication plans,³² and adopt strategies such as carrying a pillbox when going out and using medication reminders, thus reducing the chances of missing doses and improving their level of adherence.

FIG. 2. The distribution of CD4 growth in adherent and nonadherent participants.

TABLE 5. COMPARISON OF THE NUMBER OF HOSPITALIZATIONS BETWEEN ADHERENT AND NONADHERENT HIV/AIDS PATIENTS^a

Number of hospitalizations	ART adherence		Sum
	Non-adherent	Adherent	
0	26	48	74
1	8	6	14
2	5	1	6
≥3	3	1	4
Sum	42	56	98

^a $\chi^2 = 7.92$, $p = 0.005$.

Adherence and quality of life

HIV/AIDS patients on ART still had low levels of quality of life and scores of all aspects were lower than those of the general population, especially in role limitation due to physical problems, social function, and general health. Longitudinal data show that ART improved the physical aspects of patients' quality of life, but failed to show obvious impact on the aspects of role functions and general health. One reason for this finding could be the short period of treatment. The second reason is that HIV infection affects all aspects of quality of life profoundly. Although ART treatment can improve the physical condition of HIV-infected people, role function and social function, which are highly related to the social status of the clients and social discrimination toward AIDS, are rarely improved by ART alone. A comprehensive AIDS care program including psychosocial support is needed to improve the quality of life for HIV-infected people.

Adherence to ART was significantly associated with five aspects of quality of life. Consistent adherers had better physical function, general health, vitality, social function, and mental health, compared with nonadherers. There was no significant difference in the aspects of role limitation due to physical problems, such as bodily pain, and role limitation due to emotional problems between the two groups. This finding is partially supported by previous studies. Mannheimer *et al.*¹⁰ conducted a longitudinal study on the relationship of adherence and quality of life, and revealed that clients who reported 100% adherence in three or four interviews in the first 12 months of treatment had a significant enhancement in quality of life. Consistent adherence was the most important factor in improving quality of life. Similarly, a large sample study in France showed there was a significant relationship between ART medication adherence and quality of life 1 year after treatment. Poor adherence was associated with an unchanged quality of life, or even contributed to a worsening quality of life.²³ Liu *et al.*³³ reported that clients with interrupted ART had lower mental health scores than clients with consistent ART. The relationship between ART medication adherence and quality of life is reciprocal. Quality of life can affect adherence.¹⁰ HIV-infected people with a good quality of life may have an improved ability and more confidence to follow and adhere to correct ART. From this perspective, comprehensive ART management is needed to maximize its benefits and reduce side effects, thus enhancing quality of life to the greatest possible extent, which is not only the treatment goal, but also a correlate of medication adherence.

Adherence and clinical outcomes

Our study confirms that ART adherence is associated with immunological recovery in HIV-infected clients, and good adherence contributes to greater growth of CD4 cell counts. A Chinese clinical study conducted between 2003 and 2006 reported that only 5% (2/41) of patients receiving domestic antiretroviral drugs showed drug resistance and adherence played key roles in the recovery of immunity.³⁴ Mannheimer *et al.*¹⁸ also found that participants who reported 100% adherence at all study visits were more likely to achieve better virological and immunological outcomes after 12 months of treatment. Yu and colleagues¹⁶ reported that missing doses and interrupting ART were significant factors leading to a slow increase of CD4 counts. The present study supports the need to promote adherence and encourage consistently high levels of adherence to achieve a good immunological outcome and slow the development of drug resistance.

HIV/AIDS-related OIs were still a concern for clients receiving ART because many participants had CD4 counts of less than 200 cells/ μ l. The prevalence of OIs was 28.9% in participants, which was close to Gao's³⁵ report of 30.7%. Although subjects of this study had received ART for a period of time, 46.4% of the participants had CD4 cell counts below 200 cells/ μ l. Preventive treatment and periodic checking for OIs are essential for the participants to prevent, identify, and treat AIDS-related OIs in a timely manner. Participants reporting consistent adherence presented a low prevalence of opportunistic infections. San-Andres *et al.*³⁶ evaluated the effect of early ART and showed that the clients who had good adherence demonstrated a low incidence of OIs. The occurrence of OIs is closely related to the virulence of the pathogens and the depression of the immune system.³⁷ Participants with good adherence presented faster recovery of immunological status than those with poor adherence. The literature shows that HIV/AIDS clients who maintain good adherence to ART can reduce the occurrence rate of OIs from 56.1% before treatment to 9.8% 3 years after starting treatment.³⁴ Therefore, consistent adherence to ART is one of the key components in delaying the progression of HIV to AIDS.

Adherence and medical cost

This study also demonstrated an association between consistent adherence and a reduced utilization of medical resources, such as a decreased number of nontrauma hospitalizations, shorter hospital stays, and reduced hospitalization expenses. Effective ART helps clients achieve the expected virological and immunological benefits of ART, and slows down the progression of HIV/AIDS, which in turn reduces the high medical costs of inpatient HIV/AIDS care. Nosyk *et al.*¹¹ found that clients on ART had significantly lower odds of readmission compared to clients not receiving ART. Nonadherence is an important predictor for losing the long-term clinical and economic benefits of ART. Munakata *et al.*¹² reported that nonadherence with treatment reduced the expected clinical benefits of ART by 12%. Our results suggest that interventions improving adherence to ideal levels also have great potential for economic benefit, especially in developing countries without alternative treatment regimens.^{38–40}

In summary, because China is a developing country with very limited ART drug resources and a shortage of health care

resources, it is an enormous challenge to treat large numbers of AIDS patients. Evidence from our study shows that improving and facilitating patients' consistent adherence to ART will be crucial to the long-term, effective management of China's national ART program.

Limitations

Limitations of this study are associated with the measurement of adherence, the duration of follow-up, and sampling and sample size. Self-reporting was the only method of measuring adherence used. Other measurements such as pill counting and MEMS are necessary for further study. Compared with lifelong therapy, the 6-month follow-up period of this study is relatively short, and this may limit the generalizability of the findings. The selection of sample from the clinic sites may introduce selection bias, as patients who were nonadherent to the clinic visits and discontinued the treatment were potentially undersampled, although the high rate of consent would minimize this likelihood. Furthermore, the fact that the participants of this study represent a small proportion of patients receiving ART also limits the generalizability of the findings.

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Disclosure Statement

No competing financial interests exist.

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