Journal of Infection and Public Health (2013) 6, 307—315

http://www.elsevier.com/locate/jiph

Non-adherence to antiretroviral therapy in Yaounde: Prevalence, determinants and the concordance of two screening criteria

Eric Walter Pefura-Yone[a,b,*], Emmanuel Soh[b], André Pascal Kengne[c], Adamou Dodo Balkissou[a], Christopher Kuaban[a,b]

[a] *Department of Internal Medicine and Subspecialties, Faculty of Medicine and Biomedical Sciences, University of Yaounde I, Cameroon*
[b] *Pneumology Service, Yaounde Jamot Hospital, Cameroon*
[c] *South African Medical Research Council & University of Cape Town, Cape Town, South Africa*

Received 3 October 2012; received in revised form 9 February 2013; accepted 12 February 2013

KEYWORDS
Antiretroviral therapy;
Adherence;
HIV infection;
Cameroon

Summary
Purpose: To assess the prevalence and determinants of non-adherence to antiretroviral therapy (ART) as well as the concordance of two screening criteria in a major center for human immunodeficiency virus (HIV) treatment in Yaounde, Cameroon.
Methods: In 2011, we conducted a cross-sectional study involving a random sample of 889 adults (age > 18 years, 67.9% women) infected with HIV who were receiving chronic care at the Yaounde Jamot Hospital. Adherence was assessed via self-administered questionnaires using the Community Programs for Clinical Research on AIDS (CPCRA) index and the Center for Adherence Support Evaluation (CASE) index.
Results: The prevalence of non-adherence to ART was 22.5% based on the CPCRA index and 34.9% based on the CASE index, with a low agreement between the two indexes [*kappa* = 0.37 (95% confidence interval 0.31—0.44)]. Independent determinants of CPCRA-diagnosed non-adherence were as follows: being a remunerated employee [odds ratio (95% confidence interval): 1.61 (1.14—2.28)], Pentecostal Christianity [2.18 (1.25—3.80)], alcohol consumption [1.65 (1.16—2.34)] and non-adherence to cotrimoxazole prophylaxis [5.73 (3.92—8.38)]. The equivalents for CASE-diagnosed non-adherence were [1.59 (1.19—2.12)], [1.83 (1.36—2.47)], [1.70 (1.27—2.28)], respectively, in addition to association with changes to the ART regimen [1.61 (1.17—2.20)].

* Corresponding author at: Yaounde Jamot's Hospital, PO Box 4021-Yaounde, Cameroon. Tel.: +237 9653972; fax: +237 22203165.
E-mail address: pefura2002@yahoo.fr (E.W. Pefura-Yone).

1876-0341/$ — see front matter
http://dx.doi.org/10.1016/j.jiph.2013.02.003

Conclusions: Non-adherence to ART remains high in this population. The careful evaluation of patients for the presence of determinants of non-adherence identified in this study may aid ART optimization.

Introduction

The advent of highly active antiretroviral therapy (HAART) was a major breakthrough in the global fight against human immunodeficiency virus (HIV) infection. The adoption of HAART is gradually changing the landscape of HIV infection from a highly fatal condition to a chronic disease, and people on HAART live longer and in relatively healthy condition. With the improving access to treatment, patients with HIV in Africa (68% of the global population with HIV infection) have begun to enjoy the benefits of HAART, although mortality from HIV is still unacceptably high. Indeed, the estimated 1.2 million Africans who died of HIV-related illnesses in 2010 represent 69% of the global 1.8 million deaths attributable to the epidemic in that year [1]. Access to care for HIV infection in Africa is still fraught with many challenges, including poor organization of healthcare infrastructures, inadequate funding and limited human capacity [2,3]. The consequences of these challenges, in the form of a discontinuous drug supply, default from HAART or non-adherence, are deterring factors to the effectiveness of antiretroviral treatment (ART) in this setting [4].

In sub-Saharan African countries where the HAART scale-up has been successful, adherence has been identified as a major challenge and an essential factor for achieving optimal HIV treatment outcomes. Adherence to HAART relates to the capacity of a patient to take the correct dose of each anti-HIV medication at the correct time and exactly as prescribed. It has been estimated that an adherence rate of at least 95% is needed to achieve the full effectiveness of HAART treatments while minimizing virologic failure and resistance to ART [5]. A meta-analysis of 27 studies from 13 African countries found that 77% of patients on ART achieved an adequate level of adherence to such treatments [6]. This analysis, however, was based on pooling studies of small size and that were largely representative of the era prior to the more organized and subsidized treatment of HIV across Africa. Reasons for poor adherence to ART likely vary globally, with some reasons being specific to the African setting [7,8]. In Africa, patient-level factors include limited purchasing power (to acquire the medications) and remoteness from the treatment centers [3,4]. However, community empowerment implemented over the last decade is possibly attenuating the impact of socio-economic factors on the adherence to ART [9]. Furthermore, the criteria for diagnosing non-adherence may vary substantially within a single population [10].

Free access to ART was introduced in Cameroon in May 2007 [11], but we are not aware of any study that has investigated the issues involving adherence in the context of widespread access to ART in this country. Thus, the aims of the present study were to determine the prevalence of non-adherence to ART and to correlate its determinants among people infected with HIV in the capital city of Cameroon (Yaounde). We also aimed to assess the concordance between two common instruments for diagnosing non-adherence.

Materials and methods

Study settings and participants

This study was conducted at the approved treatment center (ATC) for HIV infection of the Yaounde Jamot Hospital (YJH), which has been described in detail elsewhere [12,13]. Briefly, YJH is the referral center for respiratory diseases and tuberculosis for the capital city of Cameroon (Yaounde) and the surrounding areas. This hospital also hosts one of the major ATCs in the country, and as of June 2011, 2250 patients were receiving chronic care for HIV infection at the center. Patients treated for HIV infection are systematically seen once a month for drug prescription renewal. Approximately 80—120 patients treated for HIV are seen daily. ART regimens in this center are based on the recommendations of the Cameroon National AIDS Control Committee (CNAC) [14]. First-line ART regimens combine two nucleosidic reverse transcriptase inhibitors (zidovudine and lamivudine or emtricitabine and tenofovir) and one non-nucleosidic reverse transcriptase inhibitor (nevirapine or efavirenz). Second-line regimens combine two nucleosidic reverse transcriptase inhibitors not used in the first-line regimen (zidovudine and lamivudine or emtricitabine and tenofovir) with a boosted protease

inhibitor (ritonavir-boosted lopinavir). Second-line regimens are applied to patients (1) with HIV-1 infection who failed to respond to a first-line regimen, (2) with group O HIV-1 infection or (3) with HIV-2 infection. Patients aged 18 years and above, on ART and who attended routine clinic visits during the recruitment period were considered for inclusion in the study.

Procedures

This was a cross-sectional study lasting six weeks between October and November 2011. A systematic random sampling was applied based on a sampling interval of two. The first patient (P1) received on each consultation day during the recruitment period was included. Thereafter, all patients of the order $P1 + 2 \times N$ (N being a natural number between 1 and 60) were invited to take part in the study. Patient inclusion took place each day through to the last registered patient for that day. Patients were contacted for the study via nurses and physicians involved in routine patient follow-up at the ATC. Consenting patients were directed to one of the six specially trained investigators. Procedures for completing the self-administered questionnaire were individually explained to each participant. Anxiety was assessed using the Generalized Anxiety Disorder 7-item (GAD-7) questionnaire [15], and depression was assessed using the Patient Health Questionnaire-9 (PHQ-9) [16]. Self-reported adherence to cotrimoxazole prophylaxis was based on the estimated percentage of tablets taken during the last seven days, with less than 90% of tablets taken considered to be poor adherence. Additional data collection included socio-demographic details (age, sex, education, occupation and residence), behavioral characteristics (use of condoms, alcohol consumption, smoking habits, illicit drug use, family support for adherence, personal history of stigmatization and use of native drugs and food supplements) and clinical and therapeutic data (diagnosed duration of HIV infection, duration on ART, active opportunistic infection and particularly tuberculosis, severity of immune depression prior to starting ART, most recent CD4 count, ART regimens and changes in such regimens). The primary reasons for skipping medication were also investigated by asking participants to choose from a list of possible reasons, including side effects of medications, number of tablets to take, forgetfulness, being away from home, eating difficulties required for taking drugs, privacy concerns or drug confusion. The study was approved by the Ethics Committee of the Faculty of Medicine and Biomedical Sciences of the Yaounde 1 University, Cameroon, and signed informed consent was obtained from all participants.

Assessment of the adherence to antiretroviral therapy

Two instruments were used to assess adherence to antiretroviral drugs: (1) the Antiretroviral Medication Self-Report 7-day recall self-administered questionnaire, developed by the Community Programs for Clinical Research on AIDS (CPCRA) [17], and (2) the Adherence index of the Center for Adherence support Evaluation (CASE adherence index) [18].

The CPCRA self-report comprises 5 items indicating the level of adherence to each of the prescribed medications over the last 7 days. Participants were asked to choose a unique answer from the following options: 'During the past 7 days prior to this visit, I took all my tablets, I took them most of the time, I took them about half of the time, I took them less often or I took none of my tablets.' These answers correspond to adherence rates of 100%, 80%, 50%, 20% and 0%, respectively. A CPCRA score <95% based on the average of sub-scores from each of the prescribed medications was used to indicate poor adherence [19].

The CASE adherence index is a composite score comprising three self-report adherence items. The first item (A1) assesses difficulties in taking medications on time (score of 1—4), the second item (A2) assesses the mean number of days during which the patients missed at least one dose of medications (score of 1—6), and the third item (A3) assesses the last time the patient missed at least one dose of medication (score of 1—6). The CASE index score is determined by the formula $CASE\ \ index = A1 + A2 + A3$. A score > 10 indicates good adherence, and a score ≤ 10 indicates poor adherence [18].

Data available

A total of 932 patients were seen at the ATC of the Yaounde Jamot Hospital during the study period. Forty-three (4.6%) of these patients were excluded due to lack of consent (16 patients), inappropriate completion of the self-reported questionnaires (17 patients) or non-conversance with either English or French languages (10 patients). Demographic and clinical profiles of the excluded participants were similar to those of the included participants (data not shown).

Statistical methods

Data were analyzed with the use of SPSS® v.17 statistical software for Windows® (SPSS Inc.,

Chicago, IL). Quantitative variables were expressed as mean and standard deviation (SD) or median and 25—75th percentiles, and qualitative variables were expressed as count and percentages. The comparison of the groups was conducted with the Pearson's χ^2 test or Fisher's exact test for qualitative variables and Student's *t*-test or non-parametric equivalents for quantitative variables. The agreement between instruments for diagnosing non-adherence was assessed via Spearman's correlations and kappa statistics. Logistic regression models were used to investigate the potential determinants of non-adherence to ART. Candidate variables selected for testing in final multivariable models were based on a p-value < 0.10. A p-value < 0.05 was used to characterize statistically significant results.

Results

Study population

The profiles of the 889 patients (604 [67.9%] women) included are shown in Table 1. The median age (25—75th percentiles) was 40 (34—48) years, 182 (20.5%) had primary level education or less, 427 (48%) had remunerated employment, 37 (4.2%) had active tuberculosis, 99 (11.1%) had anxiety disorders, 864 (97.2) were on first-line ART and 231 (26%) had been on ART for more than 4 years.

Prevalence of and reasons for non-adherence to ART

Non-adherence to ART was found in 200 patients [22.5% (95% confidence interval: 19.8—25.2%)] based on CPCRA index and in 310 patients [34.9% (31.7—38)] using the CASE index. Spearman's correlation coefficient between the two indexes on a continuous scale was 0.40 ($p < 0.001$). Among non-adherent patients identified by the CPCRA index ($n = 200$), the CASE index confirmed the diagnosis in 139 (69.5%) and reclassified 61 others (30.5%) as adherent. Among the 689 patients classified as adherents by the CPCRA index, the CASE index confirmed the diagnosis in 518 (75.2%) and reclassified 171 others (24.8%) as non-adherent. The CPCRA index confirmed the diagnosis in 139 (44.8%) of the 310 classified as non-adherent based on CASE index and reclassified 61 (10.5%) as non-adherent out of the 579 classified as adherent by the CASE index. The agreement between the two indexes was below average [*kappa* = 0.37 (95% confidence interval: 0.31—0.44)]. The prevalence of non-adherence based on either of the two indexes was 41.7% (38.8—45.0%), $n = 371$.

Reasons for non-adherence among the 371 non-adherent patients based on either of the indexes are depicted in Fig. 1. The main reasons were as follows: forgetting to take the ART (40.4%), being away from home at the time ART must be taken (38.3%) and concerns about privacy (14.6%).

Determinants of non-adherence to ART

The determinants of non-adherence are shown in Tables 2 and 3 separately for each of the indexes. In univariable analyses (Table 2), using a p-value < 0.10, remunerated employment, education, religious affiliation (CPCRA index only), use of condoms (CPCRA index only), alcohol consumption, past history of tuberculosis (CASE index only), current ART regimen (CASE index only), change of the ART regimen, duration on ART and adherence to cotrimoxazole prophylaxis were associated with non-adherence.

In multivariable models, mutually adjusted for significant predictors in univariable analyses, having a remunerated employment [odds ratio 1.61 (95% confidence interval: 1.14—2.28) based on CPCRA index and 1.59 (1.19—2.12) based on CASE index], alcohol consumption [1.65 (1.16—2.34) and 1.83 (1.36—2.47)] and non-adherence to cotrimoxazole prophylaxis [5.73 (3.92—8.38) and 1.70 (1.27—2.28)] were significant predictors of non-adherence to ART for both indexes. Furthermore, being a Pentecostal Christian [1.65 (1.16—2.34)] was associated with CPCRA-based non-adherence, and a change in the ART regimen [1.61 (91.17—2.20)] was associated with CASE-based non-adherence (Table 3).

Discussion

This large cross-sectional study conducted in a major ATC for HIV infection in a urban setting in sub-Saharan Africa indicates that (1) at least one quarter of HIV patients receiving ART are non-adherent to such treatments based on self-reported 7-day recall; (2) the two self-administered questionnaires used to diagnose non-adherence had a poor agreement in this population, which may have major implications on the recommendation for routine clinical practice; (3) remunerated employment, alcohol consumption, non-adherence to cotrimoxazole prophylaxis and to a certain extent Pentecostal religion and change in ART regimens were the main determinants of

Table 1 Socio-demographic, clinical and therapeutic characteristics of patients with HIV on antiretroviral treatment.

Characteristics	Categories	*n* = 889 (%)
Sex	Women	604 (67.9)
Age, years	<30	86 (9.7)
	30—59	776 (87.3)
	≥60	27 (3.0)
	Median (25—75th percentiles)	40 (34—48)
Urban residence	Urban	727 (81.8)
Education	No schooling	32 (3.6)
	Primary school	150 (16.9)
	Secondary school	537 (60.4)
	University or equivalents	170 (19.1)
Occupation	Remunerated	427 (48)
	None/housewife	462 (52)
Living in couple	Yes	391/882 (44.3)
Condom use	Never	473 (53.2)
Past history of tuberculosis	Sometime	202 (22.7)
	Never	214 (24.1)
	Yes	353 (39.7)
Active tuberculosis	Yes	37 (4.2)
Smoking	Yes	21 (2.4)
Alcohol consumption	Yes	311 (35)
Anxiety	Present	99 (11.1)
	Absent	790 (88.9)
Depression	Present	190 (21.4)
	Absent	699 (78.6)
Pre ART CD4 count, per mm3	Median (25—75th percentiles)	122 (57—183)
Current CD4 count, per mm3	Median (25—75th percentiles)	342 (235—481)
Current ART regimens	1st line	864 (97.2)
	2nd line	25 (2.8)
Duration on ART, years	<1	216 (24.3)
	1—4	442 (49.7)
	>4	231 (26)
	Median (25—75th percentiles)	2.5 (1—4.2)
CPCRA adherence index to ART	Adherent	689 (77.5)
	Non-adherent	200 (22.5)
CASE adherence index to ART	Adherent	579(65.1)
	Non-adherent	310(34.9)

ART: antiretroviral therapy; CPCRA: Self-Report 7-day recall developed by Community Programs for Clinical Research on AIDS (CPCRA); CASE: Center for Adherence Support Evaluation

non-adherence; and (4) forgetting, being away from home at the time the ART is to be taken and need of privacy were the main reasons for non-adherence disclosed by patients.

The CASE index [18] assesses adherence over a period of several weeks prior to the consultation and in our study has provided prevalence rates similar to those found by Boyer et al. [4] in Cameroon, who used a questionnaire that assessed adherence to ART over the four weeks before the consultation. The study by Boyer [4] included more ART-treated participants (2381) from 27 treatment centers across the country but was based on data collected prior to the implementation of the free access to ART in the country [11]. That the prevalence of non-adherence in our study is similar to that reported by Boyer et al. [4] suggests that decreasing the cost of acquiring ARTs has not improved adherence in the urban setting of the country. Indeed, the cost of medications is just one component of the overall cost of caring for HIV infection, and patients in this setting are still confronted with other financial charges, including the costs of transportation, laboratory tests and treatments for opportunistic conditions related to HIV infection [11]. The prevalence of non-adherence found in our study was also within the sampling variation of the pooled estimates from meta-analysis of studies on adherence to ART in Africa in the era of limited access to such treatments [6,20].

Table 2 Characteristics associated to adherence of antiretroviral therapy, by self-report type.

Characteristics	CPCRA adherence index			CASE adherence index		
	Non-adherent ($n = 200$)	Adherent ($n = 689$)	p-Value	Non-adherent ($n = 310$)	Adherent ($n = 579$)	*p*-Value
Female, *n* (%)	133 (65.5)	471 (68.4)	0.620	202 (65.2)	402 (69.4)	0.194
Median age, years (IQR)	39 (34—45)	40 (34—49)	0.110	39 (34—46.25)	40 (34—49)	0.313
Urban residence, *n* (%)	158 (79.0)	569 (82.6)	0.248	251 (81.0)	476 (82.2)	0.647
University education, *n* (%)	47 (23.5)	123 (17.9)	**0.074**	69 (22.3)	101 (17.4)	**0.082**
Living in couple, *n* (%)	87 (43.5)	304 (44.6)	0.788	140 (45.2)	251 (43.9)	0.715
Having an employment, *n* (%)	111 (55.5)	316 (45.9)	**0.016**	169 (54.5)	258 (44.6)	**0.005**
Religious affiliation			0.051			0.196
Catholic Christian, *n* (%)	127 (64.1)	418 (61.4)		194 (63.4)	351 (61.3)	
Protestant Christian, *n* (%)	35 (17.7)	156 (22.9)		56 (18.3)	135 (23.6)	
Pentecostal Christian, *n* (%)	26 (13.1)	51 (7.5)		34 (11.1)	43 (7.5)	
Muslim, *n* (%)	6 (3.0)	30 (4.4)		11 (3.6)	25 (4.4)	
Others, *n* (%)	4 (2.0)	26 (3.0)		11 (3.6)	19 (3.3)	
Duration of transportation < 45 min[a], *n* (%)	93 (46.5)	283 (41.1)		128 (41.3)	248 (42.8)	0.657
Use of the condoms			0.061			0.147
Always, *n* (%)	97 (48.5)	376 (54.6)		159 (51.3)	314 (54.2)	
Sometimes, *n* (%)	58 (29.0)	144 (20.9)		82 (26.5)	120 (20.7)	
Never, *n* (%)	45 (22.5)	169 (24.5)		69 (22.3)	145 (25.0)	
Regular food, *n* (%)	170 (85.0)	584 (84.8)		264 (85.2)	490 (84.6)	
Alcohol consumption, *n* (%)	93 (46.5)	218 (31.6)	<**0.001**	141 (45.5)	170 (29.4)	<**0.001**
Smoking, *n* (%)	4 (2.0)	17 (2.5)	>0.999	7 (2.3)	14 (2.4)	0.881
Pas history of TB, *n* (%)	82 (41.2)	271 (39.4)	0.645	136 (44.0)	217 (37.5)	**0.061**
Active TB, *n* (%)	7 (3.5)	30 (4.4)	0.594	12 (3.9)	25 (4.3)	0.751
BMI < 18.5 kg/m^2 at ART start, *n* (%)	35 (17.5)	100 (14.5)	0.300	48 (15.5)	87 (15.0)	0.856
CD4 count at ART start, *n* (%)			0.473			0.596
> 200/mm^3, *n* (%)	36/194 (18.6)	143/677 (21.1)		58/307 (18.9)	121/564 (21.5)	
50—200/mm^3, *n* (%)	119/194 (61.3)	381/677 (56.4)		183/307 (59.6)	318/564 (56.4)	
< 50/mm^3, *n* (%)	39/194 (20.1)	152/677 (22.5)		66/307 (21.5)	125/564 (22.2)	
Anxiety, *n* (%)	24 (12.0)	75 (10.9)	0.659	34 (11.0)	65 (11.2)	0.907
Mental depression, *n* (%)	45 (22.5)	145 (21.0)	0.659	66 (21.3)	124 (21.4)	0.985
Actual ART regimen, *n* (%)			0.504			**0.068**
First line, *n* (%)	193 (96.5)	671 (97.4)		297 (95.8)	567 (97.9)	
Second line, *n* (%)	7 (3.5)	18 (2.6)		13 (4.2)	12 (2.1)	
Change of ART protocol, *n* (%)	143 (71.5)	439(63.7)	**0.042**	223 (71.9)	359 (62.0)	**0.003**
ART duration < 1 year, *n* (%)	38 (19.0)	178 (25.8)	**0.047**	58 (18.7)	158 (27.3)	**0.004**
Traditional treatment for HIV, *n* (%)	11 (5.5)	23 (3.3)	0.161	14 (4.5)	20 (3.5)	0.431
Good adherence to cotrimoxazole prophylaxis, n (%)	43/196 (21.9)	412/662 (62.2)	<**0.001**	132/303 (43.6)	323/555 (58.2)	<**0.001**

CPCRA (Self-Report 7-day recall adherence), Community Programs for Clinical Research on AIDS; CASE: Center for Adherence Support Evaluation.

[a] Between patient house and Yaounde Jamot Hospital.

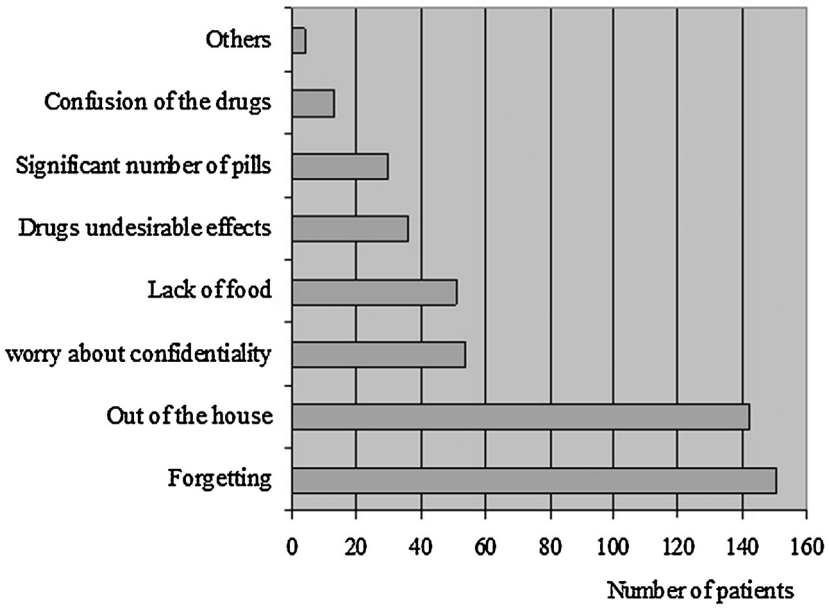

Figure 1 Reasons for non-adherence to antiretroviral therapy in Yaounde, Cameroon.

Table 3 Multivariable adjusted odds ratio and 95% confidence intervals for predictors of antiretroviral non-adherence.

Risk factors	CPCRA adherence index		CASE adherence index	
	AOR (95% CI)	*p*-Value	AOR (95% CI)	*p*-Value
Age < 50 years	/	/	1.14 (0.77–1.70)	0.493
University level of education	1.30 (0.85–2.00)	0.229	1.18 (0.81–1.70)	0.386
Having an employment	1.59 (1.11–2.26)	0.011	1.51 (1.13–2.04)	0.006
Pentecostal Christianity	2.11 (1.20–3.72)	0.010	1.54 (0.93–2.57)	0.095
Use of condoms at times	1.03 (0.66–1.61)	0.885	1.22 (0.79–1.89)	0.377
Alcohol consumption	1.51 (1.05–2.16)	0.025	1.78 (1.31–2.41)	<0.001
Past history of tuberculosis	/	/	1.28 (0.95–1.72)	0.106
Having switched ART regimen	1.31 (0.85–2.03)	0.226	1.45 (1.00–2.10)	0.049
Treatment duration ≥ 1 year	1.28 (0.79–2.11)	0.328	1.21 (0.80–1.85)	0.361
Poor adherence to cotrimoxazole	5.83 (3.97–8.56)	<0.001	1.70 (1.26–2.28)	0.001

CPCRA (Self-Report 7-day recall adherence), Community Programs for Clinical Research on AIDS; CASE; Center for Adherence Support Evaluation; AOR, adjusted odds ratio; ART, antiretroviral therapy.

Recent studies based on composite scores such as the CASE index have found prevalences of non-adherence that were much lower than that of our study in African countries such as Ethiopia (24.3%) and Kenya (18%) [21,22]. Suggestions have been made that such scores were more reliable than questionnaires that attempt to assess non-adherence by only investigating missed doses of medications [18]. This discrepancy may explain some of the disagreement between the CASE and CPCRA indexes in our study. Indeed, we found a low agreement between the two indexes. This situation may have undesirable consequences, particularly when patients who are in need of more assistance to improve adherence to medications are misclassified as adherent by a given diagnostic instrument. Poor agreement between different self-reported adherence measures has been described previously in the literature [23,24]. The large number of these indexes used to measure adherence makes it difficult to compare the results of studies on adherence, including the results among studies based on self-reports. It has been suggested that the use of different instruments may result not only in a difference in prevalence but also in the range of predictors of non-adherence across studies and settings [25].

The reasons for non-adherence disclosed by participants in our study were largely similar to those reported in other studies from Africa [21,26].

However, three factors emerged as the most dominant, accounting for approximately 93% of the reasons disclosed by participants (i.e., forgetting, being away from home at the time ART medications are to be taken and privacy concerns). Exploring these leading factors in non-adherent patients may aid personalized counseling and the personalization of treatment plans.

Three of the five determinants identified in our study were common to non-adherence diagnosed in both of the two indexes, whereas two determinants were specific to each of the indexes. The association of remunerated employment with non-adherence found in our study contrasts with reports from existing studies [4,6,22]. Disclosed reasons for non-adherence were largely similar between remunerated workers and non-workers (data not shown), which makes speculation on the observed association difficult. However, the association between alcohol consumption and non-adherence found in our study is in agreement with findings from two recent meta-analyses [6,27]. Similarly, a previous study in Cameroon also found a change of ART regimen to be associated with non-adherence [4]. These consistent findings highlight the importance of patients' past experience on adherence as well as the complexity of daily coping with ART [4]. Preaching healing messages against HIV infection through faith is not uncommon in some religious groups in the study setting [28]. Such messages may negatively impact adherence and help explain the association of non-adherence with Pentecostal Christianity in our study. The observed association between non-adherence to ART and non-adherence to cotrimoxazole would tend to suggest that non-adherence to ART reflects a generalized attitude toward chronic medications in general and not specifically to ART. Other determinants of non-adherence reported elsewhere, including young age [29], remoteness from the treatment center [22], anxiety [30], depression [27] and difficulties eating regularly [4], were not confirmed in our study.

Limitations of the current study include its cross-sectional nature, which precluded reliable assessment of the direction of the observed associations. The indirect assessment of adherence using self-administered questionnaires is subject to recall bias, may not be appropriate for individuals with memory disorders and tends to overestimate adherence relative to more objective methods such as pill count and automated pharmacy databases [10,31]. Other methods, such as the use of electronic data banks [32] or prescription data [33], are also more objective methods, but their implementation and use in countries with limited resources must be evaluated. In addition, drug provision does not automatically imply that patients will take the drugs as prescribed. However, the use of self-administered questionnaires is cheap, specific and convenient for use in busy routine clinical practice [10,17—19]. A major advantage of the current study is the large sample size as compared with many previous studies on adherence to ART in Africa [6]. This large sample size has increased the statistical power and enabled a careful examination of the potential risk factors of non-adherence in this setting.

In conclusion, non-adherence to ART is still unacceptably high in this population, even years after the implementation of a free access program to ART. Different instruments for diagnosing non-adherence identify different groups of patients within the same population. Ultimately, however, the presence of factors that are found to be associated with non-adherence, irrespective of diagnostic instruments, should prompt careful investigation of any underlying lower-than-optimal adherence to ART and other prescribed chronic medications. Several interventions for improving adherence exist [34], some of which can easily be implemented in the study setting to maximize the outcomes of ART among people living with HIV infection.

Conflict of interest

Funding: No funding Sources
Competing interests: None declared.

References

[1] WHO, Global Health Observatory (GHO). HIV/AIDS, http://www.who.int/gho/hiv/en/index.html [accessed 6.02.13].
[2] WHO, The world health report — Health systems financing: the path to universal coverage. www.who.int/whr/2010/en/index.html [accessed 12.04.12].
[3] Samb B, Evans T, Dybul M, Atun R, Moatti JP, Nishtar S, et al. An assessment of interactions between global health initiatives and country health systems. Lancet 2009;373:2137—69.
[4] Boyer S, Clerc I, Bonono CR, Marcellin F, Bile PC, Ventelou B. Non-adherence to antiretroviral treatment and unplanned treatment interruption among people living with HIV/AIDS in Cameroon: individual and healthcare supply-related factors. Social Science and Medicine 2011;72:1383—92.
[5] Lima VD, Harrigan R, Murray M, Moore DM, Wood E, Hogg RS, et al. Differential impact of adherence on long-term treatment response among naive HIV-infected individuals. AIDS 2008;22:2371—80.
[6] Mills EJ, Nachega JB, Buchan I, Orbinski J, Attaran A, Singh S, et al. Adherence to antiretroviral therapy in sub-Saharan Africa and North America: a meta-analysis. JAMA 2006;296:679—90.

[7] Nguyen VK, Grennan T, Peschard K, Tan D, Tiendrebeogo I. Antiretroviral use in Ouagadougou, Burkina Faso. AIDS 2003;17(Suppl.(3)):S109—11.
[8] Ollivier F, N'Kam M, Midoungue C, Rey JL. Study conducted at the Yaounde University Hospital on anti-retroviral treatment compliance (Cameroon). Sante Publique 2005;17:559—68.
[9] Diabate S, Alary M, Koffi CK. Determinants of adherence to highly active antiretroviral therapy among HIV-1-infected patients in Cote d'Ivoire. AIDS 2007;21:1799—803.
[10] Simoni JM, Kurth AE, Pearson CR, Pantalone DW, Merrill JO, Frick PA. Self-report measures of antiretroviral therapy adherence: A review with recommendations for HIV research and clinical management. AIDS and Behavior 2006;10:227—45.
[11] National AIDS Control Committe, Towards universal access to care and treatment for adults and children living with HIV/AIDS in Cameroon. Progress Report n 4. Yaoundé, Cameroon: Ministry of Public Health, Republic of Cameroon; 2006.
[12] Pefura Yone EW, Betyoumin AF, Kengne AP, Kaze Folefack FJ, Ngogang J. First-line antiretroviral therapy and dyslipidemia in people living with HIV-1 in Cameroon: a cross-sectional study. AIDS Research and Therapy 2011;8:33.
[13] Pefura Yone EW, Kengne AP, Kuaban C. Incidence, time and determinants of tuberculosis treatment default in Yaounde, Cameroon: a retrospective hospital register-based cohort study. BMJ Open 2011;1:e000289.
[14] Ministère de la Santé Publique du Cameroun. Directives nationales de prise en charge par les antirétroviraux des personnes (Adultes et Adolescents) infectés par le VIH. MINSANTE, République du Cameroun; 2010.
[15] Spitzer RL, Kroenke K, Williams JB, Lowe B. A brief measure for assessing generalized anxiety disorder: the GAD-7. Archives of Internal Medicine 2006;166:1092—7.
[16] Spitzer RL, Kroenke K, Williams JB. Validation and utility of a self-report version of PRIME-MD: the PHQ primary care study Primary Care Evaluation of Mental Disorders. Patient Health Questionnaire. JAMA 1999;282:1737—44.
[17] Mannheimer S, Friedland G, Matts J, Child C, Chesney M. The consistency of adherence to antiretroviral therapy predicts biologic outcomes for human immunodeficiency virus-infected persons in clinical trials. Clinical Infectious Diseases 2002;34:1115—21.
[18] Mannheimer SB, Mukherjee R, Hirschhorn LR, Dougherty J, Celano SA, Ciccarone D, et al. The CASE adherence index: a novel method for measuring adherence to antiretroviral therapy. AIDS Care 2006;18:853—61.
[19] Mannheimer SB, Matts J, Telzak E, Chesney M, Child C, Wu AW, et al. Quality of life in HIV-infected individuals receiving antiretroviral therapy is related to adherence. AIDS Care 2005;17:10—22.
[20] Ortego C, Huedo-Medina TB, Llorca J, Sevilla L, Santos P, Rodriguez E, et al. Adherence to highly active antiretroviral therapy (HAART): a meta-analysis. AIDS and behavior 2011;15:1381—96.
[21] Amberbir A, Woldemichael K, Getachew S, Girma B, Deribe K. Predictors of adherence to antiretroviral therapy among HIV-infected persons: a prospective study in Southwest Ethiopia. BMC Public Health 2008;8:265.
[22] Wakibi SN, Ng'ang'a ZW, Mbugua GG. Factors associated with non-adherence to highly active antiretroviral therapy in Nairobi, Kenya. AIDS Research and Therapy 2011;8:43.
[23] Oyugi JH, Byakika-Tusiime J, Charlebois ED, Kityo C, Mugerwa R, Mugyenyi P, et al. Multiple validated measures of adherence indicate high levels of adherence to generic HIV antiretroviral therapy in a resource-limited setting. Journal of Acquired Immune Deficiency Syndromes 2004;36:1100—2.
[24] Gao X, Nau DP. Congruence of three self-report measures of medication adherence among HIV patients. The Annals of pharmacotherapy 2000;34:1117—22.
[25] Berg KM, Arnsten JH. Practical and conceptual challenges in measuring antiretroviral adherence. Journal of Acquired Immune Deficiency Syndromes 2006;43(Suppl. (1)):S79—87.
[26] Hardon A, Davey S, Gerritis T, Hodgkin C, Irunde H, Kgatlwane J, et al. From access to adherence: the challenges of antiretroviral treatment: studies from Botswana, Tanzania and Uganda. Available from: URL: www.who.int/medicinedocs/pdf/s13400e/s13400e.pdf [accessed 14.09.12].
[27] Nakimuli-Mpungu E, Bass JK, Alexandre P, Mills EJ, Musisi S, Ram M, et al. Depression alcohol use and adherence to antiretroviral therapy in sub-Saharan Africa: a systematic review. AIDS and Behavior 2011.
[28] Mayrargue C. Les dynamiques paradoxales du pentecôtisme en Afrique subsaharienne. Available from: URL: www.ifri.org/downloads/mayrarguefinalfr.pdf. [accessed 12.04.12].
[29] Talam NC, Gatongi P, Rotich J, Kimaiyo S. Factors affecting antiretroviral drug adherence among HIV/AIDS adult patients attending HIV/AIDS clinic at Moi Teaching and Referral Hospital, Eldoret, Kenya. East African Journal of Public Health 2008;5:74—8.
[30] Campos LN, Guimaraes MD, Remien RH. Anxiety and depression symptoms as risk factors for non-adherence to antiretroviral therapy in Brazil. AIDS and Behavior 2010;14:289—99.
[31] Andrade SE, Kahler KH, Frech F, Chan KA. Methods for evaluation of medication adherence and persistence using automated databases. Pharmacoepidemiology and Drug Safety 2006;15:565—74.
[32] Goldstein MK, Coleman RW, Tu SW, Shankar RD, O'Connor MJ, Musen MA, et al. Translating research into practice: organizational issues in implementing automated decision support for hypertension in three medical centers. Journal of the American Medical Informatics Association 2004;11:368—76.
[33] Mabotuwana T, Warren J, Orr M, Kenealy T, Harrison J. Using primary care prescribing data to improve GP awareness of antidepressant adherence issues. Informatics for Primary Care 2011;19:7—15.
[34] Barnighausen T, Chaiyachati K, Chimbindi N, Peoples A, Haberer J, Newell ML. Interventions to increase antiretroviral adherence in sub-Saharan Africa: a systematic review of evaluation studies. The Lancet infectious diseases 2011;11:942—51.