Implications for Rehabilitation

- Many people living with HIV do not comply with general health recommendations.
- Physical activity counselling should be key in the rehabilitation of people living with HIV.

Global Physical Activity Levels Among People Living with HIV: A Systematic Review and Meta-analysis

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Running Head: Physical Activity Levels in HIV

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Abstract

Purpose: It is unclear how much physical activity people living with HIV (PLWH) engage in. We conducted a meta-analysis to investigate physical activity levels and its predictors in PLWH.

Methods: PubMed, PsycARTICLES and CINAHL Plus were searched by 2 independent reviewers from inception till April 1st 2016 using the keywords: 'HIV' OR 'AIDS' AND 'physical activity' OR 'exercise' OR 'sports'. A random effects meta-analysis was conducted.

Results: Across 24 studies including 34 physical activity levels there were 3,780 (2,471♂) PLWH (mean age range: 37-58 years). PLWH spent 98.9 (95%CI=64.8-133.1) minutes per day being physically active which is lower than in most other populations with chronic diseases. 50.7% (95%CI=39.3-62%) (n=2,052) of PLWH complied with the physical activity guidelines of 150 min moderate intensity physical activity per week. The number of steps walked per day in 252 PLWH was 5899 (95%CI=5678-6418), which is below the 10,000 steps per day recommendation.

Conclusions: Our data demonstrate that a considerable proportion of PLWH are insufficiently physically active. Future lifestyle interventions specifically targeting the prevention of physical inactivity in PLWH are warranted.

Keywords: Exercise; Physical Activity; HIV; AIDS

Introduction

People living with HIV (PLWH) have higher levels of morbidity and mortality than the general population. The non-AIDS related mortality rates are largely attributable to cardiovascular disease [1]. In the general population there is evidence that physical activity and exercise are broadly as effective as pharmacological interventions in preventing cardiovascular disease and premature mortality [2]. In the last decade, several systematic reviews and/or meta-analyses [3-8] have considered physical activity as a therapeutic intervention concluding that it improves the body composition, muscle strength, aerobic fitness, and quality of life.

Despite the benefits of an active lifestyle, PLWH experience a range of barriers towards engaging in physical activity, such as side-effects of antiviral therapy, depression, bodily pain, and the presence of opportunistic infections [9]. Facilitators of physical activity include a higher cardiorespiratory fitness level, a higher self-efficacy, perceived benefits and greater motivation towards health improvement [9]. Given that an active lifestyle is related to lower cardiovascular disease risk, understanding physical activity levels among PLWH is critical to improving long-term health outcomes [10].

Moreover, several important questions regarding the relationship between physical activity and HIV/AIDS remain unanswered. For instance, the exact levels of physical activity among PLWH has yet to be established. A systematic review of Schuelter-Trevisol and colleagues in 2012 indicated that there was too much heterogeneity in physical activity assessment and too limited data were available to make any firm conclusions [11]. It might be hypothesized that since 2012 a considerable number of papers have been published on physical activity levels in PLWH.

Along with obtaining an accurate estimate of the levels of PA among PLWH, understanding predictors of PA in this patient group is also of relevance for improving clinical practice, while providing a platform for future research endeavors. Next to this, it is of interest to explore whether geographical differences and differences between settings (e.g., outpatients, inpatients and community patients) in physical activity exist, as such differences might help researchers and clinicians to identify specific environmental factors (e.g. differences in health-related policies, available facilities, other lifestyle factors etc.) which may influence PA. Demographical predictors (age, gender, ethnicity, presence of co-morbidity, etc.) may also identify those at a higher risk for lower physical activity participation. In

addition, it remains unclear if PLWH engage in more or less physical activity compared to the healthy population.

In order to address the current gaps in the literature, the primary aims of this systematic review and meta-analysis were to establish: (a) the pooled mean time spent physically active (light, moderate and vigorous and total physical activity, and number of steps per day), (b) the pooled percentage of people assigned to the low, moderate or highly physically active groups as defined by the widely used International Physical Activity Questionnaire (IPAQ)[12], (c) the pooled percentage of people complying with the general health recommendation of at least 150min of moderate intensity physical activity per week, and (d) the pooled physical activity levels expressed as metabolic equivalent (MET) minutes per week taking into account established MET values for each activity level (i.e., walking: 3.3; moderate: 4.0; vigorous: 8.0). The secondary aims were to investigate predictors of physical activity using meta-regression analyses, and to explore differences in physical activity in PLWH versus the healthy population.

Methods

This systematic review adhered to the MOOSE guidelines [13] and PRISMA statement [14].

Inclusion Criteria

We included studies that: (a) involved only adult participants (≥18 years) with a diagnosis of HIV/AIDS. (b) Measured physical activity using either a subjective questionnaire (e.g. International Physical Activity Questionnaire (IPAQ)[12]) or objective measure (e.g. accelerometer). Physical activity was defined as any interventions that use bodily movement produced by skeletal muscles and which requires energy expenditure[15]. (c) Were interventional (randomized controlled trials (RCTs), clinical controlled trials (CCTs)) or observational (prospective or cross-sectional) studies conducted in any setting (inpatients or outpatients). For prospective and interventional studies only the baseline data were included. (d) Were published in an international peer-reviewed journal.

Exclusion Criteria

Exclusion criteria were: (a) non-quantitative studies, (b) not including PLWH, and (c) no adequate measure of physical activity (see outcomes), (d) studies limited to or excluding PLWH with chronic co-morbidities (e.g. cardiovascular diseases, cancer, liver diseases, etc.), and (e) studies limited to drug users.

Search Strategy

Two independent authors (DV and BS) searched PubMed, PsycARTICLES and CINAHL Plus without language restrictions from inception till April 1st 2016, using the keywords: 'HIV' OR 'AIDS' AND 'physical activity' OR 'exercise' OR 'sports'. In addition, reference lists of all eligible articles and related systematic reviews were screened to identify potentially eligible articles.

Study Selection

After removal of duplicates, two independent reviewers (DV and BS) screened titles and abstracts of all potentially eligible articles and a final list of included articles was reached through consensus. A third reviewer (JM) was available for mediation throughout this process.

Outcomes

The primary outcome was the mean time (minutes) per day that PLWH engaged in physical activity. We collected separate data for light, moderate and vigorous intensity and total physical activity if these data were reported. Next to this, the percentage of people assigned to the low, moderate or highly physically active groups as defined by the widely used International Physical Activity Questionnaire [12] were pooled. Extracted as well were the percentage of people complying with the general health recommendation of at least 150min of moderate intensity physical activity per week and physical activity levels expressed as metabolic equivalent (MET) minutes per week taking into account established MET values for each activity level (i.e., walking: 3.3; moderate: 4.0; vigorous: 8.0). Finally, we also collected data on physical activity behavior among healthy controls (where reported).

Data Extraction

One author (DV) extracted data using a predetermined data extraction form, which was subsequently validated by a second author (BS). The data extracted included first author, geographical region, setting, participants included in the article (including mean age, % male, % White, % employed, mean HIV duration, mean body mass index, mean oxygen uptake, mean CD4+ count, mean HIV viral load, % with diabetes, % smoking), physical activity assessment method (objective or self-report), and the primary outcomes.

Meta-analysis

Due to the anticipated heterogeneity across studies, we conducted a random effects meta-analysis with Comprehensive Meta-Analysis software (CMA, Version 3). The meta-analysis was conducted in the following sequence. First, we calculated the mean amount of time (total and at light, moderate and high intensity) and median total time spent in physical activity per day together with the 95% confidence intervals (CI). Second, we calculated pooled percentage of people assigned to the low, moderate or highly physically active groups and the percentage of people complying with the general

health recommendations and physical activity levels expressed as metabolic equivalent MET minutes per week and where possible, also according to the measurement (self-report versus objective measurement). Third, we investigated potential moderators of physical activity behavior in PLWH with meta-regression analyses. The potential moderators of interest were geographical location (North-America, South-America, Africa, Asia, Europe, Australia), setting (inpatients, outpatients, community patients, mixed settings), mean age (years), % male, % White, % employed, mean HIV duration (years), mean body mass index (kg/m^2), mean oxygen uptake (ml/min/kg), mean CD4+ count (cells/mm^3), mean HIV viral load (log 10 copies/mL), % with diabetes, % smoking), and physical activity assessment method (objective vs self-report). Fourth, we conducted a comparative meta-analysis investigating differences in physical activity levels with healthy controls calculating Hedges' g and the 95% CI as the effect size. In addition, we calculated the mean difference in minutes per day together with the 95% CI in levels of physical activity behavior. Heterogeneity was assessed with the I^2 statistics for each analysis [16]. Publication bias was assessed with the Begg-Mazumdar Kendall's tau [17]. For all analyses we calculated the trim and fill adjusted analysis [18] to remove the most extreme small studies from the positive side of the funnel plot, and recalculated the effect size at each iteration, until the funnel plot was symmetric about the (new) effect size.

Results

Search Results

The initial search yielded 13,340 results. After removal of duplicates and exclusion at the title/ abstract level, 74 abstracts were retrieved in full. At the full text review stage, 64 articles were considered and 40 were subsequently excluded (see figure 1 for search results). Full details of the 24 [19-42] included studies are summarized in table 1.

Insert figure 1 about here

Study and Participants' Characteristics

Except for one randomized controlled trial [28], all studies were cross-sectional. Ten studies reported physical activity levels for 2 subgroups, e.g. for men and women separately. Across the 24 unique studies, including 34 physical activity levels, there were 3,780 (2,471♂) PLWH. The mean age ranged from 37 to 58 years. The sample size ranged from 10 to 628. Fifteen physical activity levels were assessed in North-America, 6 in South-America, 6 in Africa, 3 in Europe, 2 in Asia (China) and 2 in Australia. Sixteen physical activity levels were assessed in an outpatient setting, 2 in an inpatient setting, and 14 in a community setting. Of studies reporting data, the % of White ethnicity ranged from 0 to 91.9% (N=8), the mean body mass index (BMI) from 22.9 to 36.6 (N=16), the cardiorespiratory fitness (maximal oxygen uptake) from 26.8 to 34.2 l/min/kg (N=3), the CD4+ count from 256 to 597 cells/mm^3 (N=18), the viral load from 1.6 to 4.4 log 10 copies/mL (N=6), the HIV duration from 3.9 to 18.0 years (N=13), the % of people with diabetes from 0% to 26% (N=8), and the % of people smoking from 0% to 66% (N=13). Three studies reported general population control data. In total 695 (663♂) PLWH (mean age=47.5 years) were compared with 773 (743♂) age- and gender matched controls (mean age=49.9 years). Demographical and clinical data of the 24 studies including 34 physical activity levels are summarized in table 1, physical activity outcomes in table 2.

Insert table 1 about here

Insert table 2 about here

Meta-analysis of the Time Spent Physically Active

Results of the meta-analyses are summarized below. Full details are presented in table 3. Three studies [39,40,42] including 4 physical activity levels reported the total time spent physically active across 144 PLWH. The total time spent physically active was 98.9 (95% CI= 64.8-133.1) minutes per day (after trim-and-fill adjustment). When looking at the different physical activity intensities, only 1 study (n=65) [34] provided data on the time spent in vigorous physical activity, reporting a mean of 10±1 minutes of vigorous PA per day in PLWH. Three studies [24,26,34] including 4 physical activity levels (n=171) found that PLWH engaged in a mean of 61.7 minutes per day (95% CI= 48.8-74.7) (after trim-and-fill adjustment) of moderate intensity physical activity. Also 3 studies (n=108) provided data on the time spent in light physical activity. Two studies [34,37] including 3 physical activity levels (n=95) showed that PLWH spent a mean of 72.8 (95% CI= 34.9-110.7) minutes per day in light physical activity. Trim- and fill adjustment did not affect the estimate for light physical activity.

Insert table 3 about here

Meta-analysis of the Number of Steps per Day

Four studies [19,26,28,36] including 7 physical activity levels reported the total number of steps walked per day in 202 PLWH (see Table 2). The trim-and fill adjusted number of steps per day was 5899 (95%CI=5678-6418).

Subgroup Analyses

Due to limited data, only geographical differences could be explored in subgroup analyses.Table 3 shows that the number of steps walked per day in North-American studies was not significantly different than in European studies (P=0.49).

Meta-regression Analyses

Separate single meta-regression analyses (see table 4) revealed that the number of steps walked per day was not moderated by gender (% male), body mass index and % of people with diabetes. In contrast, older age moderated a lower number of steps walked per day (β=-66.7, standard error (SE)=34.1, p=0.049; r^2=0.57).

Insert table 4 about here

Meta-analysis of the % of People Assigned to the Low, Moderate or Highly Physically Active IPAQ Groups

In total 5 studies [21-24,35] including 6 physical activity levels and involving 1,187 PLWH assigned participants to a category following the IPAQ recommendations: 31.9% (95% CI= 24.9-39.7%) was assigned to the 'low physical activity' category, 33% (95% CI= 26.2-40.7%) to the 'moderately physically active' category and 32.9% (95% CI= 23.4-44.0%) to the 'highly physically active' category.

Subgroup Analyses

As can be noticed in Table 3, there were significant geographical differences, as well as significant differences between settings. Globally, more patients were assigned to the lower IPAQ category ($P<0.001$) and less to the highly physically active IPAQ category ($P<0.001$) in South-American participants, while significantly more community patients were assigned to the highly physically active IPAQ category compared with outpatients ($P<0.001$).

Meta-regression Analyses

Separate single meta-regression analyses revealed that assignment to any IPAQ category was not moderated by gender (% male) and ethnicity (% White). In contrast, a higher mean age at study level moderated a lower assignment percentage to the moderately physically active group ($\beta=-0.05$, standard error (SE)=0.01, $p<0.001$; $r^2=1.0$). There was a trend-level association for older age with lower assignment percentage to the highly physically active group ($\beta=0.05$, standard error (SE)=0.03, $p=0.054$; $r^2=0.35$).

Meta-analysis of the Physical Activity Levels Expressed as Metabolic Equivalent (MET) Minutes per Week

There were insufficient data to pool and meta-analyze the data (N=1). The mean MET minutes per week was 1666.0.

Meta-analysis of the % of People Complying with the Guidelines

Within 9 studies [7,20,29-32,34,38,41] including 13 physical activity levels and involving 2,052 PLWH, 50.7% (95% CI=39.3-62%) complied with the physical activity guidelines by achieving ≥150 minutes of activity per week.

Subgroup Analyses

There was no difference in compliance with PA guidelines between different settings, geographical regions and assessment methods. Details can be found in table 3.

Meta-regression Analyses

Separate single meta-regression analyses revealed that age, gender and physical activity assessment method did not moderate the percentage of people adhering to the physical activity guidelines (see table 4).

Differences with Age- and Gender Matched General Population Controls

There were insufficient data to explore differences in physical activity behavior between PLWH and controls.

Discussion

General Findings

The current study is, to our knowledge, the first to meta-analyze physical activity levels and its predictors in PLWH. We found that PLWH spent 98.9 (95% CI= 64.8-133.1) minutes per day being physically active. When looking at the different physical activity intensities, PLWH spent a mean of 72.8 (95% CI= 34.9-110.7) minutes per day in light physical activity, 61 (95% CI= 47.1-76.0) minutes per day in moderate intensity and 12.4 minutes per day in vigorous physical activity. Due to lack of data, we were not able to compare these levels with age- and gender matched healthy controls. However, previous similar meta-analyses in other vulnerable populations demonstrated higher (or similar) levels of physical activity. For example, a meta-analysis [43] of 6 studies involving 279 (129♂) people with bipolar disorder (mean age=43.9 years; range: 32.0-51.5 years) demonstrated that people with established bipolar disorder spent in total 210.1 min (95%CI=146.3 to 273.9 min) per day being physically active. In another meta-analysis[44] of 35 studies representing 3,453 individuals with established schizophrenia (40.0 years; 64.0% male), engagement in light physical activity was 80.44 minutes, in moderate-vigorous physical activity 47.1 minutes and in vigorous physical activity 2 minutes per day. Our meta-analysis also showed that around half, i.e. 50.7% (95%CI=39.3-62%) of PLWH are complying with the physical activity guidelines of at least 150 min of moderate physical activity per week. When looking at the number of steps per day, PLWH walk 5798 (95%CI=5640-6212) steps which is below the general health recommendation of 10,000 [45].

Knowledge about predictors of physical activity levels helps identifying high-risk persons in whom physical activity participation is reduced, and therefore may require more intense and targeted interventions. Our data indicate, albeit inconsistently, that across the different physical activity outcomes there are geographical differences. More research is however needed to clarify these differences and for example the role of different health policies on the level of physical activity in PLWH between different countries. Also differences between settings were inconsistent. The percentage of people assigned to the highly physically active IPAQ group was higher in community versus outpatients. A possible reason might be that outpatients might have more severe physical or

psychiatric co-morbidities than community patients (who are not necessarily currently connected with a care setting). The lack of differences with inpatients might be due to the inclusion of physical activity interventions in the multidisciplinary inpatient care [46]. Meta-regression analyses demonstrated that a higher mean age at study level predicted lower levels of physical activity (e.g., number of steps per day), a relationship also seen in the general population [47]. These data point towards the need of considering in particular the lower levels of physical activity in older people with HIV. A previous 12-month randomized study of an education and home-based pedometer walking program in 84 older PLWH [28] demonstrated that such a program improves physical activity levels, and reduces the presence and severity of cardiovascular risk factors. For example, compared with controls, those in the walking intervention had better 6-minute walk test distance score (P=0.01), a more beneficial waist to hip ratio (P<0.001), lower blood glucose (P=0.001), and higher high-density lipoprotein (P= 0.01) levels over the 12-month period.

There were too limited data to explore whether moderate to vigorous physical activity as assessed by objective measures differed with self-report measures. Future research should explore whether the current physical activity questionnaires do accurately collate data on physical activity behavior in PLWH or whether they over- or underestimate physical activity participation in this at risk group. It might be hypothesized that cognitive deficits associated with PLWH may for example lead to recall bias and for example an overestimation within self-report measures. Since the introduction of combination antiretroviral therapy, the incidence of severe forms of HIV-associated neurocognitive impairment has declined significantly [29]. However, the prevalence of the milder forms which might influence recall of physical activity behaviors has increased [48]. Also, significant psychological distress and depression, which are more prevalent among PLWH [49], may influence the ability to accurately respond to self-report questionnaires.

Limitations

Several limitations of this meta-analysis should be noted. Firstly, half of the included studies relied on data drawn from subjective rather than from objective assessment methods. Secondly, in the main analyses, we encountered high levels of heterogeneity. Whilst such heterogeneity is expected when combining observational data, this is a consideration when these main analyses are reviewed in isolation. However, we follow the MOOSE guidelines [13] to address this heterogeneity and we are

able to explain large portions of the heterogeneity with our subgroup and meta-regression analyses. In particular, it appears that age among participants explained over half of the heterogeneity observed (R^2=0.57). Third, due to the relative paucity of data, some of the subgroup analyses (e.g., IPAQ categories) had relatively low numbers of studies. Therefore, some caution should be attached to such results and clearly future research is required to better understand such relationships. It is also important that future research should seek to investigate physical activity behavior in this vulnerable population compared with well-matched (age, gender and BMI) healthy controls. Finally, there was inadequate information on other lifestyle factors (such as smoking), side effects of antiviral therapy, immunity parameters and physical and psychiatric co-morbidities, thus precluding rigorous meta-analytical or meta-regression analyses. Future research is required to understand the impact of these clinical parameters on physical activity behavior in this population. Nevertheless, allowing for these caveats, the results provide important information for clinicians and researchers.

In conclusion, our data show that a considerable proportion of PLWH are insufficiently physically active. Given that physical activity is an independent predictor of cardiovascular disease (a major contributing factor towards premature mortality in PLWH), future lifestyle interventions specifically targeting the prevention of physical inactivity in PLWH are warranted.

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Conflict of Interest

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Figure 1 Flow Diagram for the Search Results

Table 1. Demographical and Clinical Data of the Included Studies

Author	Sample size	Region	Setting	Assessment methods	Mean age	Gender (% male)	Ethnicity (% White)	Employed (%)	BMI	Infection years	Diabetes (%)	Smoker (%)	Viral load	CD4+ current	VO2 peak/max
Rehm 2016 [19]	50	1	1	2	42	0			36.6						
Dirajlal-Fargo 2015 (rosuvastine group) [20]	72	1	2	2	46	81			27	11					
Dirajlal-Fargo 2015 (placebo group) [20]	75	1	2	2	46	76			27	12					
Fazeli 2015 [21]	100	1	3	2	58.2	88	82			18	26			597	
Monroe 2015 [22]	596	1	3	2	51	100	54	55	25.3		13	30		591	
Hsieh 2014 (men) [23]	170	4	2	2	38.2	100	0			3.9					
Hsieh 2014 (women) [23]	56	4	2	2	39.3	0	0			4					
Jaggers 2014 [25]	63	1	1	1	48	49.2			30.4		14.3				
Della Justina 2014 [24]	74	2	2	2	44.3	60.8	91.9					46	2.2	491	
Ramírez-Marrero 2014 (HIV Lipo) [26]	32	1	3	1	50.3	40.6	0		29		25	55			26.8
Ramírez-Marrero 2014 (HIV non- Lipo) [26]	28	1	3	1	48.1	53.6	0		26.4		0	19			32.2
Raso 2014 [27]	39	2	2	2	40.6	100			24.8				4.4	521	34.2
Roos 2014 (intervention group) [28]	42	3	3	1	38.7	16.7		45.2			0	9.5		340	
Roos 2014 (control group) [28]	42	3	3	1	39.4	26.2		61.9			2.4	11.9	2.8	347	
Edward 2013 (men) [29]	86	3	2	2	41.7	100		3.5	22.9	15.9	5.8	4.7		253	
Edward 2013 (women) [29]	179	3	2	2	37.2	0		3.9	23.6	18	6.7	0.6		362	
Segatto 2011 [30]	42	2	2	2		54.8									
Muronya 2011 (men) [31]	67	3	2	2	43.3	100						1.5			
Muronya 2011 (women) [31]	107	3	2	2	37	0						0			
Schuelter-Trevisol 2010 (men) [32]	628	2	2	2	39.5	100			24.4	5.2		66		368	
Schuelter-Trevisol 2010 (women) [32]	612	2	2	2	37.7	0			25.4	4.6		60.8		383	
Fillipas 2010 [33]	30	6	1	1	53.2	100			25.6	13.4					
Allard 2008 [34]	65	1		2	47	100			26.5	11.4		26.2		487	
Fillipas 2008 [35]	191	6	1	2	43.9	92.7									

Table 1. Continued

Author	Sample size	Region	Setting	Assessment method	Mean age	Gender (% male)	Ethnicity (% White)	Employed (%)	BMI	Infection years	Diabetes (%)	Smoker (%)	Viral load	CD4+ current	VO2 peak/max
Ramírez-Marrero 2008 (men) [36]	35	1	3	1	45.9	1			25.6						
Ramírez-Marrero 2008 (women) [36]	23	1	3	1	47.3	0			28.7						
Sutinen 2007 (lipodystrophy) [37]	30	5	2	2	43	83				8.2			1.87	572	
Sutinen 2007 (non-lipodystrophy) [37]	13	5	2	2	39	69				8.6			1.65	516	
de Lima Eidam 2006 [38]	11	2	2	2	37	61.3		47.8						345	
Clingerman 2003 [41]	78	1	3	2	40.4	90		61.5	24.2					386	
Bopp 2004 [39]	66	1	3	1	39	100	5						3.8	412	
Ramírez-Marrero 2004 (men) [40]	43	1	3	2	40.4	100								343	
Ramírez-Marrero 2004 (women) [40]	25	1	3	2	40.4	0								256	
Paton 1996 [42]	10	5		2	33.5	100									

Region: 1=North-America. 2=South-America. 3=Africa. 4=Asia. 5=Europe. 6=Australia; setting: 1=inpatients. 2=outpatients. 3=community patients; Assessment method: 1=objective assessment (accelerometers. pedometers). 2= self-report; age expressed in years; BMI=body mass index. viral load expressed in log 10 copies/mL.mean CD4+ count expressed in cells/mm³. VO2= mean oxygen uptake expressed in ml/min/kg.

Table 2. Physical Activity Outcomes of the Included Studies

Author	Light PA	Moderate PA	Vigorous PA	Total PA	Total MET minutes / day	Steps	IPAQ (low %)	IPAQ (moderate %)	IPAQ (high %)	Complying with guidelines
Rehm 2016[19]						7234±3075				
Dirajlal-Fargo 2015 (rosuvastine group) [20]										24
Dirajlal-Fargo 2015 (placebo group) [20]										24
Fazeli 2015 [21]							33	20	47	
Monroe 2015 [22]							25	26	49	
Hsieh 2014 (men) [23]							30	42	28	
Hsieh 2014 (women) [23]							29	45	27	
Della Justina 2014 [24]							55	38	7	
Jaggers 2014 [25]		88±87								
Ramírez-Marrero 2014 (HIV Lipo) [26]		59±14				6602±414				
Ramírez-Marrero 2014 (HIV non- Lipo) [26]		82±32				6759±509				
Raso 2014 [27]					1666±144					
Roos 2014 (intervention group) [28]						6888±2926				
Roos 2014 (control group) [28]						8103±5396				
Edward 2013 (men) [29]										31
Edward 2013 (women) [29]										35
Segatto 2011 [30]										55
Muronya 2011 (men) [31]										75
Muronya 2011 (women) [31]										72
Schuelter-Trevisol 2010 (men) [32]										35
Schuelter-Trevisol 2010 (women) [32]										65
Fillipas 2010 [33]										30

Table 2. Continued

Author	Light PA	Moderate PA	Vigorous PA	Total PA	Total MET minutes / day	Steps	IPAQ (low)	IPAQ (moderate)	IPAQ (high)	Complying with guidelines
Allard 2008 [34]	110±20	47±10	10±1							85
Fillipas 2008 [35]							26	33	41	
Ramírez-Marrero 2008 (men) [36]						7495±2540				
Ramírez-Marrero 2008 (women) [36]						7886±2662				
Sutinen 2007 (lipodystrophy) [37]	59±7									
Sutinen 2007 (non-lipodystrophy) [37]	49±20									
de Lima Eidam 2006 [38]										77
Clingerman 2003 [41]										60
Bopp 2004 [39]				144±31						
Ramírez-Marrero 2004 (men) [40]				72±60						
Ramírez-Marrero 2004 (women) [40]				72±42						
Paton 1996 [42]				80±10						

PA= physical activity; light, moderate and high intensity physical activity are expressed in minutes per day; MET= metabolic equivalents, steps= number per day, IPAQ=International Physical Activity Questionnaire expressed as % assigned to the low, moderate or high physically active group: Low=meets neither 'moderate' nor 'high' criteria, moderate=meets any of the following three criteria: (a) 3 days of vigorous activity of at least 20 minutes/day; (b) 5 days of moderate-intensity activity or walking of > 30 minutes/day for > 10 minutes at a time; or (c) 5 days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving at least 600 MET-minutes/week, high=meets either of two criteria: (a) vigorous-intensity activity on > 3 days/week and accumulating at least 1500 MET-minutes/week; or (b) >5 days of any combination of walking, moderate-intensity, or vigorous-intensity activities achieving at least 3000 MET-minutes/week; complying with guidelines= expressed as percentage complying with at least 150min of physical activity at moderate intensity per week.

Table 3. Meta-analytic Results of Physical Activity Participation in People Living with HIV

Analysis	N studies	N participants	Meta-analysis Point estimate	95%CI		I²	Kendall's tau	Trim and fill adjusted ES
Main analyses								
Light intensity PA (min/day)	3	108	72.8	34.9	110.7	99.4%	0.33 P=0.60	72.8 (34.9-110.7)
Moderate intensity PA (min/day)	4	171	66.5	52.4	80.7	95.0%	0.33 P=0.50	61.7 (48.8-74.7)
Total PA (min/day)	4	144	92.4	52.4	132.3	98.4%	0.33 P=0.50	98.9 (64.8-133.1)
Steps (number/day)	7	252	6914	6637	7191	59.1%	0.60 P=0.10	5899 (5678-6418)
IPAQ low category (%)	6	1,187	31.9	24.9	39.7	82.8%	0.60 P=0.10	36.2 (27.6-45.9)
IPAQ moderate category (%)	6	1,187	33.0	26.2	40.7	82.2%	0.33 P=0.35	Unchanged
IPAQ high category (%)	6	1,187	32.9	23.4	44.0	91.0%	-0.60 P=0.10	28.3 (16.5-44.0)
Complying with guidelines (%)	13	2,052	50.7	39.3	62.0	94.9%	0.10 P=0.62	Unchanged

Analysis	N studies	N participants	Meta-analysis Point estimate	95%CI		I²	P
Subgroup analyses							
-Steps (number/day)							
• Geographical region							0.49
- North-America	5	168	6681	6588	7172	65.7%	
- South-America	2	84	7204	6341	8067	39.2%	
-IPAQ low category (%)							
• Geographical region							<0.001*
- North America	2	696	27.2	22.3	32.6	64.4%	
- South-America	1	74	55.4	42.5	67.6	0%	
- Asia	2	226	29.6	22.9	37.2	0%	
- Australia	1	191	25.6	18.7	34.1	0%	
• Setting							0.51
- Inpatients	1	191	25.6	11.9	46.8	0%	
- Outpatients	3	300	37.4	25.2	51.5	87.0%	
- Community patients	2	696	28.5	17.1	43.6	64.4%	

Table 3. Continued

Analysis	N studies	N participants	Meta-analysis Point estimate	95%CI		I²	P
- IPAQ moderate category (%)							
• Geographical region							<0.001*
- North America	2	696	25.2	22.1	28.6	38.6%	
- South-America	1	74	37.8	27.6	49.3	0%	
- Asia	2	226	42.5	36.2	49.0	0%	
- Australia	1	191	33.0	26.7	40.0	0%	
• Setting							<0.001*
- Inpatients	1	191	33.0	26.7	40.0	0%	
- Outpatients	3	300	41.3	35.9	47.0	0%	
- Community patients	2	696	25.2	22.2	28.6	38.6%	
- IPAQ high category (%)							
• Geographical region							<0.001*
- North America	2	696	48.7	45.0	52.4	0%	
- South-America	1	74	6.7	2.8	15.2	0%	
- Asia	2	226	27.9	22.4	34.1	0%	
- Australia	1	191	41.4	34.5	48.5	0%	
• Setting							0.005*
- Inpatients	1	191	41.4	24.4	60.0	0%	
- Outpatients	3	300	21.1	13.5	31.4	81.3%	
- Community patients	2	696	48.1	34.8	61.6	0%	
- Complying with guidelines							
• Geographical region							0.79
- North America	4	290	48.2	26.8	70.4	95.2%	
- South-America	4	1,293	55.6	32.6	76.5	97.2%	
- Africa	4	439	53.6	31.5	74.4	95.0%	
- Australia	1	30	30	5.7	75.1	0%	
• Setting							0.15
- Inpatients	1	30	32.9	7.1	70.6	0%	
- Outpatients	10	1,879	47.7	35.2	60.4	95.5%	
- Community patients	2	78	60.2	23.4	88.3	0%	
• Physical activity assessment method							
- Self-report	12	2022	48.8	37.2	60.7	95.1%	0.08
- Objective assessment	1	30	30	5.7	75.1	0%	

ES=Effect size, PA= physical activity, IPAQ= International Physical Activity Questionnaire, *Significant when P<0.05..

Table 4. Meta-regressions of Moderators for Physical Activity Behavior in People Living with HIV

Moderator	N studies	β	SE	95%CI		P-value	R^2
Steps (number/day)							
Age (years)	7	-66.7	34.1	-133.4	0.22	0.049	0.57
Gender (% male)	7	-225.5	590.4	-1382.8	931.6	0.70	0
BMI	5	16.3	57.7	-96.8	129.4	0.78	0
Diabetes (%)	4	-1019.0	1358.8	-3618.4	1643.4	0.45	0
Smoking (%)	4	-681.4	687.4	-2028.6	665.8	0.32	0
IPAQ low category (%)							
Age (years)	6	-0.002	0.028	-0.06	0.05	0.94	0
Gender (% male)	6	-0.33	0.52	-1.35	0.69	0.53	0.05
Ethnicity (% White)	5	0.70	0.59	-0.46	1.86	0.24	0
IPAQ moderate category (%)							
Age (years)	6	-0.05	0.01	-0.08	-0.03	<0.001*	1.0
Gender (% male)	6	-0.61	0.48	-1.56	0.34	0.21	0.10
Ethnicity (% White)	5	-0.75	0.46	-1.66	0.16	0.11	0.39
IPAQ high category (%)							
Age (years)	6	0.06	0.03	-0.001	0.11	0.054	0.35
Gender (% male)	6	0.94	0.66	-0.36	2.24	0.15	0.12
Ethnicity (% White)	5	-0.25	0.86	-1.94	1.44	0.77	0
Complying with guidelines (%)							
Age (years)	13	-0.06	0.05	-0.16	0.05	0.28	0.01
Gender (% male)	13	-0.36	0.58	-1.49	0.78	0.54	0.01
Assessment method (objective method as reference)	13	0.80	0.89	-0.95	2.56	0.37	0

SE= standard error, BMI=body mass index, IPAQ= International Physical Activity Questionnaire, *Significant when P<0.05.

Figure 1 Flow Diagram for the Search Results

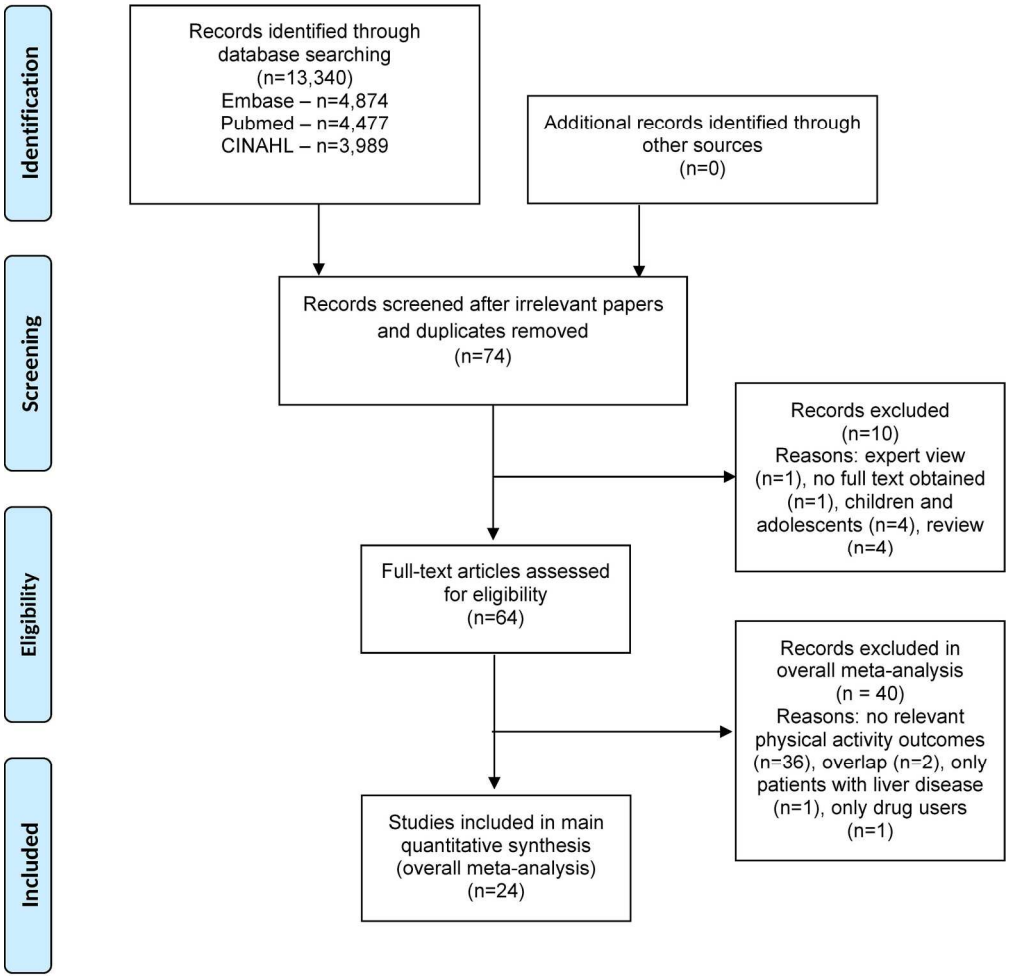

Figure 1 Flow Diagram for the Search Results

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