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Keywords:	physical activity, antiretroviral therapy, hiv/aids, Vietnam

Physical activity among HIV-positive patients receiving antiretroviral therapy

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Abstract

Objectives: Antiretroviral therapy (ART) has now turned HIV infection to a chronic disease, requiring patients to adhere to medications along with keeping a healthy life style. Increasing physical activity is recommended to maintain health among HIV-positive patients. This study aimed to determine the physical activity level and its associated factors among HIV patients receiving ART treatment.

Settings: 8 outpatient clinic sites in different levels of health systems in both rural and urban settings in Hanoi and Nam Dinh.

Participants: 1,133 HIV patients receiving ART treatment in the settings during the study period.

Primary and secondary outcome measures: Physical activity was measured using the International Physical Activity Questionnaire (IPAQ). Socio-economic, health-related quality of life, ART adherence, ART–related characteristics and peer supports were self-reported.

Result: About 16% of participants were inactive, 68% were health enhancing physical activity (HEPA) active. Rural patients reported a higher level of physical activity compared to urban patients. Changes in the physical activity level during ART treatment were non-linear. Respondents were more likely to have a higher IPAQ-score and classify as active in physical activity if they were female, self-employed and blue-collar workers/farmers. Respondents having a higher CD4 cell count, higher EQ-5D-5L index/EQ-VAS, and shared their health status with their peers were more likely to have higher IPAQ score or be active in physical activity. A lower IPAQ-score was associated with living in urban areas and being at the symptomatic stage. In addition, respondents who had poor adherence and higher duration of ART were more likely to be inactive in physical activity**.**

Conclusion: The majority of participants on ART were physically active. Interventions to promote physical activity among PLWH in urban areas and in later ART treatment are needed. Peer support and job guidance hold potentials in supporting to enhance the level of physical activity.

Keywords: Physical activity, antiretroviral therapy, HIV/AIDS, Vietnam

Strengths and limitations

- The study included large sample size of HIV-infected patients receiving antiretroviral therapy treatment across different levels of health systems placed in both rural and urban areas.
- The study employed validated international instruments to increase the comparability between our results and other studies in elsewhere.
- The IPAQ was an objectively self-reported measure that may under- or over-estimate the physical activity of PLWH.
- Convenience sampling technique was used and this may limit the generalizability of findings as well as representative of HIV/AIDS population.
- The causal inference between level of physical activity and number of CD4 cells, quality of life could not be established due to the cross-sectional design.

Introduction

The use of highly active antiretroviral therapy (HAART) have achieved significant milestones in reduction of HIV/AIDS- related morbidity and mortality. According to the UNAIDS report in 2016, among 36.7 million people living with HIV (PLWH), an estimated 19.5 million patients had access to life-saving antiretroviral medicines and the global coverage of ART reached 53% [1]. PLWH taking potent combination antiretroviral (ARV) drug regimen lived longer and had healthier lives [1], which may transform HIV/AIDS into a chronic disease [2]. However, one of the most common adverse health effects of ART among PLWH was lipodystrophy syndrome [3] including morphologic (peripheral lipoatrophy and central fat accumulation) and metabolic (hyper-triglyceridaemia, hyper-cholesterolaemia, insulin resistance, type 2 diabetes, lactic acidaemia) symptoms[4] [5]. It contributes to an increase in the risk of cardiovascular and other non-communicable diseases as a result of changes in adipose tissue distribution and metabolism [6] [7]. These side-effects were also found to be the main reasons for non-adherence to antiretroviral medication and discontinuing the therapy [8] [9].

Since ART is requisite for viral suppression and recovering immune system, strategies which prevent these adverse effects and achieve optimization of treatment should be adopted [10] [11]. Physical activity was recommended as a non-pharmacological treatment and alternative intervention [12]. Physical activity is defined as the movement of body that works skeletal muscles and expend more energy than resting [13]. Physical activity has been shown to increase functional capacity, muscle strength, joint flexibility, endurance and energy among people living with HIV [14] [15]. Physical activity reduces the incidents of chronic diseases such as cardiovascular disease by lowering blood pressure in hypertensive patients and improving lipid lipoprotein profiles [16-18]; diabetes by improving glucose homeostasis [19]; and breast cancer [20] [21]. Physical activity can also reverse metabolic and body composition change by lowering visceral and subcutaneous fat in the center of the body and increasing diameter of the peripheral parts, therefore prevent lipodystrophy [22] [23].

Engaging in physical activities is a very important health- related behavior, particularly among PLWH because they are often not motivated to do physical activity [24]. A typical physical activity guideline for normal adults is that they should have a minimum of 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity physical activity each week or an equivalent combination of both moderate- and vigorous-intensity activity [25]. Center for Disease Control and Prevention (CDC) suggests that PLWH should comply at least with this guideline to keep healthy [26]. However, in developing countries, the rates of physical inactivity have been shown to be more than 50% among PLWH [27] [28] as compared to to about one fourth in the United States and Australia [29] [30]. The differences depend on various factors such as gender, age groups, occupations, level of CD4 cell count and quality of life [27] [28] [30].

In Vietnam, most previous studies were focused on physical activity among Vietnamese adolescents [31] [32] and adults with chronic diseases and metabolic syndrome [33] [34]. A previous study by Tan Bui et al found that 70% of the population met the WHO recommendations of physical activity for 18 to 64-year-old adults [35]. Besides, the socioeconomic and geographical differences were considered as factors that shape behavior in physical activity. Prior studies revealed that physical

activity was greater in male compared to female [35] and among people who had lower educational attainment [36]. In addition, level of physical activity in rural areas was significantly higher than in urban settings due to the modern transport system and sedentary behavior in urbanization [35 37]. A national representative survey with more than 14700 participants in 2010 indicated that provinces with higher urban population proportions had less proportion of active people [38]. Nonetheless, the rate of urbanization in Vietnam has been escalating in the recent years, from 21% in 2008 to 32% in 2013 and is projected to reach 45% in 2020 [39]. These changes raise the needs of understanding the potential variability of the prevalence of physical activity or inactivity between rural and urban settings, especially among people with chronic illness states such as HIV/AIDS and non-communicable diseases.

Vietnam is still in concentrated HIV epidemic stage and the proportion of ART coverage estimated approximately 42% (of people living with HIV/AIDS) in 2015 [40], and half of them has been undergoing ART for a long time. To reduce risk of chronic diseases and enhance the effectiveness of ART treatment, physical activity plays a requisite role in potential intervention strategies. However, little attention paid to determine the degree of physical activity and intervention to enhance physical activity among individuals with HIV infection in Vietnam, particularly between urban and rural areas. According to the Vietnam Constitution 2013, an urban area is defined as settlements with a high population density and built environment, while a rural area refers to places that have a low population density and are located outside urban settings, where people mostly work in the agriculture sector [41]. Based on the literature, we hypothesized that PLWH in urban area had lower level of physical activity compared to their counterparts. This study aimed to assess the level of physical activity and examine the factors associated with physically active among HIV patients receiving ART treatment across different levels of health systems and in both rural and urban settings.

Methods

Study setting and subjects

A cross-sectional study was performed from January to August 2013 in Hanoi and Nam Dinh, two Vietnamese epicenters providing HIV/AIDS surveillance and treatment services in the north of Vietnam. The study was performed at 8 outpatient clinics: 5 in Hanoi and 3 in Nam Dinh. There were one national hospital (Bach Mai Hospital), one provincial hospital (Nam Dinh provincial hospital), one provincial center (Nam Dinh Provincial AIDS Control Centre) and five district health centers (Hoang Mai, Long Bien, Dong Anh, Ha Dong, Xuan Truong). The eligibility criteria for selecting outpatient clinic sites in Hanoi and Nam Dinh included: 1) being representative of public health system in Vietnam which contains central-; provincial- and district- levels); 2) being able to afford ART service implemented following the official guidelines of the Vietnamese Ministry of Health [42].

Patients were recruited using convenience sampling technique if they met the following eligibility criteria: 1) being 18 years old or above; 2) receiving ART treatment from those clinics mentioned above; 3) having a confirmatory testing of HIV-positive; 4) agreeing to participate in the study; 5) Be able to communicate with the data collectors normally. The exclusive criteria included those being suffered from serious illness during the recruitment process. We approached patients when they visited clinics for taking medication or receiving counseling. Based on the health

staff's feedback, we identified eligible patients for the study. These patients were invited into a small counseling room by well trained health workers. They were introduced to the purpose of study, the benefits and drawbacks of participating, and were then asked to join the study. If they agreed, patients signed a written informed consent. We ensured patients of the confidentiality of their participation in the study. The consent process took place in a comfortable room with restricted access, allowing patients privacy as they decided whether or not to join the project. A total of 1,133 patients agreed to enroll in this study. The response rate was 80-90% across different clinics. Patients refused to participate in the study because they had insufficient physical health, felt discomfort or had busy work.

Measures and instruments

Patients were invited to participate in 20-minute face-to-face interviews, conducting by data collectors who were medical students at Hanoi Medical University and experts in HIV-related fields. We did not involve health staff in collecting data to avoid social desirability bias. We developed a structured questionnaire with following information:

Socioeconomic characteristics

We asked patients to report their socioeconomic information included gender (male/female), education attainment (illiterate/ elementary/ secondary/ high school/ vocational training/ university), age, marital status (single/ live with spouse/ live with partner/ divorced/ widow), religion (cult of ancestors/ Buddhism/ Catholic/ Protestant), and employment status (Unemployed/ Self-employed/ White-collar/ Blue-collar or farmer/ Others).

ART – related characteristics

Self-reports about the latest CD4 cell count, HIV stages and ART treatment duration were collected from patients. Data on viral load were not collected due to their unavailability at the study period. Non-adherence to ART was measured by self-report items. First, ART adherence last month was determined by visual analog scale (VAS) where 0-point showed complete non-adherence and 100-point showed complete adherence [43]. Participants were asked whether they forget to take ART medicine in the last four days. This approach has been applied successfully in a previous study [44]. We also asked the participants about whether they received peer support during ART treatment (Yes/No), and whether they shared their health status with their peers or not (Yes/No).

Health – related quality of life

HRQOL was measured using the EQ-5D-5L instrument in the Vietnamese version, which was validated elsewhere [45]. This tool measures five dimensions including mobility, self-care, usual activities, pain/discomfort and anxiety/ depression with five response levels: no problems, slight problems, moderate problems, severe problems, and extreme problems [46]. The combination of responses gives 3125 health states with weighting to have aggregate single index [45]. Cronbach's alpha of this instrument was 0.85 with good convergent validity [45]. Furthermore, we also use the EQ-VAS (visual analogue scale) which measures the self-rated health on a 20-cm vertical scale, with the endpoint ranges from 0 to 100 point, labeled 'the worst health you can imagine" and 'the best health you can imagine" [47].

Physical activity

To assess level of physical activity of respondent, we used the International Physical Activity Questionnaire (IPAQ). The IPAQ is developed to use in adults (15-69 years old) [48]. Several questions were used to assess three specific types of activity: vigorous activity, moderate activity and walking activity. Examples of each type of activity in our research context are listed below:

- Vigorous activity: Heavy lifting, hoeing, weight lifting, fast paced cycling, etc.
- Moderate activity: Playing badminton, slow paced cycling, cradling baby, selling, etc.
- Walking activity: Going to work, going to school, going elsewhere, going jogging, etc.

Each activity was scored separately by frequency (measured by days per week) and duration (measured by time per day). Volume of each activity was also measured by its energy requirements determined in METs (METs are multiple of the resting metabolic rate) [48].

The total IPAQ score was used as a continuous variable which was calculated by adding the MET minute per week of three types of activity. We also evaluated the IPAQ score as categorical variable which divided their physical activity into 3 levels: Inactive, minimally active and HEPA active. Participants were categorized into (1) HEPA (health enhancing physical activity) active group if they did vigorous activity on at least 3 days obtaining at least 1500 MET-minutes/week; OR 7 or more days of walking combining with moderate-intensity or vigorous activities obtaining at least 3000 MET-minutes/week. Participants were in (2) Minimally active group if they had 3 or more days of vigorous activity of at least 20 minutes per day (800 MET-minutes/week) OR 5 or more days of moderate activity or walking of at least 30 minutes per day OR 5 or more days of walking combining with moderate-intensity or vigorous intensity activities obtaining at least 600 MET-min/week. Participants were (3) Inactive if Individuals who not meet requirements for Categories 2 or 3 were determined as insufficiently active [48].

Statistical analysis

Data was analyzed by STATA version 12 (Stata Corp. LP, College Station, United States of America). Chi-square test and Mann Whitney test was used for demographic characteristics of respondents as well as HRQOL, ART status and sexual behaviors. Multivariate linear regression was employed to identify factors associated with IPAQ score. Because the IPAQ score had non-normal distribution, we performed log-transformation for this variable in order to meet the requirement of regression model. We also applied multivariate logistic regression to identify factors associated with whether the respondents were active in physical activity or not. We applied forward stepwise selection strategy to remove non-significant factors, the p-value of log likelihood ratio test was set as less than 0.1 and this was the threshold to include a variable. A p-value <0.05 was considered as statistical significance.

Ethics approval

The study protocol was reviewed and ethics approval was granted by the Vietnam Authority of HIV/AIDS Control's Scientific Research Committee. Patients confidently participated in the study and signed a written informed consent after receiving clearly

introduction about the benefits and drawbacks of the study. The consent process took place in a room with restricted access. Respondents can withdraw from the interview at any time and this did not affect their current treatment.

Results

The demographic and socioeconomic characteristics of respondents living in rural and urban are given in **Table 1**. Out of 1,133 ART respondents, approximately 60% was male. The majority had secondary and high school education (36.9% and 32% respectively); participants in urban areas had higher education than people in rural area (p=0.04). The marital status and employment were also significant different between rural and urban group (p<0.01). There was no difference of age group between rural and urban respondents.

Table 1: Socio-economic characteristic of PLWH in the study (n=1133)

	Rural		Urban		Total		p-value
	n	%	n	%	n	%	
Gender							
Male	145	56.2	520	59.4	665	58.7	0.36†
Female	113	43.8	355	40.6	468	41.3	
Education							
Illiterate	5	1.9	7	0.8	12	1.1	0.04†
Elementary school	48	18.6	172	19.7	220	19.4	
Secondary school	109	42.3	309	35.3	418	36.9	
High school	80	31	282	32.2	362	32	
Vocational training	6	2.3	48	5.5	54	4.8	
University	10	3.9	57	6.5	67	5.9	
Marital status							
Single	26	10.1	143	16.3	169	14.9	0.01†
Live with spouse	178	69	507	57.9	685	60.5	
Live with partner	0	0	8	0.9	8	0.7	
Divorced	22	8.5	66	7.5	88	7.8	
Widow	32	12.4	151	17.3	183	16.2	
Religion							
Cult of ancestors	222	86.1	779	89	1,001	88.4	0.03†
Buddhism	12	4.7	43	4.9	55	4.9	
Catholic	24	9.3	44	5	68	6	
Protestant	0	0	9	1	9	0.8	
Employment							
Unemployed	47	18.2	184	21	231	20.4	<0.01†
Self-employed	98	38	371	42.4	469	41.4	
White-collar worker	13	5	67	7.7	80	7.1	
Blue-collar worker or farmer	94	36.4	188	21.5	282	24.9	
Others	6	2.3	65	7.4	71	6.3	
Age group							
18- <25	6	2.3	17	1.9	23	2	0.91†
25-<30	30	11.6	119	13.6	149	13.2	
30- <35	94	36.4	319	36.5	413	36.5	
35- <40	71	27.5	237	27.1	308	27.2	
40- <45	34	13.2	98	11.2	132	11.7	
>=45	23	8.9	85	9.7	108	9.5	

Significance level was p<0.05
†*Chi-square test*

Antiretroviral therapy status

About half of respondents were asymptomatic and the proportion of rural respondents unaware of their stage of HIV infection was significantly higher than urban patients (52.1% vs 24.7%) (**Table 2**). The mean number of CD4 measurements and duration of ART treatment were 294.7 cells/μL (SD=215.2) and 3.5 years (SD=2.2) respectively. About 50% of patients shared health status with their peers and only one-third received peer support.

Table 2: Antiretroviral therapy status of patients (n=1133)

	Rural		Urban		Total		p-value
	n	%	n	%	n	%	
HIV period							
Asymptomatic	67	28.4	389	46	456	42.1	<0.01†
Symptomatic	32	13.6	161	19	193	17.8	
AIDS	14	5.9	87	10.3	101	9.3	
Unknown	123	52.1	209	24.7	332	30.7	
ART duration (year)							
1 year	47	19.0	213	26.9	260	25.0	<0.01†
2 – 4 years	91	36.9	354	44.7	445	42.8	
More than 4 years	109	44.1	225	28.4	334	32.2	
Share health status with peers							
Yes	110	43.3	446	52.7	556	50.6	0.01†
No	144	56.7	400	47.3	544	49.5	
Receiving peer support							
Yes	77	29.8	314	35.9	391	34.5	0.07†
No	181	70.2	561	64.1	742	65.5	
Forgetting to take medicine in the last 4 days							
No	243	98	780	97.7	1,023	97.8	0.82†
Yes	5	2	18	2.3	23	2.2	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	
ART Duration (year)	4.0	2.4	3.3	2.1	3.5	2.2	<0.01¶
CD4 cell count	312.5	220.6	289.2	213.4	294.7	215.2	0.08¶
ART adherence (VAS)	94.8	8.2	93.9	11	94.1	10.4	0.55¶

Significance level was p<0.05
†*Chi-square test*
¶*Mann Whitney test*

Self-reported health status

The percentage of urban respondents having any problem in mobility, self-care, doing usual activities were significant higher than those of rural respondents (p<0.01) (**Table 3**). About 40% of respondents suffered from anxiety or depression, and about half of the respondents suffered from pain or discomfort, with no significant difference between rural and urban respondents. The mean EQ-5D-5L index was 0.8 (SD=0.2) and the perceived EQ-VAS score among rural respondents was statistically significantly higher than those of urban respondents (p<0.01).

Table 3: Health status among respondents (n=1133)

	Rural		Urban		Total		p-value
	n	%	n	%	n	%	
Self-reported health problems							
Mobility	33	12.8	199	22.7	232	20.5	<0.01†
Self-care	12	4.7	98	11.2	110	9.7	<0.01†
Usual Activities	26	10.1	162	18.5	188	16.6	<0.01†
Pain or Discomfort	85	33.0	342	39.1	427	37.7	0.07†
Anxiety or Depression	104	40.3	405	46.3	509	44.9	0.09†
Complications and concurrent disease	76	29.5	329	37.6	405	35.8	0.02†
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	
EQ-5D-5L index	0.8	0.2	0.8	0.3	0.8	0.2	0.18¶
EQ-VAS	70.1	16.0	68.4	17.6	68.8	17.3	<0.01¶

Significance level was p<0.05
†*Chi-square test*
¶*Mann Whitney test*

Physical activity level

Sixteen percent of respondents were inactive and 68% of participants were HEPA active using the IPAQ. Rural patients reported statistically higher level of physical activity and IPAQ score compared to urban patients (p=0.03 and p<0.01 respectively). Regarding moderate activity, number of days per week and mean value of MET-score among respondents living in rural areas were higher than those in urban areas (p<0.01 and p=0.01 respectively). However, mean MET-score of vigorous activity and walking activity were similar between two groups.

Table 4: Physical activity levels of participants

	Rural		Urban		Total		p-value
	n	%	n	%	n	%	
Level of physical activity							
Inactive	29	11.3	152	17.4	181	16.0	**0.03**†
Minimally active	37	14.3	144	16.4	181	16.0	
HEPA active	192	74.4	579	66.2	771	68.0	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	
Vigorous activity							
Days per week	1.5	0.2	1.2	0.1	1.3	2.5	0.09¶
Minutes per day	95.4	11.2	81.1	6	84.4	177.6	0.15¶
MET-score	4360.9	555.5	3444.4	282.5	3651.9	8465.9	0.11¶
Moderate activity							
Days per week	5.4	0.2	4.8	0.1	4.9	2.8	**<0.01**¶
Minutes per day	170.2	5.7	155.9	3.3	159.1	96	0.04¶
MET-score	4211.3	165.7	3737.9	92.2	3845.9	2711.1	**0.01**¶

	Rural		Urban		Total		p-value
	n	%	n	%	n	%	
Walking activity							
Days per week	3.4	0.2	3.3	0.1	3.4	3.3	0.67¶
Minutes per day	18.6	1.8	21.8	1.3	21.1	36.8	0.99¶
MET-score	377.1	38.3	451.5	29.3	434.6	816.3	0.87¶
IPAQ Score	8977.9	535.5	7613.5	280.5	7922.9	8333.8	**<0.01**¶

Number of total participants, n= 1133
Significance level was p<0.05
†*Chi-square test and*
¶*Mann Whitney test*

IPAQ score also differentially associated with ART treatment duration (**Figure 1**). A higher IPAQ score was associated with a shorter antiretroviral therapy (ART) duration; longer antiretroviral therapy (ART) treatment was associated with a lower IPAQ score. Specifically, it increased within the first year of ART, plateaued during 2 to 4 years of treatment, and then decreased.

Figure 1. Physical activity among antiretroviral therapy (ART) patients regarding ART duration.

Factors associated with level of activity

Respondents were more likely to have a higher IPAQ-score and classify as active in physical activity if they were female, self-employed and were blue-collar workers or farmers. Respondents who had a higher CD4 cell count, shared their health status with their peers, and reported a higher EQ-5D-5L index/EQ-VAS were also more likely to have higher IPAQ score or be active in physical activity. By contrast, a lower IPAQ-score was associated with living in urban areas and being at the symptomatic stage. In addition, respondents who had poor adherence and higher duration of ART were more likely to be inactive in physical activity.

Table 5: Factors associated with levels of physical activity among antiretroviral therapy patients in Vietnam in 2013

	IPAQ-score		Active	
	Coef.	95 CI	OR	95 CI
Gender (Female vs Male)	0.25*	0.11; 0.39	2.53*	1.58; 4.07
Living location (Urban vs Rural)	-0.17*	-0.34; -0.01	0.60	0.35; 1.05
Education attainment (vs Illiterate)				
High school			1.52	0.94; 2.46
Religion (vs Cults of Ancestor)				
Buddhism			2.78	0.73; 10.57
Occupation (vs Unemployed)				
Self-employed	0.60*	0.41; 0.79	2.98*	1.78; 4.99
White-collar workers	0.29	-0.02; 0.59	2.43	0.87; 6.79
Blue-collar worker/farmers	0.73*	0.52; 0.94	2.24*	1.27; 3.95

Others	0.53*	0.22; 0.84	3.28*	1.07; 10.05
EQ-5D index			4.49*	1.68; 12.02
EQ-VAS	0.01*	0.00; 0.01	1.02*	1.00; 1.03
Current CD4 cell count	0.01*	0.00; 0.01	1.02*	1.01; 1.03
ART duration			0.91*	0.82; 1.00
HIV Stages (vs Asymptomatic)				
Symptomatic	-0.20*	-0.38; -0.01		
AIDS			1.81	0.87; 3.79
Forgetting to take medicine in the last 4 days (Yes vs No)			0.26*	0.09; 0.80
Share health status with peers (Yes vs No)	0.26*	0.12; 0.40	1.86*	1.21; 2.84

**p<0.05; OR: Odds Ratio; 95% CI: 95% Confidence Interval*

Discussion

This study confirms our hypothesis that PLWH in urban areas had lower level of physical activity compared to their peer in rural settings. In our study, a majority of ART patients achieved HEPA active in physical activity. By using multivariate regression models, we found a number of sociodemographic, clinical and social factors that are associated with the level of physical activity among PLWH in Vietnam. These results will contribute significantly to the development of tailored interventions to boost the physical activity among this population in the future.

Compared to previous studies on ART patients using the IPAQ system, the percentage of inactive (16%) or minimally active (16%) respondents in our study was much lower [12 27 29 30]. Most respondents reported the highest frequency of moderate activity (playing sport, cycling, cradling baby, etc.), which is different from previous studies founding that walking was the most preferred physical activity among PLWH [14 30]. These activities can positively affect PLWH by decreasing side-effects associated with HIV/AIDS and and cardiometabolic complications accompanied with ART treatment [15 49]. However, a number of patients in our study, particularly in urban settings, had difficulty in mobility or pain/discomfort that limited their ability to engage in healthy physical activities. Therefore, the health staff may provide alternative methods of exercising such as passive motion exercise, hydrotherapy or stationary cycling since it found to be as effective for enhancing functional fitness as active exercise practice [50].

The total physical activity score in rural area was higher than in urban areas in our study, which is consistent with the physical activity level of the general Vietnamese population [35]. In Vietnam, the main occupations in rural areas were farmers and blue-collar workers and rural participants often viewed working on farm or heavy working conditions as vigorous physical activity. Moreover, some environmental factors in rural areas such as sidewalk conditions, the availability of exercise equipment and sedentary behavior in urbanization may affect individual willingness to take part in physical activity [37 51].

Our study also found that respondents who were unemployed were less likely to be physically active, which concurs with prior findings [52 53]. Unemployed patients are

less likely to obtain adequate physical activity because occupational activity is concerned as a vital component of daily physical activity in adulthood [54-56]. In addition, our study found that female respondents were more likely to get a higher level of physical activity. This can be explained by the fact that in the traditional Vietnamese culture, women still have responsibilities of taking care children and all household activities, which were mainly classified as moderate physical activity in our study [57 58].

Interestingly, we found that people with higher duration of ART were less likely to be physically active. Notably, this association was found as a non-linear relationship. This is probably because patients had to adapt with rigorous adherence during the initiation of their treatment, which might enhance their willingness to involve in physical activities [44 59 60]. However, the later reduction can be supposed that patients became careless and complacent when their health status recovered, which made it harder for them to comply with strict physical regimen [44 59]. We also observed that non-adherence to ART was associated with a physically inactive status and this probably because disliking physical activity has been found to be significantly related to low antiretroviral medication adherence [59].

In term of health status, patients with higher quality of life and higher number of CD4 cell count had higher IPAQ score, while patients at symptomatic stage had lower IPAQ score compared to those having asymptomatic stage. We supposed that active in physical activity would help patients to improve and maintain their strength and quality of life. Two systemic reviews by O'Brien et al. (2016, 2017) found that PLWH should do physical exercise at least three times per week in at least five weeks to get stable health [61 62].

Our current study suggested that respondents who shared health status with their peers were more likely to have a higher IPAQ score. The association between peer supports and physical activity was investigated by Jerome et al (2012) which found that peer support was an important determinant to assist patients in adherence to exercise programs [63]. Additionally, WHO, PEPFAR and Global Fund have proposed that social support should be considered as an effective adjunct in improving physical health among PLWH receiving ART treatment [64 65]. As PLWH were more vulnerable and withdrawn from social situations [66], peer support can promote patients' health through sharing relevant personal experiences to acquire knowledge, reducing stigma and discrimination, improving physical functioning, and enhancing retention in ART treatment [67-69].

Several implications can be drawn from this study. First, providing different physical activity strategies based on rural and urban settings is needed. For example, the health staff in clinics may organize some outdoor activities via peer educators/groups to engage urban patients in physical activity. Second, job opportunities and vocational training should be prioritized to promote physically active among ART patients [52 53]. Third, the reduction in IPAQ score observed in prolonged ART duration suggests physical health assessments and appropriate physical activity programs such as resistance trainings and aerobic exercises should be in place. Besides, passive motion exercise should be considered for immobilized patients or who had difficulty in mobility or physical impairments [50]. Fourth, given the association between the level of physical activity and ART treatment status from our findings, integrative

intervention including physical activity, ART medication adherence and health related quality of life may prove to be efficient and cost-effective [70]. Finally, promoting social support, especially among peers should be prioritized that enables HIV patients to share their experiences that motivate others to involve in physical activity [63]. Furthermore, peer support groups integrated into assigned health facilities would be useful to patients who are at the initial ART medication.

The strengths of this study included a large sample size of HIV-infected patients receiving antiretroviral therapy treatment, which increased the statistic power of the result. Additionally, we recruited patients from different levels of health systems (central, provincial and district ART clinics) in both rural and urban areas, which made the sample more representative of the general Vietnamese population. We also employed international instruments such as IPAQ and EQ-5D-5L, which help to increase the comparability between our results and other global studies.

However, several limitations should be acknowledged. Firstly, the convenience sampling technique was used, which may limit the generalizability of our findings to other settings and patient populations. Secondly, because the data was based on self-reported information, it was susceptible to be influenced by interviewers, social desirability and recall bias. To minimize these biases, interviewers affiliated with selected health centers were excluded from the study and patients were given clear instructions on the benefits and drawbacks of the study. Thirdly, the causal inferences could not be established due to the cross-sectional design. Finally, some barriers to physically active such as social factors (stigma, discrimination), family support or clinical settings (healthcare providers) were not fully addressed in this study, warranting further research to elucidate these gaps.

Conclusion

In conclusion, the study confirmed the high percentage of HIV patients receiving ART treatment physically active. Our study also emphasized the association between high level of physical activity and the improvement of ART adherence, health-related quality of life and CD4 cell count. Interventions to promote physical activity among PLWH in urban areas and in later ART treatment are needed. Peer support and job guidance hold potentials in supporting to enhance the level of physical activity.

LIST OF ABBREVIATION

ART: Antiretroviral Therapy
PLWH: People Living With HIV
WHO: World Health Organization
PEPFAR: President's Emergency Plan For AIDS Relief

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Authors' Contributions

AKD, LHN, AQN, BXT, TTT, CAL conceived of the study, and participated in its design and implementation and wrote the manuscript. AKD, LHN, BXT, analysed the data. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

Data sharing statement

The data that support the findings of this study are available from the Vietnam Authority of HIV/AIDS Control but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of the Vietnam Authority of HIV/AIDS Control.

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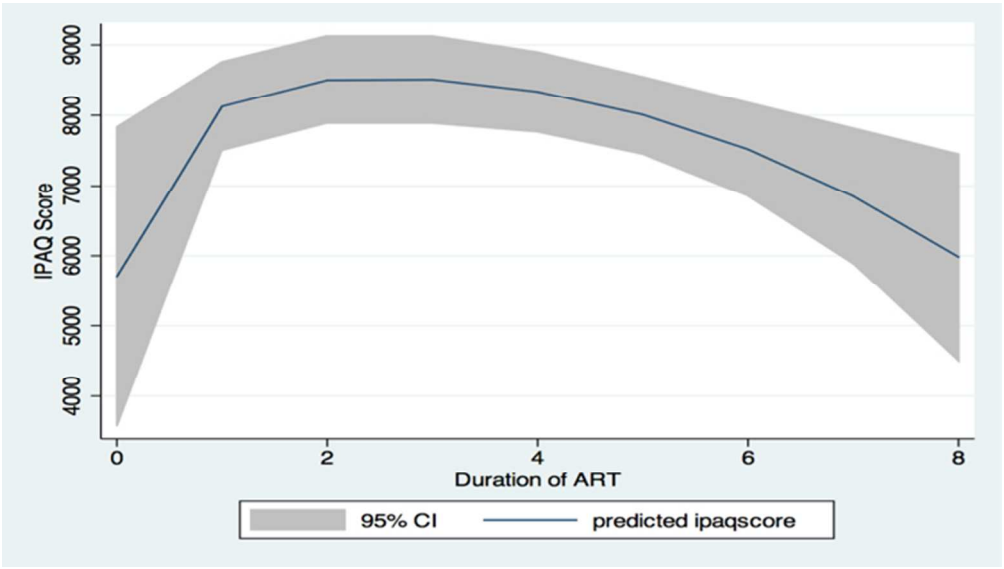

Figure 1. Physical activity among antiretroviral therapy (ART) patients regarding ART duration

338x190mm (54 x 54 DPI)

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Page	Recommendation
Title and abstract	1	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		2	(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction			
Background/rationale	2	4,5	Explain the scientific background and rationale for the investigation being reported
Objectives	3	5	State specific objectives, including any prespecified hypotheses
Methods			
Study design	4	5	Present key elements of study design early in the paper
Setting	5	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	5	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
			(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	6,7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	6,7	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	7	Describe any efforts to address potential sources of bias
Study size	10	6	Explain how the study size was arrived at
Quantitative variables	11	6,7	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	2	7	(*a*) Describe all statistical methods, including those used to control for confounding
		7	(*b*) Describe any methods used to examine subgroups and interactions
		7	(*c*) Explain how missing data were addressed
			(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
			(*e*) Describe any sensitivity analyses

	Item No	Page	Recommendation
Results			
Participants	13*	8	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
			(b) Give reasons for non-participation at each stage
			(c) Consider use of a flow diagram
Descriptive data	14*	8-11	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		7	(b) Indicate number of participants with missing data for each variable of interest
			(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*		*Cohort study*—Report numbers of outcome events or summary measures over time
			Case-control study—Report numbers in each exposure category, or summary measures of exposure
		7	*Cross-sectional study*—Report numbers of outcome events or summary measures
Main results	16	7, 8,9,10	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
			(*b*) Report category boundaries when continuous variables were categorized
			(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17		Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion			
Key results	18	9	Summarise key results with reference to study objectives
Limitations	19	14	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	12, 13, 14	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	14	Discuss the generalisability (external validity) of the study results
Other information			
Funding	22	none	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Physical activity among HIV-positive patients receiving antiretroviral therapy

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Primary Subject Heading:	HIV/AIDS
Secondary Subject Heading:	HIV/AIDS, Public health
Keywords:	physical activity, antiretroviral therapy, hiv/aids, Vietnam, PLWH

Physical activity among HIV-positive patients receiving antiretroviral therapy

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Abstract

Objectives: Antiretroviral therapy (ART) has turned HIV infection to a chronic disease, requiring patients to adhere to medications along with keeping a healthy life style to maintain their health status. Increasing in physical activity is recommended for HIV-positive patients to maintain their health. This study aimed to determine the physical activity level and its associated factors among ART patients.

Settings: 8 outpatient clinic sites across different levels of health systems in both rural and urban settings in Hanoi and Nam Dinh, Vietnam.

Study design and participants: A cross-sectional study was performed among 1,133 HIV patients receiving ART treatment during the study period.

Primary and secondary outcome measures: Physical activity was measured using the International Physical Activity Questionnaire (IPAQ). Socio-economic, health-related quality of life, ART adherence, ART–related characteristics were self-reported.

Result: About 16% of participants were inactive, 68% were health enhancing physical activity (HEPA) active. Rural participants reported a higher level of physical activity compared to urban participants. People living with HIV with longer ART duration were less likely to be physically active. Participants were more likely to have a higher IPAQ-score and classify as physically active if they were female, self-employed and blue-collar workers/farmers. Participants having higher CD4 cell count, higher EQ-5D-5L index/EQ-VAS, and sharing their health status with peers were more likely to have a higher IPAQ score or be physically active. A lower IPAQ-score was associated with urban participants and being at the symptomatic stage. In addition, participants who had poor adherence and higher duration of ART were more likely to be physically inactive**.**

Conclusion: The majority of participants on ART were physically active. Interventions to promote physical activity among PLWH in urban areas and in later ART treatment phases are needed. Peer support and job guidance have potentials in supporting the increase level of physical activity.

Keywords: Physical activity, antiretroviral therapy, HIV/AIDS, Vietnam, PLWH

Strengths and limitations

- The study included a large sample size of HIV-infected patients receiving antiretroviral therapy treatment (ART) across different levels of health systems placed in both rural and urban areas.
- The study employed various validated international instruments to increase the comparability between our results and other studies elsewhere.
- The IPAQ was an subjectively self-reported measure that may under- or over-estimate the actual physical activity of PLWH.
- Convenience sampling technique was used and this may limit the generalizability of the findings as well as accurate representative of HIV/AIDS population.
- The causal inference between level of physical activity and number of CD4 cells, and physical activity and quality of life could not be established due to the cross-sectional design.

Introduction

The use of highly active antiretroviral therapy (HAART) have achieved significant milestones in reduction of HIV/AIDS- related morbidity and mortality. According to the UNAIDS report in 2016, among 36.7 million people living with HIV (PLWH), an estimated 19.5 million patients had access to life-saving antiretroviral medicines and the global coverage of ART reached 53% [1]. PLWH taking potent combination antiretroviral (ARV) drug regimen enjoy longer and healthier lives [1], which may transform HIV/AIDS into a chronic disease [2]. However, one of the most common adverse health effects of ART among PLWH was lipodystrophy syndrome [3] including morphologic (peripheral lipoatrophy and central fat accumulation) and metabolic (hyper-triglyceridaemia, hyper-cholesterolaemia, insulin resistance, type 2 diabetes, lactic acidaemia) symptoms [4 5]. It contributes to an increase in risks of cardiovascular and other non-communicable diseases as a result of changes in adipose tissue distribution and metabolism [6 7]. These side-effects were also found to be the main reasons for patient's non-adherence to antiretroviral medication and discontinuing the therapy [8 9].

Since ART is requisite for viral suppression and recovering immune system, strategies which prevent these adverse effects and achieve optimization of treatment should be adopted [10 11]. Physical activity was recommended as a non-pharmacological treatment and alternative intervention [12]. Physical activity is defined as the movement of the body that works skeletal muscles and expend more energy than resting [13]. Physical activity can be categorized into subgroups such as occupation, conditioning exercises, sports, household tasks (for example cradling baby, cleaning) and other activities as well as into level of intensity included light, moderate or heavy [13]. Physical activity has been shown to increase functional capacity, muscle strength, joint flexibility, endurance and energy among people living with HIV [14 15]. Physical activity reduces the incidents of chronic diseases such as cardiovascular disease by lowering blood pressure in hypertensive patients and improving lipid lipoprotein profiles [16-18]; diabetes by improving glucose homeostasis [19]; and breast cancer [20 21]. Physical activity can also reverse metabolic and body composition change by lowering visceral and subcutaneous fat in the center of the body and increasing diameter of the peripheral parts, therefore prevent lipodystrophy [22 23].

Engaging in physical activities is a very important health- related behavior, particularly among PLWH, because they are less likely to do physical activity compared to uninfected patients [24]. A typical physical activity guideline for normal adults is that they should have a minimum of 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity physical activity each week or an equivalent combination of both moderate- and vigorous-intensity activity [25]. The Center for Disease Control and Prevention (CDC) suggests that PLWH should comply at least with this guideline to keep healthy [26]. However, in developing countries, the rates of physical inactivity have been shown to be more than 50% among PLWH [27 28] as compared to about one fourth in the United States and Australia [29 30]. The differences depend on various factors such as gender, age groups, occupations, level of CD4 cell count and quality of life [27 28 30].

In Vietnam, most previous studies focused on physical activity among Vietnamese adolescents [31 32] and adults with chronic diseases and metabolic syndrome [33 34]. A previous study by Tan Bui et al in 2015 found that 70% of the population met the WHO recommendations of physical activity for 18 to 64-year-old adults [35]. Additionally,, the socioeconomic and geographical differences were considered as factors that shape behavior in physical activity. Prior studies also revealed that physical activity was greater in male compared to female [35] and among people who had lower educational attainment [36]. Furthermore, the level of physical activity in rural areas was significantly higher than in urban settings due to the modern transport system and sedentary behavior in urbanization [35 37]. A national representative survey with more than 14,700 participants in 2010 indicated that provinces with higher urban population proportions had less proportion of active people [38]. Nonetheless, the rate of urbanization in Vietnam has been escalating in recent years, from 21% in 2008 to 32% in 2013 and is projected to reach 45% in 2020 [39]. These changes raise the need for understanding the potential variability of the prevalence of physical activity or inactivity between rural and urban settings, especially among people with chronic illnesses such as HIV/AIDS and non-communicable diseases.

Currently, Vietnam is still in a concentrated HIV epidemic stage and the proportion of ART coverage is estimated approximately 42% (of people living with HIV/AIDS) in 2015 [40], and half of them has been undergoing ART for a long time. To reduce the risk of chronic diseases and enhance the effectiveness of ART treatment, physical activity plays an important role as one of the potential intervention strategies. However, little attention has been paid to determine the degree of physical activity and intervention to enhance physical activity among individuals with HIV infection in Vietnam, particularly between urban and rural areas. According to the Vietnam Constitution in 2013, an urban area is defined as settlements with a high population density and built environment, while a rural area refers to places that have a low population density and are located outside urban settings, where people mostly work in the agriculture sector [41]. Based on this literature, we hypothesized that PLWH in urban area had lower level of physical activity compared to their counterparts. This study aimed to assess the level of physical activity and examine the factors associated with physically active among HIV patients receiving ART treatment across different levels of health systems and in both rural and urban settings.

Methods

Study setting and subjects

A cross-sectional study was performed from January to August 2013 in Hanoi and Nam Dinh, two Vietnamese epicenters providing HIV/AIDS surveillance and treatment services in the north of Vietnam. The study was performed at 8 outpatient clinics: 5 in Hanoi and 3 in Nam Dinh. The locations included: one national hospital (Bach Mai Hospital), one provincial hospital (Nam Dinh provincial hospital), one provincial center (Nam Dinh Provincial AIDS Control Centre) and five district health centers (Hoang Mai, Long Bien, Dong Anh, Ha Dong, Xuan Truong). The eligibility criteria for selecting outpatient clinic sites in Hanoi and Nam Dinh included: 1) being representative of public health system in Vietnam which contains central-; provincial- and district- levels); 2) being able to afford ART service implemented following the official guidelines of the Vietnamese Ministry of Health [42].

Participants were recruited using convenience sampling technique if they met the following eligibility criteria: 1) being 18 years old or above; 2) receiving ART treatment from those clinics mentioned above; 3) having a confirmatory testing of HIV-positive; 4) agreeing to participate in the study; 5) Be able to communicate with the data collectors normally. The exclusion criteria included those being suffered from serious illness during the recruitment process. We approached participants when they visited clinics for medication or to receive counseling. We identified eligible participants for the study based on the health staff's feedback. These participants were invited into a small counseling room by well-trained health workers. They were introduced to the purpose of study, the benefits and drawbacks of participating, and were then asked to join the study. If they agreed, participants signed a written informed consent. We ensured participants of the confidentiality of their participation in the study. The consent process took place in a comfortable room with restricted access, allowing participants privacy as they decided whether or not to join the project. A total of 1200 patients were invited to participate into the study, but only 1133 patients agreed to enroll. The reasons for refusal included insufficient health, discomfort or having busy work schedule.

Measures and instruments

Participants were invited to participate in 20-minute face-to-face interviews. Data were ascertained through an interview-administered questionnaire conducted by data collectors who were medical students at Hanoi Medical University and experts in HIV-related fields. We did not involve health staff in collecting data to avoid social desirability bias. We developed a structured questionnaire with following information:

Socioeconomic characteristics

We asked participants to report their socioeconomic information included gender (male/female), education attainment (illiterate/ elementary/ secondary/ high school/ vocational training/ university), age, marital status (single/ live with spouse/ live with partner/ divorced/ widow), religion (cult of ancestors/ Buddhism/ Catholic/ Protestant), and employment status (Unemployed/ Self-employed/ White-collar/ Blue-collar or farmer/ Others).

ART – related characteristics

Self-reports about the latest CD4 cell count, HIV stages (including 1) asymptomatic – patients without HIV-related symptoms, 2) symptomatic - patients having HIV-related clinical symptoms without AIDS indicators, and 3) AIDS [43]) and ART treatment duration were collected from participants. Data on viral load were not collected due to their unavailability at the study period. Non-adherence to ART was measured by self-report items. First, ART adherence last month was determined by visual analog scale (VAS) where 0-point showed complete non-adherence and 100-point showed complete adherence [44]. Participants were asked whether they forget to take ART medicine in the last four days. This approach has been applied successfully in a previous study [45]. We also asked the participants about whether they received peer support during ART treatment (Yes/No), and whether they shared their health status with their peers or not (Yes/No).

Health – related quality of life

HRQOL was measured using the EQ-5D-5L instrument in the Vietnamese version, which was validated elsewhere [46]. This tool measures five dimensions including

mobility, self-care, usual activities, pain/discomfort and anxiety/ depression with five response levels: no problems, slight problems, moderate problems, severe problems, and extreme problems. The combination of responses gives 3125 health states with weighting to have aggregate single index [46]. Cronbach's alpha of this instrument was 0.85 with good convergent validity [46]. Furthermore, we also use the EQ-VAS (visual analogue scale) which measures the self-rated health on a 20-cm vertical scale, with the endpoint ranges from 0 to 100 point, labeled 'the worst health you can imagine" and 'the best health you can imagine" [47].

Physical activity

To assess level of physical activity of participants, we used the International Physical Activity Questionnaire (IPAQ). The IPAQ is developed to use in adults (15-69 years old) [48]. Several questions were used to assess three specific types of activity: vigorous activity, moderate activity and walking activity. Examples of each type of activity in our research context are listed below:

- Vigorous activity: Heavy lifting, hoeing, weight lifting, fast paced cycling, etc.
- Moderate activity: Playing badminton, slow paced cycling, cradling baby, selling, etc.
- Walking activity: Going to work, going to school, going elsewhere, going jogging, etc.

Each activity was scored separately by frequency (measured by days per week) and duration (measured by time per day). Volume of each activity was also measured by its energy requirements determined in METs (METs are multiple of the resting metabolic rate) [48].

The total IPAQ score was used as a continuous variable which was calculated by adding the MET minute per week of three types of activity. We also evaluated the IPAQ score as categorical variable which divided their physical activity into 3 levels: Inactive, minimally active and HEPA active.

Participants were categorized into (1) HEPA (health enhancing physical activity) active group if they did:

- vigorous activity on at least 3 days obtaining total physical activity of at least 1500 MET-minutes/week;
- OR 7 or more days of combination between days of walking and days of moderate-intensity or vigorous activities obtaining total physical activity of at least 3000 MET-minutes/week.

Participants were in (2) Minimally active group if they had

- 3 or more days of vigorous activity of at least 20 minutes per day (800 MET-minutes/week)
- OR 5 or more days of moderate activity or walking of at least 30 minutes per day
- OR 5 or more days of walking combining with moderate-intensity or vigorous intensity activities obtaining at least 600 MET-min/week.

Participants were (3) Inactive if Individuals who not meet requirements for Categories 2 or 3 were determined as insufficiently active [48].

Statistical analysis

Data were analyzed by STATA version 12 (Stata Corp. LP, College Station, United States of America). Chi-square test and Mann Whitney test was used for demographic characteristics of participants as well as HRQOL, ART status and sexual behaviors. Multivariate linear regression was employed to identify factors associated with IPAQ score. Because the IPAQ score had non-normal distribution, we performed log-transformation for this variable in order to meet the requirement of regression model. We also applied multivariate logistic regression to identify factors associated with whether the participants were active in physical activity or not. We applied forward stepwise selection strategy to remove non-significant factors, the p-value of log likelihood ratio test was set as less than 0.1 and this was the threshold to include a variable. A p-value <0.05 was considered as statistical significance.

Ethics approval

The study protocol was reviewed and ethics approval was granted by the Vietnam Authority of HIV/AIDS Control's Scientific Research Committee. Participants confidently participated in the study and signed a written informed consent after receiving clearly introduction about the benefits and drawbacks of the study. The consent process took place in a room with restricted access. Participants can withdraw from the interview at any time and this did not affect their current treatment.

Results

The demographic and socioeconomic characteristics of participants living in rural and urban are given in **Table 1**. A total of 1,133 participants agreed to enroll in this study. Out of 1,133 ART patients, approximately 60% was male. The majority had secondary and high school education (36.9% and 32% respectively); participants in urban areas had higher education than people in rural area (p=0.04). The marital status and employment were also significant different between rural and urban group (p<0.01). There was no difference of age group between rural and urban participants.

Table 1: Socio-economic characteristic of PLWH in the study (n=1133)

	Rural		Urban		Total		p-value
	n	%	n	%	n	%	
Gender							
Male	145	56.2	520	59.4	665	58.7	0.36†
Female	113	43.8	355	40.6	468	41.3	
Education							
Illiterate	5	1.9	7	0.8	12	1.1	0.04†
Elementary school	48	18.6	172	19.7	220	19.4	
Secondary school	109	42.3	309	35.3	418	36.9	
High school	80	31	282	32.2	362	32	
Vocational training	6	2.3	48	5.5	54	4.8	
University	10	3.9	57	6.5	67	5.9	
Marital status							
Single	26	10.1	143	16.3	169	14.9	0.01†
Live with spouse	178	69	507	57.9	685	60.5	
Live with partner	0	0	8	0.9	8	0.7	
Divorced	22	8.5	66	7.5	88	7.8	
Widow	32	12.4	151	17.3	183	16.2	
Religion							

	Rural		Urban		Total		p-value
	n	%	n	%	n	%	
Cult of ancestors	222	86.1	779	89	1,001	88.4	0.03†
Buddhism	12	4.7	43	4.9	55	4.9	
Catholic	24	9.3	44	5	68	6	
Protestant	0	0	9	1	9	0.8	
Employment							
Unemployed	47	18.2	184	21	231	20.4	<0.01†
Self-employed	98	38	371	42.4	469	41.4	
White-collar worker	13	5	67	7.7	80	7.1	
Blue-collar worker or farmer	94	36.4	188	21.5	282	24.9	
Others	6	2.3	65	7.4	71	6.3	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	
Age	35.6	6.6	35.5	7.0	35.5	6.9	0.6¶

Significance level was p<0.05
†*Chi-square test*
¶*Mann Whitney test*

Antiretroviral therapy status

About half of participants were asymptomatic and the proportion of rural participants unaware of their stage of HIV infection was significantly higher than urban participants (52.1% vs 24.7%) (**Table 2**). The mean number of CD4 measurements and duration of ART treatment were 294.7 cells/μL (SD=215.2) and 3.5 years (SD=2.2) respectively. About 50% of participants shared health status with their peers and only one-third received peer support.

Table 2: Antiretroviral therapy status of participants (n=1133)

	Rural		Urban		Total		p-value
	n	%	n	%	n	%	
HIV period							
Asymptomatic	67	28.4	389	46	456	42.1	<0.01†
Symptomatic	32	13.6	161	19	193	17.8	
AIDS	14	5.9	87	10.3	101	9.3	
Unknown	123	52.1	209	24.7	332	30.7	
ART duration (year)							
1 year	47	19.0	213	26.9	260	25.0	<0.01†
2 – 4 years	91	36.9	354	44.7	445	42.8	
More than 4 years	109	44.1	225	28.4	334	32.2	
Share health status with peers							
Yes	110	43.3	446	52.7	556	50.6	0.01†
No	144	56.7	400	47.3	544	49.5	
Receiving peer support							
Yes	77	29.8	314	35.9	391	34.5	0.07†
No	181	70.2	561	64.1	742	65.5	
Forgetting to take medicine in the last 4 days							
No	243	98	780	97.7	1,023	97.8	0.82†
Yes	5	2	18	2.3	23	2.2	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	
ART Duration (year)	4.0	2.4	3.3	2.1	3.5	2.2	<0.01¶
CD4 cell count	312.5	220.6	289.2	213.4	294.7	215.2	0.08¶

	Rural		Urban		Total		p-value
	n	%	n	%	n	%	
ART adherence (VAS)	94.8	8.2	93.9	11	94.1	10.4	0.55¶

Significance level was p<0.05
†*Chi-square test*
¶*Mann Whitney test*

Self-reported health status

The percentage of urban participants having any problem in mobility, self-care, doing usual activities were significant higher than those of rural participants (p<0.01) (**Table 3**). About 40% of participants suffered from anxiety or depression, and about half of the participants suffered from pain or discomfort, with no significant difference between rural and urban participants. The mean EQ-5D-5L index was 0.8 (SD=0.2) and the perceived EQ-VAS score among rural participants was statistically significantly higher than those of urban participants (p<0.01).

Table 3: Health status among participants (n=1133)

	Rural		Urban		Total		p-value
	n	%	n	%	n	%	
Self-reported health problems							
Mobility	33	12.8	199	22.7	232	20.5	<0.01†
Self-care	12	4.7	98	11.2	110	9.7	<0.01†
Usual Activities	26	10.1	162	18.5	188	16.6	<0.01†
Pain or Discomfort	85	33.0	342	39.1	427	37.7	0.07†
Anxiety or Depression	104	40.3	405	46.3	509	44.9	0.09†
Complications and concurrent disease	76	29.5	329	37.6	405	35.8	0.02†
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	
EQ-5D-5L index	0.8	0.2	0.8	0.3	0.8	0.2	0.18¶
EQ-VAS	70.1	16.0	68.4	17.6	68.8	17.3	<0.01¶

Significance level was p<0.05
†*Chi-square test*
¶*Mann Whitney test*

Physical activity level

Sixteen percent of participants were inactive and 68% of participants were HEPA active using the IPAQ **(Table 4**). Rural participants reported statistically higher level of physical activity and IPAQ score compared to urban participants (p=0.03 and p<0.01 respectively). Regarding moderate activity, number of days per week and mean value of MET-score among participants living in rural areas were higher than those in urban areas (p<0.01 and p=0.01 respectively). However, mean MET-score of vigorous activity and walking activity were similar between two groups.

Table 4: Physical activity levels of participants

	Rural		Urban		Total		p-value
	n	%	n	%	n	%	

Level of physical activity							
Inactive	29	11.3	152	17.4	181	16.0	**0.03**†
Minimally active	37	14.3	144	16.4	181	16.0	
HEPA active	192	74.4	579	66.2	771	68.0	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	
Vigorous activity							
Days per week	1.5	0.2	1.2	0.1	1.3	2.5	0.09¶
Minutes per day	95.4	11.2	81.1	6	84.4	177.6	0.15¶
MET-score	4360.9	555.5	3444.4	282.5	3651.9	8465.9	0.11¶
Moderate activity							
Days per week	5.4	0.2	4.8	0.1	4.9	2.8	**<0.01**¶
Minutes per day	170.2	5.7	155.9	3.3	159.1	96	0.04¶
MET-score	4211.3	165.7	3737.9	92.2	3845.9	2711.1	**0.01**¶
Walking activity							
Days per week	3.4	0.2	3.3	0.1	3.4	3.3	0.67¶
Minutes per day	18.6	1.8	21.8	1.3	21.1	36.8	0.99¶
MET-score	377.1	38.3	451.5	29.3	434.6	816.3	0.87¶
IPAQ Score	8977.9	535.5	7613.5	280.5	7922.9	8333.8	**<0.01**¶

Number of total participants, n= 1133
Significance level was p<0.05
†*Chi-square test and*
¶*Mann Whitney test*

Figure 1 shows that IPAQ score differentially associated with ART treatment duration. A higher IPAQ score was associated with a shorter antiretroviral therapy (ART) duration; longer antiretroviral therapy (ART) treatment was associated with a lower IPAQ score. Specifically, it increased within the first year of ART, plateaued during 2 to 4 years of treatment, and then decreased.

Factors associated with level of activity

Participants were more likely to have a higher IPAQ-score and classify as active in physical activity if they were female, self-employed and were blue-collar workers or farmers **(Table 5)**. Participants who had a higher CD4 cell count, shared their health status with their peers, and reported a higher EQ-5D-5L index/EQ-VAS were also more likely to have higher IPAQ score or be active in physical activity. By contrast, a lower IPAQ-score was associated with living in urban areas and being at the symptomatic stage. In addition, participants who had poor adherence and higher duration of ART were more likely to be inactive in physical activity.

Table 5: Factors associated with levels of physical activity among antiretroviral therapy patients in Vietnam in 2013

	IPAQ-score		Active	
	Coef.	**95 CI**	**OR**	**95 CI**
Gender (Female vs Male)	0.25*	0.11; 0.39	2.53*	1.58; 4.07
Living location (Urban vs Rural)	-0.17*	-0.34; -0.01	0.60	0.35; 1.05
Education attainment (vs Illiterate)				

High school			1.52	0.94; 2.46
Religion (vs Cults of Ancestor)				
Buddhism			2.78	0.73; 10.57
Occupation (vs Unemployed)				
Self-employed	0.60*	0.41; 0.79	2.98*	1.78; 4.99
White-collar workers	0.29	-0.02; 0.59	2.43	0.87; 6.79
Blue-collar worker/farmers	0.73*	0.52; 0.94	2.24*	1.27; 3.95
Others	0.53*	0.22; 0.84	3.28*	1.07; 10.05
EQ-5D index			4.49*	1.68; 12.02
EQ-VAS	0.01*	0.00; 0.01	1.02*	1.00; 1.03
Current CD4 cell count	0.01*	0.00; 0.01	1.02*	1.01; 1.03
ART duration			0.91*	0.82; 0.98
HIV Stages (vs Asymptomatic)				
Symptomatic	-0.20*	-0.38; -0.01		
AIDS			1.81	0.87; 3.79
Forgetting to take medicine in the last 4 days (Yes vs No)			0.26*	0.09; 0.80
Share health status with peers (Yes vs No)	0.26*	0.12; 0.40	1.86*	1.21; 2.84

**p<0.05; OR: Odds Ratio; 95% CI: 95% Confidence Interval*

Discussion

Findings of this study suggest that PLWH in urban areas had lower level of physical activity compared to their peer in rural settings. In our study, a majority of ART patients achieved HEPA active in physical activity. By using multivariate regression models, we found a number of sociodemographic, clinical and social factors that are associated with the level of physical activity among PLWH in Vietnam. These results will contribute significantly to the development of tailored interventions to boost the physical activity among this population in the future.

Compared to previous studies on ART patients using the IPAQ system, the percentage of inactive (16%) or minimally active (16%) participants in our study was much lower [12 27 29 30]. Most participants reported the highest frequency of moderate activity (playing sport, cycling, cradling baby, etc.), which is different from previous studies founding that walking was the most preferred physical activity among PLWH [14 30]. These activities can positively affect PLWH by decreasing side-effects associated with HIV/AIDS and cardio-metabolic complications accompanied with ART treatment [15 49]. However, a number of participants in our study had difficulty in mobility which limited their ability to engage in healthy physical activities regardless of living location. Therefore, the health staff could provide alternative methods of exercising such as passive motion exercise, hydrotherapy or stationary cycling which is found to be just as effective for enhancing functional fitness as active exercise practice [50].

The total physical activity score in rural area was higher than in urban areas in our study, which is consistent with the physical activity level of the general Vietnamese population [35]. Some environmental factors in rural areas such as sidewalk conditions, the availability of exercise equipment and sedentary behavior in

urbanization may affect individual willingness to take part in physical activity [37 51]. Meanwhile, in Vietnam, the main occupations in rural areas were farming and blue-collar works in which rural participants often viewed working on farm or heavy working conditions as vigorous and moderate physical activities. However, MET-score obtaining by walking activity was the smallest and this did not differ between rural and urban areas. This can be explained by factors such as low residential density and long distances between destinations in rural areas that may discourage people from walking [52]. Similarly, in urban settings, walking intensity could be influenced by the presence of pedestrian infrastructure such as sidewalk as well as safety concerns from crime or traffic flow [53].

Our study also found that participants who were unemployed were less likely to be physically active, which concurs with prior findings [54 55]. Unemployed patients are less likely to obtain adequate physical activity because occupational activity is concerned as a vital component of daily physical activity in adulthood [56-58]. In addition, our study found that female respondents were more likely to get a higher level of physical activity. This can be explained by the fact that in the traditional Vietnamese culture, women still have many responsibilities of taking care of their children and all household activities, which were mainly classified as moderate physical activity in our study [59 60].

Interestingly, we found that people with higher duration of ART were less likely to be physically active. Notably, this association was found as a non-linear relationship. This is likely because patients had to adapt with rigorous adherence during the initiation of their treatment, which might enhance their willingness to involve in physical activities [45 61 62]. However, the later reduction can be supposed that patients became complacent when their health status recovered, and less motivated to comply with strict physical regimen [45 61]. Findings from another study emphasized the role of age in relationships between advanced HIV disease and worsen physical function [24]. As prolonged ART treatment has been positively associated with an accelerated aging process, age-related comorbidity may reduce the level of physical activity intensity [24]. However, in this study, the influence of age on physical activity was not statistically significant since it was dropped out of multivariate regression model. We also observed that non-adherence to ART was associated with a physically inactive status. Other studies also reveal that low level of physical activity has been found to be significantly related to low antiretroviral medication adherence [61 63]. This finding can be explained by the fact that physical activity can reduce depressive symptomatology which may lead to optimal ART adherence [63].

In this study, we combined both EQ-5D-5L and EQ-VAS instruments due to the variation of health utility scores based on different instruments [64]. EQ-VAS is a self-reported instrument that directly assesses perceived health status of patients in short-term. Meanwhile, EQ-5D index is composited by five domains that indirectly measures quality of life in long-term [65]. In the short-term, patients' hope for improving their health condition might influence their perceived health status. On the other hand, in the long-term, because of the acclimation with their health status, patients tend to report quality of life more accurately [64]. In term of health status, participants with higher quality of life and higher number of CD4 cell count had higher IPAQ score, while participants at symptomatic stage had lower IPAQ score compared to those having asymptomatic stage. We supposed that physical activity would help

patients to improve and maintain their strength and quality of life. Two systemic reviews by O'Brien et al in 2016 and 2017 found that exercises including aerobic and resistive or a combination performed at least three times per week for at least five weeks may lead to improvements in cardiopulmonary fitness, strength, weight and body composition and quality of life among PLWH who are medically stable. [66 67].

Our current study suggested that participants who shared health status with their peers were more likely to have a higher IPAQ score. The association between peer supports and physical activity was investigated by Jerome et al (2012) which found that peer support was an important determinant to assist patients in adherence to exercise programs [68]. Additionally, WHO, PEPFAR and Global Fund have proposed that social support should be considered as an effective adjunct in improving physical health among PLWH receiving ART treatment [69 70]. As PLWH were more vulnerable and withdrawn from social situations [71], peer support can promote patients' health through sharing relevant personal experiences to acquire knowledge, reduce stigma and discrimination, improve physical functioning, and enhance retention in ART treatment [72-74].

Several implications can be drawn from this study. First, providing different physical activity strategies based on rural and urban settings is needed to improve health status of PLWH in these areas. For example, the health staff in clinics may organize some outdoor activities via peer educators/groups to engage urban patients in physical activity. Second, job opportunities and vocational training should be prioritized to promote physically active among ART patients [54 55]. Third, the reduction in IPAQ score observed in prolonged ART duration suggests that physical health assessments and appropriate physical activity programs such as resistance trainings and aerobic exercises should be in place. Additionally, passive motion exercise should be considered for immobilized patients or who had difficulty in mobility or physical impairments [50]. Fourth, given the association between the level of physical activity and ART treatment status from our findings, integrative intervention including physical activity, ART medication adherence and health related quality of life may prove to be efficient and cost-effective [63]. Finally, promoting social support, especially among peers should be prioritized to enables HIV patients to share their experiences that motivate others to be involved in physical activity [68]. Furthermore, peer support groups integrated into assigned health facilities would be useful to patients who are at the initial ART medication stage.

The strengths of this study included the large sample size of HIV-infected patients receiving antiretroviral therapy treatment, which increased the statistic power of the result. Additionally, we recruited participants from different levels of health systems (central, provincial and district ART clinics) in both rural and urban areas, which made the sample more representative of the general Vietnamese population. We also employed international instruments such as IPAQ and EQ-5D-5L, which help to increase the comparability between our results and other global studies.

However, several limitations should be acknowledged. Firstly, the convenience sampling technique was used, which may limit the generalizability of our findings to other settings and patient populations. Secondly, because collected data was based on self-reported information, it is susceptible to be influences by interviewers, social desirability and recall bias. To minimize these biases, interviewers affiliated with

selected health centers were excluded from the study and patients were given clear instructions on the benefits and drawbacks of the study. Thirdly, the causal inferences could not be established due to the cross-sectional design. Finally, some barriers to physically active such as social factors (stigma, discrimination), family support or clinical settings (healthcare providers) were not fully addressed in this study, warranting further research to elucidate these gaps.

Conclusion

In conclusion, findings from this study suggests for some potential interventions to improve the health status and quality of life for HIV patients receiving ART in rural and urban Vietnam. More studies of different populations in different settings are needed to confirm the positive association between high level of physical activity and ART adherence. Intervention focusing on promoting physical activities for PLWH should take into consideration of the location and external environment of the target population. Furthermore, peer support and job guidance for PLWH also have great potentials to increase their level of physical activity.

LIST OF ABBREVIATION

ART: Antiretroviral Therapy
PLWH: People Living With HIV
WHO: World Health Organization
PEPFAR: President's Emergency Plan For AIDS Relief

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Authors' Contributions

AKD, LHN, AQN, BXT, TTT, CAL, MWBZ, RCMH conceived of the study, and participated in its design and implementation and wrote the manuscript. AKD, LHN, BXT, analysed the data. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

Data sharing statement

The data that support the findings of this study are available from the Vietnam Authority of HIV/AIDS Control but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of the Vietnam Authority of HIV/AIDS Control.

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Figure 1. Physical activity among antiretroviral therapy (ART) patients regarding ART duration.

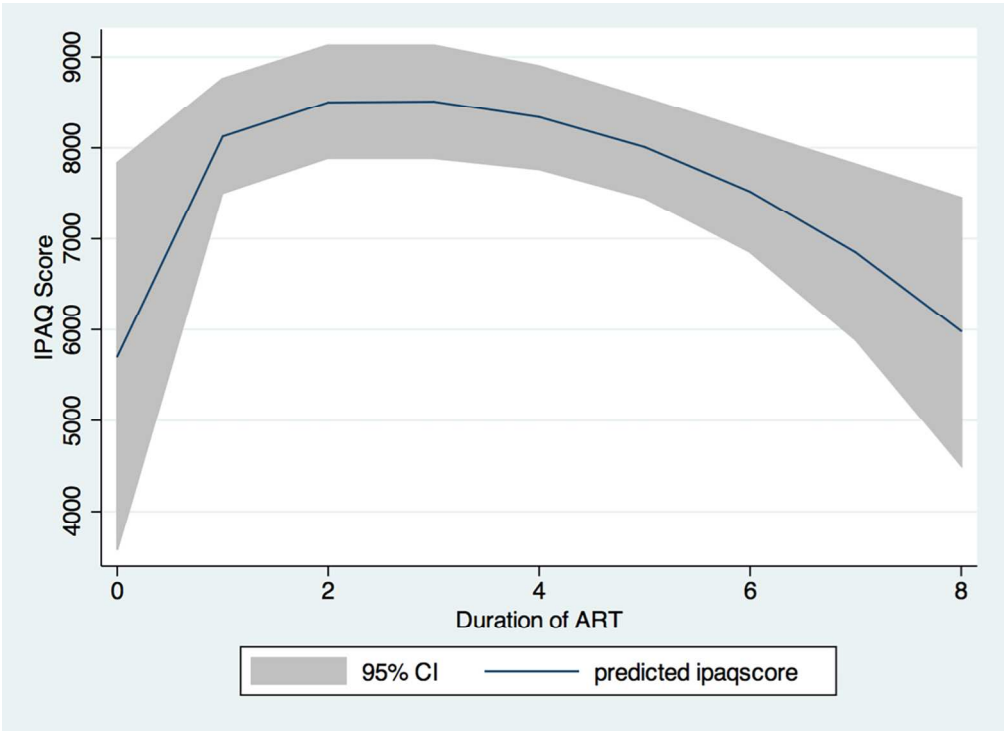

Figure 1. Physical activity among antiretroviral therapy (ART) patients regarding ART duration

137x99mm (300 x 300 DPI)

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Page	Recommendation
Title and abstract	1	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		2	(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction			
Background/rationale	2	4,5	Explain the scientific background and rationale for the investigation being reported
Objectives	3	5	State specific objectives, including any prespecified hypotheses
Methods			
Study design	4	5	Present key elements of study design early in the paper
Setting	5	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	5	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
			(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	6,7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	6,7	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	7	Describe any efforts to address potential sources of bias
Study size	10	6	Explain how the study size was arrived at
Quantitative variables	11	6,7	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	2	7	(*a*) Describe all statistical methods, including those used to control for confounding
		7	(*b*) Describe any methods used to examine subgroups and interactions
		7	(*c*) Explain how missing data were addressed
			(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
			(*e*) Describe any sensitivity analyses

	Item No	Page	Recommendation
Results			
Participants	13*	8	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
			(b) Give reasons for non-participation at each stage
			(c) Consider use of a flow diagram
Descriptive data	14*	8-11	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		7	(b) Indicate number of participants with missing data for each variable of interest
			(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*		*Cohort study*—Report numbers of outcome events or summary measures over time
			Case-control study—Report numbers in each exposure category, or summary measures of exposure
		7	*Cross-sectional study*—Report numbers of outcome events or summary measures
Main results	16	7, 8,9,10	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
			(*b*) Report category boundaries when continuous variables were categorized
			(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17		Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion			
Key results	18	9	Summarise key results with reference to study objectives
Limitations	19	14	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	12, 13, 14	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	14	Discuss the generalisability (external validity) of the study results
Other information			
Funding	22	none	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Physical activity among HIV-positive patients receiving antiretroviral therapy in Hanoi and Nam Dinh, Vietnam : A cross - sectional study

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Secondary Subject Heading:	HIV/AIDS, Public health
Keywords:	physical activity, antiretroviral therapy, hiv/aids, Vietnam, PLWH

Physical activity among HIV-positive patients receiving antiretroviral therapy in Hanoi and Nam Dinh, Vietnam : A cross – sectional study

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Abstract

Objectives: Antiretroviral therapy (ART) has facilitated the transition of HIV infection into a chronic disease, where adherence to medications is required along with keeping a healthy lifestyle. Therefore, an increase in physical activity has been recommended for HIV patients in order to maintain their health status. This study looked to determine the physical activity level and its associated factors among HIV patients receiving ART treatment.

Settings: 8 outpatient clinic sites across different levels of the health systems in both rural and urban settings in Hanoi and Nam Dinh, Vietnam.

Study design and participants: A cross-sectional study was performed among 1,133 HIV patients receiving ART treatment from January to August 2013.

Primary and secondary outcome measures: Physical activity level was measured using the International Physical Activity Questionnaire (IPAQ). Socio-economic, health-related quality of life, ART adherence, ART–related characteristics were self-reported.

Result: 16% of participants were inactive, and 68% were reported active via health-enhancing physical activity (HEPA). Rural participants reported a higher level of physical activity compared to urban participants. Participants having longer duration of ART were less likely to be physically active. Participants who were female and self-employed, who had higher CD4 cell count, higher EQ-5D-5L index/EQ-VAS, and shared their health status with their peers were more likely to have a higher IPAQ score or be physically active. A lower IPAQ-score was associated with participants living in urban areas and being at the symptomatic stage. Participants having poor adherence and higher duration of ART were more likely to be physically inactive**.**

Conclusion: The majority of participants who received ART were physically active. There is a need for interventions to promote physical activity among HIV patients in urban areas and in the later ART treatment phases. Other potentials interventions to increase the level of physical activity include peer support and job guidance.

Keywords: Physical activity, antiretroviral therapy, HIV/AIDS, Vietnam, PLWH

Strengths and limitations

- This study included a large sample size of HIV-positive patients who received antiretroviral therapy treatment (ART) across different levels of the health systems in both rural and urban areas of Vietnam.
- The study employed a number of validated international instruments to ensure the comparability between our results and other studies elsewhere.
- The IPAQ was a subjectively self-reported measure that may under- or over-estimate the actual physical activity of PLWH.
- A convenience sampling technique was used and this may limit the generalizability of the findings as well as an accurate representative of HIV/AIDS population.
- The causal inference between the level of physical activity and the number of CD4 cells, and the level of physical activity and the quality of life could not be established due to the study's cross-sectional design.

Introduction

The implementation of highly active antiretroviral therapy (HAART) has led to significant milestones in the reduction of HIV/AIDS-related morbidity and mortality. According to a UNAIDS report in 2016, among 36.7 million people living with HIV (PLWH), an estimated 19.5 million patients had access to life-saving antiretroviral medicines and the global coverage of ART has reached 53% [1]. PLWH who take a potent combination of antiretroviral (ARV) drug regimen enjoy longer and healthier lives [1]. This improvement has also transformed HIV/AIDS into a chronic disease [2]. However, one of the most common adverse health effects of ART among PLWH is lipodystrophy syndrome [3] including morphologic (peripheral lipoatrophy and central fat accumulation) and metabolic (hyper-triglyceridaemia, hyper-cholesterolaemia, insulin resistance, type 2 diabetes, lactic acidaemia) symptoms [4 5]. This contributes to an increase in risks of cardiovascular and other non-communicable diseases as a result of changes in adipose tissue distribution and metabolism [6 7]. These side-effects were also found to be the main reasons for the patient's non-adherence to antiretroviral medication and discontinuing the therapy [8 9].

Since ART is requisite for viral suppression and recovering of the immune system, it is important for health providers to identify and patients to adopt strategies to prevent these adverse effects and achieve optimization of the treatment [10 11]. Physical activity was recommended as an alternative and non-pharmacological treatment intervention to improve the patient's health status [12]. Physical activity is defined as the movement of the body that works the skeletal muscles and expends more energy than the resting state [13]. There several subgroups of physical activities such as occupational activities, conditioning exercises, sports, household tasks (for example cradling baby, cleaning) and other activities. There are also different levels of intensity, which include light, moderate or heavy [13]. Physical activity has been shown to be able to increase the functional capacity, muscle strength, joint flexibility, endurance and energy among people living with HIV [14 15]. Engaging in physical activity has been found to reduce incidences of certain chronic diseases such as cardiovascular by lowering blood pressure in hypertensive patients and improving lipid-lipoprotein profiles [16-18]; or improving glucose homeostasis [19] in people with diabetes; and breast cancer [20 21]. Physical activity can also reverse the metabolic and body composition change of the patient by lowering visceral and subcutaneous fat in the center of the body and increasing the diameter of the peripheral parts, therefore prevent lipodystrophy [22 23].

Thus, engaging in physical activities is a very important health-related behavior for PLWH, because they are found to be less likely to do physical activity compared to uninfected patients [24]. A typical physical activity guideline for normal adults recommends a minimum of 150 minutes of moderate-intensity physical activity or 75 minutes of vigorous-intensity physical activity each week or an equivalent combination of moderate- and vigorous-intensity activities [25]. The Center for Disease Control and Prevention (CDC) suggests that a PLWH should comply at least one type of physical activity in this guideline to keep healthy [26]. However, in many developing countries, the rates of physical inactivity have been shown to be more than 50% among PLWH [27 28] in comparison to about one fourth in the United States and Australia [29 30]. The difference depends on various factors such as gender, age groups, occupations, level of CD4 cell count and quality of life [27 28 30].

In Vietnam, most previous studies have focused on the physical activity levels among Vietnamese adolescents [31 32] and adults with chronic diseases and metabolic syndromes [33 34]. A previous study by Tan Bui et al (2015) found that 70% of the population met the WHO recommendations for physical activity level for 18 to 64-year-old adults [35]. Additionally, the socioeconomic and geographical differences were considered as factors that shape attitude and behavior toward physical activity. Prior studies also revealed that physical activity level was greater in male compared to female [35] and among people who had lower educational attainment [36]. Furthermore, the level of physical activity in rural areas was significantly higher than those in urban settings perhaps due to more access to modern transportation systems and sedentary behaviors in the urban setting [35 37]. A national representative survey of more than 14,700 participants in 2010 indicated that provinces with higher urban population proportions had a lesser proportion of active people [38]. Nonetheless, the rate of urbanization in Vietnam has been quickly on the rise in recent years, from 21% in 2008 to 32% in 2013 and is projected to reach 45% in 2020 [39]. These changes raise the need for understanding the potential variability of the prevalence of physical activity or inactivity between rural and urban settings, especially among people with chronic illnesses such as HIV/AIDS and other non-communicable diseases.

Currently, Vietnam is still in a concentrated HIV epidemic stage and the proportion of ART coverage is estimated approximately at 42% of the country's PLWH's population in 2015 [40]. Half of this number has been undergoing ART for a long time. Engaging in physical activity to reduce the risk of chronic diseases and enhance the effectiveness of the ART treatment is a potential intervention strategy to be considered by healthcare providers. However, little attention has been paid to determining the degree of physical activity as an intervention that could enhance the level of physical activity among individuals with HIV infection in Vietnam, particularly between urban and rural areas. According to the Vietnamese Constitution in 2013, an urban area is defined as a settlement with a high population density and built environment, whereas a rural area refers to a place that has a low population density and is located outside the urban setting, where people mostly work in the agriculture sector [41]. Based on this definition, we hypothesized that PLWH in an urban area would have a lower level of physical activity compared to their counterparts in the rural area. This study looked to assess the level of physical activity across different settings and examine the factors associated with the level of physical activity among HIV patients receiving ART treatment across different levels of the health systems and in both rural and urban settings.

Methods

Study setting and subjects

A cross-sectional study was performed from January to August 2013 in Hanoi and Nam Dinh, two Vietnamese epicenters providing HIV/AIDS surveillance and treatment services in the Northern region of Vietnam. The study was performed at 8 outpatient clinics: 5 in Hanoi and 3 in Nam Dinh. The locations included: one national hospital (Bach Mai Hospital), one provincial hospital (Nam Dinh provincial hospital), one provincial center (Nam Dinh Provincial AIDS Control Centre) and five district health centers (Hoang Mai, Long Bien, Dong Anh, Ha Dong, Xuan Truong). The eligibility criteria for selecting outpatient clinic sites in Hanoi and Nam Dinh included:

1) being representative of the public health system in Vietnam which contains central-; provincial- and district- levels); 2) being able to afford ART service implemented following the official guidelines of the Vietnamese Ministry of Health [42].

Participants were recruited using convenience sampling technique if they met the following eligibility criteria: 1) being 18 years old or above; 2) receiving ART treatment from those clinics mentioned above; 3) having a confirmatory testing of HIV-positive; 4) agreeing to participate in the study; 5) being able to communicate with the data collector. The exclusion criteria included those who suffered from serious illness during the recruitment process. We approached participants when they visited clinics for medication or to receive counseling. We identified eligible participants for the study based on the health staff's feedbacks. These participants were invited into a small counseling room by well-trained health workers. They were introduced to the purpose of the study, the benefits and drawbacks of participating, and were then asked to join the study. If they agreed, participants would sign a written informed consent. We ensured the participants of the confidentiality of their participation in the study. The consending process took place in a comfortable room with restricted access, which allowed for participants to have some privacy as they decide whether or not to join the project.

Measures and instruments

Participants were invited to participate in 20-minute face-to-face interviews. Data were ascertained through interview-administered questionnaires conducted by data collectors who were medical students at Hanoi Medical University and experts in HIV-related fields. We did not involve health staff in collecting data to avoid social desirability bias. We developed a structured questionnaire with the following information:

Socioeconomic characteristics

We asked participants to report their socioeconomic information which included gender (male/female), education attainment (illiterate/ elementary/ secondary/ high school/ vocational training/ university), age, marital status (single/ live with spouse/ live with partner/ divorced/ widow), religion (cult of ancestors/ Buddhism/ Catholic/ Protestant), and employment status (Unemployed/ Self-employed/ White-collar/ Blue-collar or farmer/ Others).

ART–related characteristics

We asked each participant for a self-report of their latest CD4 cell count, HIV stages (any asymptomatic/ symptomatic condition defined as "HIV-infected patients having clinical symptoms but not including AIDS-Indicator Conditions that meet at least one of the eligible criteria/ AIDS-Indicator Conditions") [43] and ART treatment duration. Data on viral load were not collected due to their unavailability at the time of the study. Non-adherence to ART was measured by self-report items. First, ART adherence of the last month was determined by a visual analog scale (VAS) where 0-point showed completely non-adherence and 100-point showed completely adherence [44]. Participants were asked whether they forget to take ART medicine in the last four days. This approach has been applied successfully in a previous study [45]. We also asked the participants about whether they received peer support during ART treatment (Yes/No), and whether they shared their health status with their peers or not (Yes/No).

Health–related quality of life

HRQOL was measured using the EQ-5D-5L instrument in the Vietnamese version, which was validated elsewhere [46]. This tool measures five dimensions of health-related quality of life including mobility, self-care, usual activities, pain/discomfort and anxiety/ depression with five response levels: no problems, slight problems, moderate problems, severe problems, and extreme problems. The combination of responses gives 3125 position health statuses with an aggregate single index weighting [46]. The Cronbach's alpha of this instrument was 0.85 with a good convergent validity [46]. Furthermore, we also used the EQ-VAS (visual analogue scale) which measures the self-rated health on a 20-cm vertical scale, with the endpoint ranges from 0 to 100 point, labeled 'the worst health you can imagine" and 'the best health you can imagine" [47].

Physical activity

To assess the level of physical activity of the participants, we used the International Physical Activity Questionnaire (IPAQ). The IPAQ was developed to use in adults aged 15-69 years old [48]. Several questions were used to assess three specific types of activity: vigorous activity, moderate activity, and walking activity. Example for each type of activity in our research context are listed below:

- Vigorous activity: Heavy lifting, hoeing, weight lifting, fast paced cycling, etc.
- Moderate activity: Playing badminton, slow paced cycling, cradling baby, selling, etc.
- Walking activity: Going to work, going to school, going elsewhere, going jogging, etc.

Each activity was scored separately by frequency (measured by days per week) and by duration (measured by times per day). The volume of each activity was also measured by its energy requirement determined in METs (METs are multiple of the resting metabolic rate) [48].

The total IPAQ score was used as a continuous variable which was calculated by adding the MET minute per week of the three types of activity. We also evaluated the IPAQ score as a categorical variable which divided the physical activity into 3 levels: Inactive, minimally active and HEPA active.

Participants were categorized into (1) HEPA (health enhancing physical activity) active group if they did:

- vigorous activity for at least 3 days and obtained a total physical activity of at least 1500 MET-minutes/week;
- OR 7 or more days of combination physical activities of walking, moderate-intensity or vigorous activities and obtained a total physical activity of at least 3000 MET-minutes/week.

Participants were in the (2) Minimally active group if they had:

- 3 or more days of vigorous activity of at least 20 minutes per day (800 MET-minutes/week)
- OR 5 or more days of moderate activity or walking of at least 30 minutes per day

- OR 5 or more days of walking combining with moderate-intensity or vigorous intensity activities obtaining at least 600 MET-min/week.

Participants were (3) Inactive or were determined as insufficiently active [48] if the individual did not meet the requirements for Categories 2 or 3.

Statistical analysis

Data were analyzed by STATA version 12 (Stata Corp. LP, College Station, United States of America). A Chi-square test and a Mann Whitney test was used for analyzing demographic characteristics of participants as well as HRQOL, ART status, and sexual behaviors. Multivariate linear regression was employed to identify factors associated with IPAQ score. Because the IPAQ score had a non-normal distribution, we performed log-transformation for this variable in order to meet the requirement of the regression model. We also applied multivariate logistic regression to identify factors associated with whether the participants were active in physical activity or not. We applied a forward stepwise selection strategy to remove non-significant factors, the p-value of log-likelihood ratio test was set as less than 0.1 and this was the threshold to include a variable. A p-value <0.05 was considered as statistical significance.

Ethics approval

The study protocol was reviewed and granted ethics approval by the Vietnam Authority of HIV/AIDS Control's Scientific Research Committee. Participants confidently participated in the study and signed a written informed consent after received clear information on the benefits and drawbacks of the study. The consent process took place in a room with restricted access. Participants can withdraw from the interview at any time and this did not affect their current treatment.

Patient and Public Involvement

We conducted a pilot survey of fifty participants of different ages, genders, and occupations and only minor changes to the wording were made in order to meet patient's preferences and culture. After revision, we performed data collection using a structured questionnaire. Participants were not taken part in the recruitment as well as the conduct of the study. We aim to show our study results at national and international scientific meetings as well as publish our study in open-access journals. Therefore, our study is widely available to be disseminated to study participants and other interested international researchers

Results

A total of 1200 patients were invited to participate into the study, and 1133 patients agreed to enroll. The reasons for refusal included insufficient health, discomfort or having busy work schedules.

The demographic and socioeconomic characteristics of participants living in rural and urban are given in **Table 1**. Out of 1,133 ART patients, approximately 60% was male. The majority had secondary and high school education (36.9% and 32% respectively); participants in urban areas had higher education than people in rural area (p=0.04). The marital status and employment were also significant different between rural and urban group (p<0.01). There was no difference of age group between rural and urban participants.

Table 1: Socio-economic characteristic of PLWH in the study (n=1133)

	Rural		Urban		Total		p-value
	n	%	n	%	n	%	
Gender							
Male	145	56.2	520	59.4	665	58.7	0.36†
Female	113	43.8	355	40.6	468	41.3	
Education							
Illiterate	5	1.9	7	0.8	12	1.1	0.04†
Elementary school	48	18.6	172	19.7	220	19.4	
Secondary school	109	42.3	309	35.3	418	36.9	
High school	80	31	282	32.2	362	32	
Vocational training	6	2.3	48	5.5	54	4.8	
University	10	3.9	57	6.5	67	5.9	
Marital status							
Single	26	10.1	143	16.3	169	14.9	0.01†
Live with spouse	178	69	507	57.9	685	60.5	
Live with partner	0	0	8	0.9	8	0.7	
Divorced	22	8.5	66	7.5	88	7.8	
Widow	32	12.4	151	17.3	183	16.2	
Religion							
Cult of ancestors	222	86.1	779	89	1,001	88.4	0.03†
Buddhism	12	4.7	43	4.9	55	4.9	
Catholic	24	9.3	44	5	68	6	
Protestant	0	0	9	1	9	0.8	
Employment							
Unemployed	47	18.2	184	21	231	20.4	<0.01†
Self-employed	98	38	371	42.4	469	41.4	
White-collar worker	13	5	67	7.7	80	7.1	
Blue-collar worker or farmer	94	36.4	188	21.5	282	24.9	
Others	6	2.3	65	7.4	71	6.3	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	
Age	35.6	6.6	35.5	7.0	35.5	6.9	0.6¶

Significance level was p<0.05
†*Chi-square test*
¶*Mann Whitney test*

Antiretroviral therapy (ART) status

About half of the participants were asymptomatic and the percentage of the rural participants who were unaware of their stage of HIV infection was significantly higher than the urban participants (52.1% vs 24.7%) (**Table 2**). The mean number of CD4 measurements and duration of ART treatment were 294.7 cells/μL (SD=215.2) and 3.5 years (SD=2.2) respectively. About 50% of the participants shared health status with their peers and only one-third received peer support.

Table 2: Antiretroviral therapy status of participants (n=1133)

	Rural		Urban		Total		p-value
	n	%	n	%	n	%	
HIV period							
Asymptomatic	67	28.4	389	46	456	42.1	<0.01†

	Rural		Urban		Total		p-value
	n	%	n	%	n	%	
Symptomatic	32	13.6	161	19	193	17.8	
AIDS	14	5.9	87	10.3	101	9.3	
Unknown	123	52.1	209	24.7	332	30.7	
ART duration (year)							
1 year	47	19.0	213	26.9	260	25.0	<0.01†
2 – 4 years	91	36.9	354	44.7	445	42.8	
More than 4 years	109	44.1	225	28.4	334	32.2	
Share health status with peers							
Yes	110	43.3	446	52.7	556	50.6	0.01†
No	144	56.7	400	47.3	544	49.5	
Receiving peer support							
Yes	77	29.8	314	35.9	391	34.5	0.07†
No	181	70.2	561	64.1	742	65.5	
Forgetting to take medicine in the last 4 days							
No	243	98	780	97.7	1,023	97.8	0.82†
Yes	5	2	18	2.3	23	2.2	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	
ART Duration (year)	4.0	2.4	3.3	2.1	3.5	2.2	<0.01¶
CD4 cell count	312.5	220.6	289.2	213.4	294.7	215.2	0.08¶
ART adherence (VAS)	94.8	8.2	93.9	11	94.1	10.4	0.55¶

Significance level was p<0.05
†*Chi-square test*
¶*Mann Whitney test*

Self-reported health status

The percentage of urban participants reported having any problem in mobility, self-care, doing usual activities were significantly higher than those of rural participants (p<0.01) (**Table 3**). About 40% of the participants reported suffering from anxiety or depression, and about half of the participants reported suffering from pain or discomfort, with no significant difference between rural and urban participants. The mean EQ-5D-5L index was 0.8 (SD=0.2) and the perceived EQ-VAS score among rural participants was statistically significantly higher than those of urban participants (p<0.01).

Table 3: Health status among participants (n=1133)

	Rural		Urban		Total		p-value
	n	%	n	%	n	%	
Self-reported health problems							
Mobility	33	12.8	199	22.7	232	20.5	<0.01†
Self-care	12	4.7	98	11.2	110	9.7	<0.01†
Usual Activities	26	10.1	162	18.5	188	16.6	<0.01†
Pain or Discomfort	85	33.0	342	39.1	427	37.7	0.07†
Anxiety or Depression	104	40.3	405	46.3	509	44.9	0.09†
Complications and	76	29.5	329	37.6	405	35.8	0.02†

	Rural		Urban		Total		p-value
	n	%	n	%	n	%	
concurrent disease							
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	
EQ-5D-5L index	0.8	0.2	0.8	0.3	0.8	0.2	0.18¶
EQ-VAS	70.1	16.0	68.4	17.6	68.8	17.3	<0.01¶

Significance level was p<0.05
†*Chi-square test*
¶*Mann Whitney test*

Physical activity level

Table 4 shows that 16% percent of the participants were inactive and 68% of participants were HEPA active using the IPAQ. Rural participants reported a statistically higher level of physical activity and IPAQ score compared to urban participants (p=0.03 and p<0.01 respectively). In term of moderate activity, the number of days per week and the mean value of MET-scores from participants living in rural areas were higher than those in urban areas (p<0.01 and p=0.01 respectively). However, the mean MET-scores of vigorous activity and walking activity were similar between two groups.

Table 4: Physical activity levels of participants

	Rural		Urban		Total		p-value
	n	%	n	%	n	%	
Level of physical activity							
Inactive	29	11.3	152	17.4	181	16.0	**0.03**†
Minimally active	37	14.3	144	16.4	181	16.0	
HEPA active	192	74.4	579	66.2	771	68.0	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	
Vigorous activity							
Days per week	1.5	0.2	1.2	0.1	1.3	2.5	0.09¶
Minutes per day	95.4	11.2	81.1	6	84.4	177.6	0.15¶
MET-score	4360.9	555.5	3444.4	282.5	3651.9	8465.9	0.11¶
Moderate activity							
Days per week	5.4	0.2	4.8	0.1	4.9	2.8	**<0.01**¶
Minutes per day	170.2	5.7	155.9	3.3	159.1	96	0.04¶
MET-score	4211.3	165.7	3737.9	92.2	3845.9	2711.1	**0.01**¶
Walking activity							
Days per week	3.4	0.2	3.3	0.1	3.4	3.3	0.67¶
Minutes per day	18.6	1.8	21.8	1.3	21.1	36.8	0.99¶
MET-score	377.1	38.3	451.5	29.3	434.6	816.3	0.87¶
IPAQ Score	8977.9	535.5	7613.5	280.5	7922.9	8333.8	**<0.01**¶

Number of total participants, n= 1133
Significance level was p<0.05
†*Chi-square test and*
¶*Mann Whitney test*

IPAQ score was also found to be differentially associated with ART treatment duration (**Figure 1**). A higher IPAQ score was associated with a shorter antiretroviral therapy (ART) duration, and longer antiretroviral therapy (ART) treatment was associated with a lower IPAQ score. Specifically, the score increased within the first year of ART, plateaued during 2 to 4 years of treatment, and then decreased.

Factors associated with level of activity

Table 5 illustrates that participants were more likely to have a higher IPAQ-score and classified as physically active if they were female, self-employed, blue-collar workers or farmers. Participants who had a higher CD4 cell count, who shared their health status with their peers, and who reported a higher EQ-5D-5L index/EQ-VAS were also more likely to have higher IPAQ score or be physically active. By contrast, a participant with a lower IPAQ-score was associated with living in an urban area and being at the symptomatic stage. In addition, participants who had poor adherence and higher duration of ART were more likely to be physically inactive.

Table 5: Factors associated with levels of physical activity among antiretroviral therapy patients in Vietnam in 2013

	IPAQ-score		Active	
	Coef.	**95 CI**	**OR**	**95 CI**
Gender (Female vs Male)	0.25*	0.11; 0.39	2.53*	1.58; 4.07
Living location (Urban vs Rural)	-0.17*	-0.34; -0.01	0.60	0.35; 1.05
Education attainment (vs Illiterate)				
High school			1.52	0.94; 2.46
Religion (vs Cults of Ancestor)				
Buddhism			2.78	0.73; 10.57
Occupation (vs Unemployed)				
Self-employed	0.60*	0.41; 0.79	2.98*	1.78; 4.99
White-collar workers	0.29	-0.02; 0.59	2.43	0.87; 6.79
Blue-collar worker/farmers	0.73*	0.52; 0.94	2.24*	1.27; 3.95
Others	0.53*	0.22; 0.84	3.28*	1.07; 10.05
EQ-5D index			4.49*	1.68; 12.02
EQ-VAS	0.01*	0.00; 0.01	1.02*	1.00; 1.03
Current CD4 cell count	0.01*	0.00; 0.01	1.02*	1.01; 1.03
ART duration			0.91*	0.82; 0.98
HIV Stages (vs Asymptomatic)				
Symptomatic	-0.20*	-0.38; -0.01		
AIDS			1.81	0.87; 3.79
Forgetting to take medicine in the last 4 days (Yes vs No)			0.26*	0.09; 0.80
Share health status with peers (Yes vs No)	0.26*	0.12; 0.40	1.86*	1.21; 2.84

**p<0.05; OR: Odds Ratio; 95% CI: 95% Confidence Interval*

Discussion

Findings of this study suggest that PLWH in urban areas reported a lower level of physical activity compared to their peer in rural settings. In our study, a majority of ART patients achieved HEPA active in physical activity. By using multivariate regression models, we found a number of sociodemographic, clinical and social factors that are associated with the level of physical activity among PLWH in Vietnam. These results could contribute significantly to the development of interventions aimed to boost the level of physical activity among this population in the future.

Compared to previous studies on ART patients using the IPAQ system, the percentage of inactive (16%) or minimally active (16%) participants in our study was much lower [12 27 29 30]. Most participants reported the highest frequency of moderate activity (playing sport, cycling, cradling baby, etc.), which was different from previous studies' findings that walking was the most preferred physical activity among PLWH [14 30]. These activities can have a positive effect on PLWH by decreasing the side-effects associated with HIV/AIDS and cardio-metabolic complications accompanied with ART treatment [15 49]. However, a number of participants in our study reported having difficulty in mobility which limited their ability to engage in healthy physical activities regardless of living location. With this information, health staff could provide alternative methods of exercising such as passive motion exercise, hydrotherapy or stationary cycling which is found to be just as effective for enhancing functional fitness as active exercise practice [50].

The total physical activity score in rural areas was higher than the score in urban areas in our study, which is consistent with the physical activity level of the general Vietnamese population [35]. There are certain environmental factors in rural areas such as the condition of sidewalks, the availability of exercise equipment and the sedentary behavior in urbanize setting may affect individual's willingness to participate in physical activity [37 51]. At the same time, in Vietnam, the main occupations in rural areas are farming and blue-collar works, in which the rural participants often consider working on the farm or in heavy working conditions as vigorous and moderate physical activities. However, MET-score obtaining by walking activity indicated that this was the least performed physical activity and this did not differ between rural and urban areas. This can be due to factors such as low residential density and long distances between destinations in rural areas that may discourage people from walking [52]. Similarly, in urban settings, walking intensity could be influenced by the presence or lack of pedestrian infrastructure such as sidewalk as well as safety concerns from crime or traffic flow [53].

Our study also found that participants who were unemployed were less likely to be physically active, which concurs with prior findings [54 55]. Unemployed patients are less likely to obtain adequate physical activity because an occupational activity is likely to be included as a component of daily physical activity in adulthood [56-58]. In addition, our study found that female participants were more likely to get a higher level of physical activity. This can be explained by the fact that in the traditional Vietnamese culture, women still have many responsibilities requiring physical movements such as taking care of their children and all household activities, which were mainly classified as moderate physical activity in our study [59 60].

Interestingly, we found that people who reported a higher duration of ART were less likely to be physically active. Notably, this association was found in a non-linear relationship. This is likely because these patients may have had to adapt to a rigorous adherence at the initiation of their treatment, which might have promoted their willingness to involve in physical activities [45 61 62]. However, they might become more complacent when their health status recovered in the latter stages, and less motivated to comply to any strict physical regimen [45 61]. Findings from another study emphasized the role of age in the relationships between the advanced stages HIV disease and worsen physical function [24]. As prolonged ART treatment has been positively associated with an accelerated aging process, age-related comorbidity may reduce the patient's level of physical activity intensity [24]. However, in this study, the influence of age to the level of physical activity was not statistically significant since it was dropped out of multivariate regression model. We also observed that non-adherence to ART was associated with a physically inactive status. Other studies also revealed that a low level of physical activity has been found to be significantly related to a low antiretroviral medication adherence [61 63]. This finding can be explained by the fact that engaging in physical activity can reduce depressive symptomatology which may lead to a more optimal ART adherence [63].

In this study, we combined both EQ-5D-5L and EQ-VAS instruments due to the variation of health utility scores based on different instruments [64]. EQ-VAS is a self-reported instrument that directly assesses the perceived health status of patients in the short-term. Meanwhile, the EQ-5D index is composited by five domains that indirectly measures the quality of life in the long-term [65]. In the short-term, the patient's hope for improving their health condition might influence their perceived health status. On the other hand, in the long-term, because of the acclimation with their health status, the patient tends to report quality of life more accurately [64]. In term of health status, participants who reported a higher quality of life and a higher number of CD4 cell count also had a higher IPAQ score, while participants at symptomatic stage had a lower IPAQ score compared to those at the asymptomatic stage. We supposed that engaging in physical activity would help patients improve and maintain their strength and quality of life. Two systemic reviews by O'Brien et al. in 2016 and 2017 found that exercises including aerobic and resistive or a combination of both performed at least three times per week for at least five weeks may lead to improvements in cardiopulmonary fitness, strength, weight and body composition and quality of life among PLWH who are medically stable. [66 67].

Our current study suggested that participants who shared their health status with their peers were more likely to have higher IPAQ scores. The association between peer supports and physical activity was investigated by Jerome et al (2012) which found that peer support was an important determinant to assist patients in adherence to exercise programs [68]. Additionally, WHO, PEPFAR, and Global Fund have proposed that social support should be considered as an effective adjunct in improving physical health among PLWH receiving ART treatment [69 70]. As PLWH were more vulnerable and withdrawn from social situations [71], peer support can have a positive effect on patients' health through sharing relevant personal experiences to acquire knowledge, reduce stigma and discrimination, improve physical functioning, and enhance retention in ART treatment [72-74].

Several implications can be drawn from this study. First, providing different physical activity strategies based on rural and urban settings is necessary to improve the health status of PLWH in these areas. For example, health staff in urban clinics may organize some outdoor activities via peer educators/groups to engage urban patients in physical activity. Second, job opportunities and vocational training should be prioritized to promote physically active among ART patients [54 55]. Third, the reduction in IPAQ score observed in prolonged ART duration suggests that physical health assessments and appropriate physical activity programs such as resistance training and aerobic exercises should be in place. Additionally, passive motion exercises should be considered for immobilized patients or those who had difficulty in mobility or physical impairments [50]. Fourth, given the association between the level of physical activity and ART treatment status from our findings, integrative intervention including physical activity, ART medication adherence and health-related quality of life may prove to be efficient and cost-effective [63]. Finally, programs promoting social support, especially among peers should be prioritized to enable HIV patients to share their experiences that motivate others to be involved in physical activity [68]. Furthermore, peer support groups integration into assigned health facilities would be useful to patients who are at the initial ART medication stage.

The strengths of this study included the large sample size of HIV-infected patients receiving antiretroviral therapy treatment, which increased the statistic power of the result. Additionally, we recruited participants from different levels of the health systems (central, provincial and district ART clinics) in both rural and urban areas, which made the sample more representative of the general Vietnamese population. We also employed international instruments such as IPAQ and EQ-5D-5L, which would help increase the comparability between our results and other global studies.

However, several limitations should be acknowledged. First, a convenience sampling technique was used, which may limit the generalizability of our findings to other settings and patient populations. Second, because collected data were based on self-reported information, it is susceptible to be influenced by interviewers, social desirability and recall bias. To minimize these biases, interviewers affiliated with selected health centers were excluded from the study and patients were given clear instructions on the benefits and drawbacks of the study. Thirdly, the causal inferences could not be established due to the cross-sectional design. Finally, some barriers to physically active such as social factors (stigma, discrimination), family support or clinical settings (healthcare providers) were not fully addressed in this study, warranting further research to elucidate these gaps.

Conclusion

In conclusion, findings from this study provided many suggestions for potential health behavior interventions to improve the level of physical activity for HIV patients receiving ART in rural and urban Vietnam. Health care providers should consider developing peer support and job guidance programs for PLWH as they have great potentials to increase PLWH's level of physical activity, quality of life, and overall health status. Furthermore, future studies of a similar population in different settings (coastal, mountainside, ect) are needed to confirm the positive association between high level of physical activity and ART adherence.

LIST OF ABBREVIATION

ART: Antiretroviral Therapy
PLWH: People Living With HIV
WHO: World Health Organization
PEPFAR: President's Emergency Plan for AIDS Relief

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Authors' Contributions

AKD, LHN, AQN, BXT, TTT, CAL, MWBZ, RCMH conceived of the study, and participated in its design and implementation and wrote the manuscript. AKD, LHN, BXT, analysed the data. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

Data sharing statement

The data that support the findings of this study are available from the Vietnam Authority of HIV/AIDS Control but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of the Vietnam Authority of HIV/AIDS Control.

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Figure 1. Physical activity among antiretroviral therapy (ART) patients regarding ART duration.

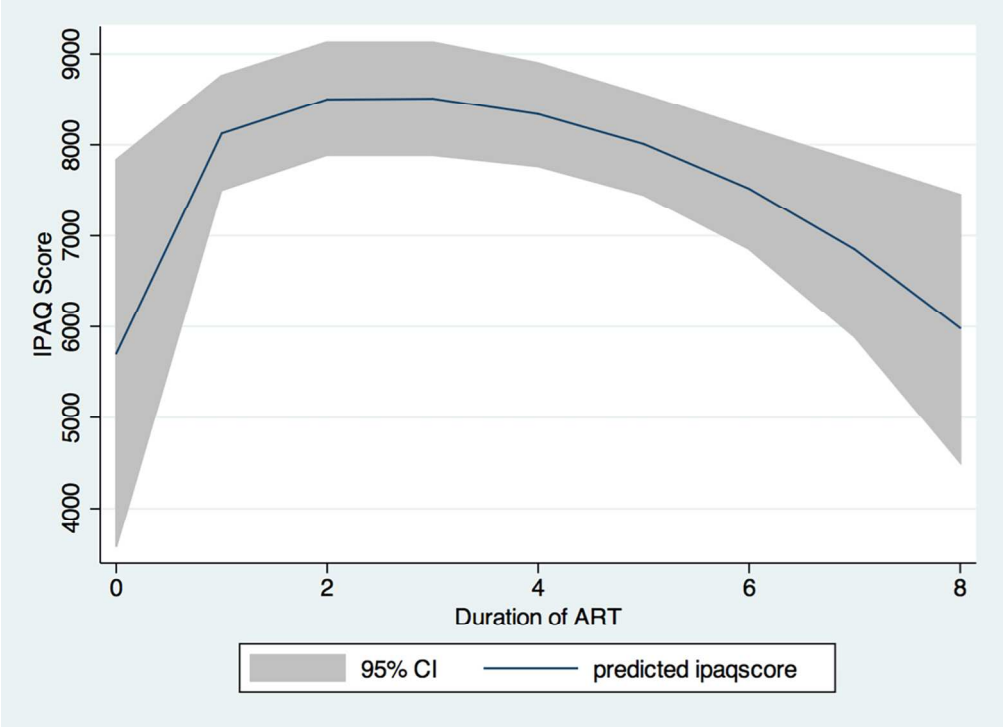

Figure 1. Physical activity among antiretroviral therapy (ART) patients regarding ART duration

137x99mm (300 x 300 DPI)

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Page	Recommendation
Title and abstract	1	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		2	(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction			
Background/rationale	2	4,5	Explain the scientific background and rationale for the investigation being reported
Objectives	3	5	State specific objectives, including any prespecified hypotheses
Methods			
Study design	4	5	Present key elements of study design early in the paper
Setting	5	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	5	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
			(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	6,7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	6,7	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	7	Describe any efforts to address potential sources of bias
Study size	10	6	Explain how the study size was arrived at
Quantitative variables	11	6,7	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	2	7	(*a*) Describe all statistical methods, including those used to control for confounding
		7	(*b*) Describe any methods used to examine subgroups and interactions
		7	(*c*) Explain how missing data were addressed
			(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
			(*e*) Describe any sensitivity analyses

	Item No	Page	Recommendation
Results			
Participants	13*	8	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
			(b) Give reasons for non-participation at each stage
			(c) Consider use of a flow diagram
Descriptive data	14*	8-11	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		7	(b) Indicate number of participants with missing data for each variable of interest
			(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*		*Cohort study*—Report numbers of outcome events or summary measures over time
			Case-control study—Report numbers in each exposure category, or summary measures of exposure
		7	*Cross-sectional study*—Report numbers of outcome events or summary measures
Main results	16	7, 8,9,10	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
			(*b*) Report category boundaries when continuous variables were categorized
			(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17		Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion			
Key results	18	9	Summarise key results with reference to study objectives
Limitations	19	14	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	12, 13, 14	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	14	Discuss the generalisability (external validity) of the study results
Other information			
Funding	22	none	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.