Physical Activity: Do Patients Infected with HIV Practice? How Much? A Systematic Review

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Abstract: Several studies have suggested that aerobic physical activity is safe and beneficial for HIV-infected adults. However, there is information lacking regarding whether HIV-infected patients practice physical activity and to what extent. Therefore, the aim of this systematic review was to determine the prevalence of physical activity, sedentary lifestyle or lack of physical activity in non-experimental conditions performed by HIV-infected subjects. The electronic search was conducted using Medline and EMBASE bibliographic databases and the platforms of Bireme, Ovid, Science Direct, High Wire and SCIELO from January 1990 to July 2011. Original observational studies were included. Of the 2,838 articles found, 48 met the inclusion criteria. Following data extraction and after reading the manuscripts, 24 were selected for systematic review. Of the 24 studies, most were cross-sectional studies. The average quality score using the modified Newcastle-Ottawa scale was 2.8±1.5. The diversity of methods used to assess physical activity precluded the calculated summary estimate of prevalence. The percentage of sedentary lifestyle was determined in 13 articles which conducted studies on HIV-infected individuals. The percentage of sedentary lifestyle or physical inactivity ranged from 19% to 73%, with the level determined by different methods. In conclusion, there are few well-designed studies with adequate sample size to represent the population of HIV-infected individuals. A pooled estimate could not be calculated due to the differences in physical activity measurements and definitions of physically active and non-active HIV-infected individuals.

Keywords: HIV, AIDS, physical activity, motor activity, lifestyle, sedentary, systematic review.

INTRODUCTION

Regular physical activity has been recommended as a part of the global strategy for prevention of non-transmissible diseases [1-3]. The current physical activity guideline suggests that adults should engage in moderate-to-vigorous physical activity for at least 30 minutes a day, five days a week [1]. The guideline aimed at the general population [4] and there is no specific recommendation for HIV-infected individuals. However, a systematic review has found that aerobic exercise or its combination with strength training for four weeks, at least three times a week, might be enough for improving cardio-respiratory capacity of HIV-infected individuals [5]. Additional evidence suggests that the effect of long-term endurance exercise can increase CD4, improve functional capacity, and quality of life, as well as reduce the prevalence of depression and pre-hypertension [6-8]. Furthermore, moderate-to-vigorous exercise improved cardio-respiratory fitness and promoted weight loss with no detrimental influence on immunological profile or viral load level increase in subjects on antiretroviral treatment [9-11]. Most of these results were obtained through experimental studies, founded on interventions administered for a short period of time - some of them had no control group, and conducted on small samples of highly selected participants. Therefore the findings could not be generalized to the overall population of HIV-infected individuals and do not support long-term benefits. Moreover, there is scarce information regarding the level of physical activity performed by HIV-infected individuals. This systematic review aimed to verify the prevalence of physical activity, sedentary lifestyle or lack of physical activity in non-experimental conditions performed by HIV-infected subjects in order to obtain a pooled estimate.

METHODS

Searching

The search strategy was performed using Medline and EMBASE bibliographic databases and the platforms of LILACS, Ovid, Science Direct, High Wire and SCIELO. Unpublished studies were investigated in the largest doctoral thesis and dissertations database of a Brazilian Agency (CAPES). The searching by hand was conducted in the references of the review papers and in non-indexed Medline Brazilian journals. Duplicate publication was checked and, wherever necessary, the corresponding author was contacted.

Three investigators conducted independent search strategies, and the final one included primary descriptors for

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PubMed: "physical activity" [textword] or "exercise" [MESH] or "motor activity" [MESH] that were intersected with secondary descriptors: "lifestyle" [MESH], "HIV" [MESH], "AIDS" [MESH] using Boolean operators. Even though this review was not focused on "exercise", this descriptor was included in order to capture papers that might contain both physical activity and exercise measurement.

Selection

The eligibility criteria included observational studies that evaluated physical activity performed by HIV-infected adults, published from January 1990 to July 2011, and with no language restriction. Prevalence, cross-sectional, and cohort studies that assessed physical activity using a standardized protocol or equipment were eligible.

Validity Assessment

Screening and eligibility were checked by three independent investigators who read the titles and the abstracts of all articles in order to identify those that met the inclusion criteria or those that could not be clearly excluded. Disagreements were solved by consensus in staff meetings.

Ethics Statement

The project was approved by the Ethics Committee of Hospital de Clinicas de Porto Alegre, which is accredited by the US Office of Human Research Protections as an Institutional Review Board.

Data Extraction

A standardized record form was designed, pretested, piloted and revised. Two independent investigators extracted the data using a spreadsheet previously tested and refined. Divergences were resolved by discussion between the reviewers. Selected studies were critically appraised and data were recorded in a tabular format allowing comparisons between studies. Three authors were contacted in order to obtain additional information or to clarify some details about the methodology of measurement or physical activity score.

Study Characteristics

Characteristics of the study such as year, setting, population and sampling, study design, instrument or equipment used to quantify physical activity were recorded, and quality of the study was assessed by the Newcastle-Ottawa scale, adapted for cross-sectional studies [12]. The data was reported according to the PRISMA Statement checklist, and a four-phase flow diagram was produced [12].

Information was extracted from each included article on: (1) article identification; (2) characteristics of participants, such as age, gender, HIV or AIDS diagnosis/testing method; (3) design and setting; (4) sample size; (5) physical activity, including measurement methods and type, duration, frequency and intensity of physical activity in order to classify the level.

Quantitative Data Synthesis

It was anticipated that the report of physical activity might be presented using different formats, so all continuous (mean and SD) or categorical (percentage) data were recorded for type, duration and frequency of physical activity. Individuals physically active could be identified by moderate-to-vigorous physical activity performed during 150 min/week [13], questionnaire or accelerometer; walking at least 10,000 steps/day measured by a pedometer [13], or any other standardized definition. Participants who did not achieve such levels were classified as inactive. A priori, it was planned to aggregate the results of the studies into a summary measure of prevalence rate, and assessing heterogeneity using the Comprehensive Meta-Analysis® software.

The modified Newcastle-Ottawa Scale, derived from quality assessment scales for case-control studies, was used to assess the quality of the study regarding sampling, selection, exposure, and outcome measurements. The questions of case-control study assessment were adapted to investigate exposure (HIV infection diagnosis) and outcome (Physical activity). A star was given for each item completed, resulting in scores ranging from 0 (worst) to 7 (best) [12]. Fig. (**1**) shows the questions used for quality assessment of the studies.

RESULTS

Flow of Included Studies

The database search identified 2,830 as potentially eligible studies. Six were detected by checking the references of relevant papers and two doctoral theses were additionally retrieved. All studies were screened by reviewing the title and abstract and 48 needed review of the full-text. The remaining retrieved studies were excluded since they did not meet the eligibility criteria, and the full text of 48 studies was examined by two investigators. Fig. (**2**) presents the flowchart to summarize study selection processes that showed in the inclusion of 24 articles.

Study Characteristics

In the overall, 24 studies were included, two cohort studies, eight prevalence studies, and 14 cross-sectional studies. Two articles [14,15] showed superposition of the main and complementary results, and they were handled as a single article for data analysis purpose.

Of the 24 articles included in this systematic review, 14 primarily aimed to determine the prevalence of physical activity or to examine its association with metabolic disorders, abnormal fat distribution, progression of HIV infection or its influence on the immune system. The remaining 10 studies assessed physical activity to test secondary hypotheses, verifying energy intake and expenditure or the association with lifestyle, coronary heart disease, metabolic syndrome or other outcomes among HIV-infected individuals.

Exposure	
HIV status	a) secure record (e.g. surgical records) ☆ b) structured interview where blind to outcome status ☆ c) interview not blinded to outcome status d) written, self-report or medical record only e) no description
Same method of ascertainment for positive and negative	a) yes ☆ b) no
Non-response rate	a) same rate for both groups ☆ b) non respondents described c) rate different and no designation
Outcome	
Is the physical activity definition adequate?	a) yes, with independent validation ☆ b) yes, e.g. record linkage or based on self reports c) no description
Representativeness of sample	a) consecutive or obviously representative ☆ b) potential for selection biases or not stated
Selection of participants	a) community ☆ b) hospital c) no description
Definition of control group	a) no history of disease (endpoint) ☆ b) no description of source

Fig. (1). The modified Newcastle-Ottawa Scale* used to assess the quality of the studies. *Adapted from NOS for case-control study, using the HIV infection as the exposure and physical activity as the outcome with the attributed stars.

Quantitative Data Synthesis

At the database search phase, the overall agreement rate among investigators was 95%. Disagreements regarding eligibility or quality of the study were solved by consensus. Most articles presented prevalence data, but only half had a control group in order to compare rates. The majority did not present the non-response rate, these studies had a low average score on the adapted Newcastle-Ottawa scale, and no study reached the maximum score (Table **1**).

Participants

A total of 4,982 participants were analyzed and their characteristics were described in Table **1**. The main inclusion criteria entailed adults aged 18 years or older, who reported having been tested positively for HIV infection and their physical activity assessed. Most studies included men and women. Seven studies enrolled only men, one did not specify how many of the 66 participants were males or females, and gender was not reported in one study. Most participants were males (n=3,494), with age ranging between 18 and 81 years, and the mean age ranged from 33 to 47 years.

Physical Activity Measurement

Most studies adopted standardized instruments (n=13), specific questions (n=10), accelerometer or pedometer (n=3), and a few additionally used laboratory tests, assessing indirect calorimetry, proxies of energy expenditure and peak of oxygen uptake (n=5). The questionnaires used to assess physical activity included the short version of IPAQ (International Physical Activity Questionnaire), Behavior

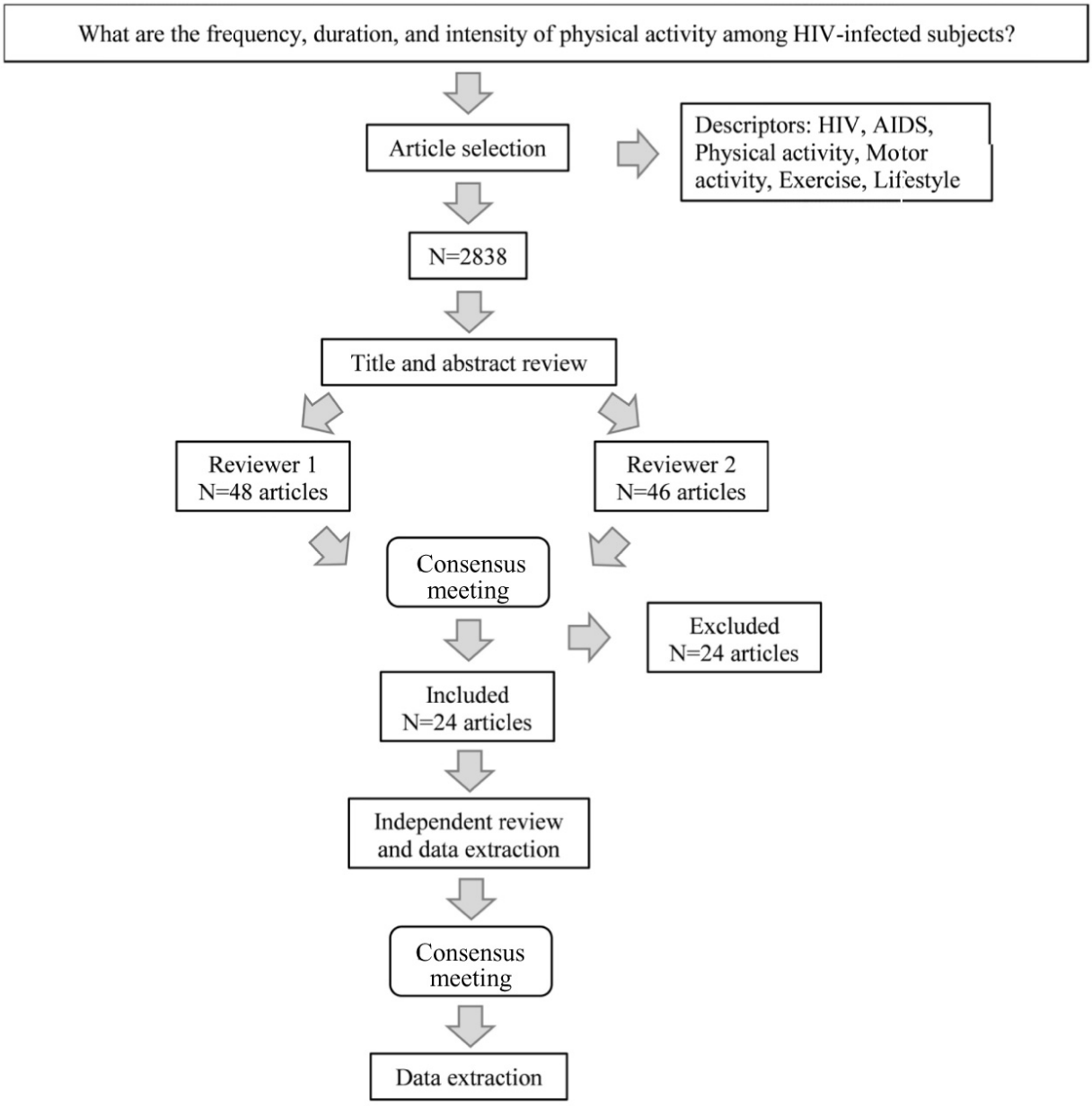

Fig. (2). Flowchart of article search and selection for systematic review.

Risk Factor Surveillance Survey (BRFSS-PAQ), Minnesota Leisure Time Physical Activity Questionnaire, Leisure Activity Inventory and Seven-Day Physical Activity Recall, Baecke Questionnaire, Modified Paffenbarger Questionnaire, Daily Life and Sports Exercise. Data were obtained from face-to-face interviews, administered questionnaires (n=17), self-completed questionnaire (n=2), and the use of diaries (n=2). All instruments used different protocols to classify sedentary and active lifestyle. Physical activity was assessed for the usual pattern and for periods of time that ranged from one to seven days.

Sedentary Lifestyle or Insufficient Physical Activity

Prevalence of sedentary lifestyle or lack of physical activity among HIV-infected individuals was described in 13 articles, ranging from 19.0% to 73.3% [13,15-26]. The IPAQ identified 81% as physically active, followed by the accelerometer ActiGraph (54%) and the pedometer DigiWalker (17%), while the prevalence of inactivity was inverse for the pedometer (83%), accelerometer (46%), and IPAQ (19%) [13]. The other two studies using the IPAQ either followed the IPAQ protocol for analysis or classified as active individuals who achieved at least 150 min/week of moderate-to-vigorous physical activity [17,26].

The studies that used the Minnesota Leisure Time Physical Activity Questionnaire considered sedentary patients who had a total activity metabolic index below 143 kcal/day [20]. Studies using the Baecke Questionnaire did not outline sedentary behavior or physical inactivity. They presented the total score as mean and standard deviation and the percentage of active individuals in some activities or sports [27-29].

Table 1. Characteristics of Observational Studies that Measurement Physical Activity in HIV Infected Patients

Reference, Year of Publication	Number of Stars in the Modified NOS	Population, Setting and Data Collection	Study Design and Sample Size	Gender, Age (Mean ±SD and Range)	Physical Activity Instruments and Measurements	Physical Activity Results of the Studies	Inactivity Prevalence
Paton, 1996. [34]	2	Men with stable infection without opportunistic disease; St George's Hospital, London.	Prevalence study n=10	100% males, 33.5 years (26-45)	Diary of PA, fulfilled for 2 days.	Level of PA 1.34±0.16 (daily) Level of PA 1.42±0.14 (measured)	-
Clingerman 2003. [15]	-	Infectious disease clinics and community service for HIV patients, Northern Great Lakes region, USA.	Prevalence study n=78	89.7% males, 40.4 ±8.33 years (23-70)	PA Questionnaire, regarding frequency (d/w) and duration (min/w) of leisure time and occupational PA	Walking: 53.8%* Moderate PA: 28.2%* Vigorous PA: 19.2%* * Some participants fulfilled two categories	25.6%
Bopp 2004. [35]	1	Convenience sample of HIV-infected individuals receiving care at the outpatient referring clinic Columbia, South Carolina, USA.	Prevalence study n=66	Male and female, 39 ±8 years (18-64)	Mini-motion logger wrist accelerometer, for three days.	Average minutes of PA: 144 ± 31 min/day (range 43-193 min) Average PA index: 84 ± 8.4% PA index averaged: 84 ±8.4% Acceleration index averaged: -0.22	-
Ramirez-Marrero 2004. [22]	2	AIDS Clinical Trial Unit at the University of Puerto Rico, Puerto Rico.	Prevalence study n=68	63% males, 40.4 ±8 years (30-50)	Leisure Activity Inventory and Seven-Day PA Recall.	Leisure Activity Inventory score: Overall mean: 43.4 ±10.6 Men: 44.0 ±11.9 Women: 42.0 ±12.3 Leisure time (average score) 45.0±10.8 in the active *vs* 41.1±9.9 in the inactive group. The cutoff point ≥300 kcal/day of PA–related energy expenditure was used to identify participants physically active: 58.8% Seven-Day PA Recall: daily average of 1.2 hours	TV watching (h/day): 5.4; 4.5±2.4 in the active *vs* 5.9 ±2.9 in the inactive group.
Florindo 2007.[27]	3	Infectious Disease Clinic, Clinical Hospital of São Paulo, Brazil.	Prevalence study n=220	76.8% males (20-59 years)	Baecke Questionnaire, 16 Likert scale questions	PA adequate locomotion 65% Leisure-time exercise 47.3% Walking: 33.7% Weight training: 20.2% Swimming: 9.6% Other forms: 36.5% Overall score: 8.7 ± 1.3	-
Sutinen 2007. [36]	2	Helsinki Central University Hospital, Finland.	Prevalence study n=43	79% males 41.8 ±2 years	Questions about PA during the interview and indirect calorimetry	Light (6.9 ±0.8 *vs*5.7 ±2.3 h/wk, Strenuous physical activity (2.4 ±0.7 *vs* 2.7±0.8 h/wk).	-

(Table 1) contd…..

Reference, Year of Publication	Number of Stars in the Modified NOS	Population, Setting and Data Collection	Study Design and Sample Size	Gender, Age (Mean ±SD and Range)	Physical Activity Instruments and Measurements	Physical Activity Results of the Studies	Inactivity Prevalence
Arendt 2008. [16]	1	Unidentified Between July 2004 and May 2007.	Prevalence study n=65	100% males, 47 ±0.9 years	Daily life and sports exercise, recommended by PA Guide and Institute of Medicine (IOM)	Recommendation of ≥ 60 min of mild activity per day 30 to 60 of moderate 84.5% Moderate to very strenuous 81%	IOM 41.4% sedentary
Ramirez-Marrero 2008. [13]	2	AIDS Clinical Trial Unit at the University of Puerto Rico, Puerto Rico.	Prevalence study n=58	60.3% males 46.5 ±8.8 years	IPAQ ActiGraph Accelerometer Digiwalker Pedometer	Active individuals IPAQ 81% Accelerometer 54% Pedometer 17%	IPAQ 19% Accelerometer 46% Pedometer 83%
Gavrila 2003. [21]	1	Outpatients of the General Clinical Research Center; Beth Israel Deaconess Medical Center, Boston, Massachussetts, USA.	Cross-sectional study n=120	89% males 43.7 ±8.0 years	3 Multiple-choice questions with type, intensity, frequency and duration of exercise)	Any exercise: 86% Aerobic exercise: 83% Mild: 39% Moderate/ heavy: 44%	14%
Domingo 2003. [20]	3	Patients on metabolic disturbances associated with HAART AIDS Clinic, Hospital de la Santa Creu i Sant Pau, Autonomous University of Barcelona, Barcelona, Spain June to August, 2000.	Cross-sectional study n=150	78.7% males 39.05 ±9.05 years (21-69)	Spanish version for Minnesota Leisure Time PA Questionnaire Physically active: total activity metabolic index ≥143 kcal/day.	PA: 28% (patients on d4T) and 25.3% (patients on AZT)	73.3%
Shah 2005. [24]	2	Participants exposed to protease inhibitors with fat redistribution. Parkland Health and Hospital Systems, HIV Clinics at the University of Texas Southwestern Medical Center, Dallas, USA.	Cross-sectional study n=51	88% males 46.5 ±8.1 years	Questions about the type and number of hours of light, moderate and intense activity per week Total number of hours spent exercising per week.	Exercise [h/week (% exercising)] Total aerobic: 2.3 ±3.0 (62.2%) for males and 1.3±2.8 (33.3%) for females Moderate/heavy aerobic: 0.5±1.2 (20%) *vs* 0 (0%) Weight training/lifting: 1.4±2.3 (44.4%) *vs* 0 (0%) Flexibility: 0.2 ±0.6 (11.1%) *vs* 0.3 ±0.8 (16.7%) Total exercise: 3.9±4.2 (66.7%) *vs*1.7±2.7 (50%)	No exercise: Men: 33.3% Women: 50%
Eidam 2006. [18]	2	Convenience sample of HIV-infected individuals at the outpatient clinic of infectious disease, Florianopolis, Santa Catarina, Brazil. October to December, 2002.	Cross-sectional study n=111	61.3% males 37 years (21-55)	Lifestyle profile with 3 questions regarding: 1) walking or bicycling as the usual transportation mode, 2) PA for at least 30 minutes 5 or more days per week, and 3) lifting or stretching exercises.	Walking or bicycling as the usual transportation mode: 66,7% PA for at least 30 minutes 5 or more days per week: 76.6% Lifting or stretching exercises:27.0% Overall habitual PA: 50.5%	45.5%

(Table 1) contd…..

Reference, Year of Publication	Number of Stars in the Modified NOS	Population, Setting and Data Collection	Study Design and Sample Size	Gender, Age (Mean ±SD and Range)	Physical Activity Instruments and Measurements	Physical Activity Results of the Studies	Inactivity Prevalence
Salyer J 2006. [23]	2	Participants from two infectious diseases clinics (urban and rural areas of the same state) with cumulative exposure to HAART. Medical College of Virginia/Virginia Commonwealth University Virginia, USA. May to December, 2002.	Cross-sectional study n=95	83% males 41 ±8.4 years (21-68)	Duke Activity Scale Index (DASI) with 12 items providing an indirect measure of exercise capacity.	≤2 times/week: 33.7% ≥3 times/week: 66.3% Participation in strenuous sports: 47% Heavy work around the house: 28% Participate in moderate recreational activity: 27%.	33.3%
Jaime 2006. [29]	3	Participants HIV/AIDS, on HAART, Referral Center for HIV/AIDS, Sao Paulo, São Paulo, Brazil. March to June, 2002.	Cross-sectional study n=223	76.8% males 38.9 years (20-59)	Baecke questionnaire investigated habitual PA, for the last 12 months, with 16 questions covering three components: occupational activity, leisure time and locomotion activities.	Prevalence rate for PA was not described, neither the average score for the whole population. The final score for participants with central obesity were 2.75±0.7 and 2.88±0.65 for those with no central obesity.	-
Florindo 2006. [28]	3	Participants from a consecutive sampling at the AIDS clinic, Department of Infectious Diseases of the School of Medicine, University of São Paulo, São Paulo, Brazil October 2001 to June 2002.	Cross-validation study n=30	Mean age 37.2 years (26-49.5)	Baecke questionnaire investigated habitual PA, for the last 12 months, with 16 questions covering three components: occupational activity, leisure time and locomotion activities.	The first and second PA scores were: Occupational: 2.6 ±0,5 *vs* 2.7 ±0.6 Leisure time: 2.3 ±0,7 *vs* 2.4 ±0.5 Leisure and locomotion: 2.6 ±0.6 *vs* 2.7 ±0.5 Total score = 7.3 ±1.2 *vs* 7.5 ±1.3	-
Jacobson 2006. [31]	5	Participants HIV-positive, living in the greater Boston area or Rhode Island, recruited through advertisements. Nutrition for Health Living (NFHL), Cohort study of volunteers with HIV, comparing HIV negative of the NHANES, USA. July, 2000.	Cross-sectional analysis of a cohort study n=477	74.6% males 42.6 years (25-63)	Questionnaire developed by Sallis *et al.* [33], for measuring the usual activity over the past 7 days.	Regular exercise: 50.7% Strength exercise: 34.3%	-
Mohammed 2007. [32]	5	HIV+ and HIV- with hepatic alterations Clinics of the University Health Network. October 2003 to June 2005.	Cross-sectional study n=51	100% males HIV- 43.1 ±2.5 years; HIV+ 46.2±1.5 years	Questions about PA performed, duration, intensity and date and time in the last week	HIV+ patients were more physically active than HIV-	-

(Table 1) contd…..

Reference, Year of Publication	Number of Stars in the Modified NOS	Population, Setting and Data Collection	Study Design and Sample Size	Gender, Age (Mean ±SD and Range)	Physical Activity Instruments and Measurements	Physical Activity Results of the Studies	Inactivity Prevalence
Kowal 2008. [25]	3	Outpatient clinic at publicly funded university teaching hospital in an urban area.	Cross-sectional study n=97	84% males 39.4 ±8.7 years	Questions about health behaviors included PA	None 36 (37%) One to three times per week 38 (39%) More than three times per week 23 (24%)	37%
Filipas 2008. [17]	5	Infectious Diseases Unit The Alfred Hospital, Melbourne, Australia. April, 2006.	Cross-sectional study n=261	86.6% Males 43.3 (18-81)	IPAQ short version, usual week	HIV positives Low: 49 (25.7%) Moderate: 63 (33.0%) High: 79 (41.3%) Walking: 90.1% HIV negatives Low: 24 (34.3%) Moderate: 23 (32.9%) High: 23 (32.9%) Walking: 84.3% Not fulfilled classification 142 (73.8%) HIV- *vs* 46 (65.8%) HIV+ p <0.05	28%
Tsiodras 2009. [37]	3	Outpatient General Clinical Research Center of Beth Israel Deaconess Medical Center (BIDMC), Israel.	Cross-sectional study n=218	85.3% males 44.1 ±7.9 years	Current exercise was evaluated using 3 multiple-choice questions regarding the type and intensity of exercise, frequency and duration.	Exercise (number of sessions/week) Non-fat redistribution group: 4.7±2.6 Fat accumulation group: 4.1±2.8 Mixed fat redistribution group: 3.7±.8 Fat wasting group: 5.3±2.3	-
Tang 2010. [38]	4	The Tufts Nutrition Collaborative (TNC) Study. Persons with or without HIV living in three US cities (Baltimore, Boston, Providence), USA. 2005-2007.	Cross-sectional study n=511 54.4% HIV+	65% males 42.9 ±7.4 years	Questions about exercise were determinate from the audio computer-assisted self-interview (ACASI) Regular strength training ≥ 1/w Aerobic exercise ≥1/w.	30-40% engaging in regular strength training and 50% engaged in regular aerobic exercise	-
Schuelter-Trevisol 2010. [26]	4	Outpatient Health Care Center, state of Rio Grande do Sul, Brazil. 2006-2008.	Cross-sectional study n=1,240	50.6% males 39.1 ±10.1 (18-78)	IPAQ ActiGraph Accelerometer	Subjects were considered active if they performed PA of moderate-to-vigorous intensity at least 150 min/w. Active individuals: IPAQ: 57.7%. Accelerometer: 33.3%.	IPAQ 42.3% Accelerometer 66.7%
Mustafa 1999. [19]	5	Homosexual or bisexual living in New York, USA, who took part in a cohort study: The Longitudinal AIDS Impact Project December, 1991.	Cohort study n=415 * 156 HIV+ 259 HIV- * Subsample that had HIV status determined	100% males, HIV+ 35 ±6.4 (22-55); HIV- 37 ±9.1 (20-75)	Question: How many times a week do you exercise?	Exercise: Exercising daily: 35% HIV+ *vs* 31% HIV- 3-4 times/wk: 36% HIV+ *vs* 41% HIV-	Non-exercisers: 29% HIV+ *vs* 28% HIV-

(Table 1) contd…..

Reference, Year of Publication	Number of Stars in the Modified NOS	Population, Setting and Data Collection	Study Design and Sample Size	Gender, Age (Mean ±SD and Range)	Physical Activity Instruments and Measurements	Physical Activity Results of the Studies	Inactivity Prevalence
Smit 2006. [30]	5	Subjects of a sub-study from the AIDS Linked to Intravenous Experiences (ALIVE) cohort, an ongoing study of HIV-negative and -positive IDUs. For the Alive, participants were recruited in the Baltimore area at several clinics, hospital emergency rooms, homeless shelters and the Street Outreach AIDS Prevention in Unit. Baltimore, Maryland, USA.	Cohort study n=324	67% males	Modified Paffenbarger questionnaire Energy expenditure (kcals) was estimated by multiplying the time spent in each activity by body weight and by the specific MET level for each activity.	Males: 13.2±0.3 h/w of light; 2.6±0.2 h/w of moderate and 1.1 ±0.2 h/w of vigorous activity. Females: 13.3±0.4 h/w of light; 3.0±0.3 h/w of moderate and 0.3±0.1 h/w of vigorous activity. Regular exercise (times/w): 1.21 HIV+ on HAART *vs* 1.23 HIV+ and no treatment *vs* 1.37 HIV- Strength exercise (times/w): 0.57 HIV+ on HAART *vs* 0.45 HVI+ and no treatment *vs* 0.74 HIV- Light PA (h/d): 13.6 HIV+ on HAART *vs* 13.0 HIV+ and no treatment *vs* 12.7 HIV- Moderate PA (h/d): 2.74 HIV+ on HAART *vs* 2.81 HVI+ and no treatment *vs* 3.1 HIV- Vigorous PA (h/d): 0.57 HIV+ on HAART *vs* 1.41 HVI+ and no treatment *vs* 1.03 HIV-	-

PA = physical activity; IPAQ = International Physical Activity Questionnaire; OR = odds ratio; NOS: Newcastle-Ottawa score.

These several criteria used for defining lack of physical activity resulted in barely comparable prevalence rates. For instance, one of the studies defined the exercise behavior based on the answer to the question: "how many times a week do you engage in physical activity?". Those who reported never exercising, or exercising less than once a month, once a month, every few weeks, or twice a week were aggregated into non-exercising category [19]. In another study, inactive were those who neither walked for more than 10 minutes at a time, nor performed moderate, vigorous, or strengthening physical activity [15]. In a few studies, individuals who performed some types of exercises (running, jogging, weight training) were classified as physically active [27,30]. For one study, the rate of inactive or sedentary individuals was not described and had to be extracted from the difference on percentages shown in the figures [21]. Ramirez-Marrero *et al*. defined those participants with energy expenditure below 300 kcal/day as inactive [22]. Shah *et al*. did not present the cutoff point for physical activity, but this article presented the percentage of active individuals separated by gender, thus allowing calculation of the overall percentage of inactive subjects [24]. In another study, using the lifestyle questionnaire created by Nahas, those participants who scored below 27 were classified as poorly physically active [18]. Salyer *et al*. defined inactive as those who performed ≤ 2 times of physical activity per week [23]. Arendt *et al*. defined active as those who did usual physical activity during daily living activities, such as household shores, walking to get the bus etc. [16].

Effects of Physical Activity Undertaken

The effect of physical activity has been established as inversely related to several metabolic disorders, such as high level of triglycerides and insulin resistance [21], and directly associated with an increase in CD4 T-lymphocyte counts, a slower HIV progression and death with AIDS [19] and High Density Lipoproteins (HDL) level [24]. Some studies suggested that physical activity was related to higher quality of life [15], and the potential explanation was that healthier body composition was more prevalent among active ones [22]. Arendt *et al*. [16] attributed the metabolic abnormalities to high-fat diet with low intake of micronutrients and fiber, rather than to the lack of physical activity and energy gain, noting that patients with metabolic syndrome generally were overweight or obese, despite having a satisfactory level of physical activity.

Level of Physical Activity Among HIV-Positive and -Negative Subjects

The comparison between HIV-infected and non-infected subjects regarding levels of physical activity was conducted on five studies. In two studies, HIV-negative subjects had

higher prevalence of physical activity than those with HIV-infection, but there were controversial results for those on potent highly active antiretroviral therapy (HAART) [30,31].

The energy expenditure from vigorous physical activity was higher among HIV-negative and untreated HIV-positive individuals than among those on HAART [30]. However, in one study there was no statistically significant difference between HIV-infected individuals with or without antiretroviral treatment. However, when comparison was made between HIV-infected and those without HIV infection, the latter performed regular physical activity more frequently (46% *vs* 60%, respectively) [31]. A third study detected that HIV-positive patients reported more physical activity than the non-infected ones. However, the comparison group was composed of patients with nonalcoholic fatty liver disease [32].

The study by Fillipas *et al.* [17] showed that HIV-positive individuals spent more time in performing vigorous physical activity (P value = 0.034) and physical activity in general (P value = 0.01) than HIV-negative individuals. Similarly, with regard to energy expenditure at each intensity, they showed that HIV-positive patients had higher expenditure in vigorous (P value = 0.03), moderate (P value = 0.046) and total (P value = 0.02) activities than HIV-negative individuals.

Finally, a fifth study did not find differences in the level of physical activity carried out among HIV-infected and non-infected individuals [19].

DISCUSSION

This systematic review screened 2,838 studies measuring physical activity performed by HIV-infected adults. Despite extensive literature search to obtain studies, only a few met the eligibility criteria. Moreover, the studies had low quality score, assessed by the modified Newcastle-Ottawa Scale, in addition to heterogeneity in the methods of physical activity measurement. The absence of a reference test for the assessment of physical activity in population-based studies contributed to the diversity of methods used to measure physical activity, which precluded from conducting a quantitative meta-analysis.

There were also controversial results with regard to the difference of physical activity levels among HIV-infected and uninfected individuals. However, there were few studies with a control group for conducting this analysis. While Mohammed *et al.* [32] and Fillipas *et al.* [17] rejected the null hypothesis, detecting that HIV-infected individuals had higher levels of physical activity in comparison with uninfected individuals, Smit *et al.* [30] found that individuals without HIV infection performed physical activity for longer periods than theinfected ones. Jacobson *et al.* [31] also reported that the practice of regular physical activity over the past 30 days was higher among individuals without infection, while Mustafa *et al.* [19] found no difference between the groups.

In order to avoid the variability in the measurement of physical activity, the percentage of sedentary lifestyle or physical inactivity which ranged from 19% to 73% was assessed [13]. An estimate from the United States for the last decade showed that 45% to 50% of the adult population did not perform physical activity during leisure time [1]. A study conducted between 1996-1997 in two most populous Brazilian regions, Southeast and Northeast, found a prevalence of 87% of sedentary lifestyle [33].

In conclusion, there are few well-designed studies with adequate sample size to represent the population of HIV-infected individuals. From the evidence available, it was not possible to calculate a pooled estimate of the level and intensity of physical activity performed by HIV-infected patients.

LIMITATIONS

The studies available had low quality and high heterogeneity, which precluded the calculated summary estimate of physical activity prevalence. The lack of temporality of most studies, did not allow determining whether inactivity or sedentary lifestyle was due to the infection or whether it could be influenced by the antiretroviral treatment. Further studies are needed of using the same standardized instruments to determine the level of physical activity, and larger samples of HIV-infected individuals assessed to establish how physical activity works on the clinical parameters.

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CONFLICT OF INTEREST

The author(s) confirm that this article content has no conflicts of interest.

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