PHYSICAL TRAINING FOR HIV POSITIVE INDIVIDUALS SUBMITTED TO HAART: EFFECTS ON ANTHROPOMETRIC AND FUNCTIONAL PARAMETERS

EXERCISE AND SPORTS MEDICINE CLINIC

ORIGINAL ARTICLE

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ABSTRACT

Introduction: The use of highly active antiretroviral therapy (HAART) has improved the prognosis of HIV-infected individuals. However, HAART has been associated with the development of metabolic and fat distribution abnormalities, known as HIV-associated lipodystrophy syndrome (HIVALS). Objective: This study investigated the impact of 24 weeks of resistance exercise with aerobic component (REAC) on anthropometric and functional parameters in HIV-infected patients undergoing HAART. Methods: Ninety- nine HIV-infected patients were randomly allocated into four groups: exercise and lipodystrophy (n = 24; EX + LIP); exercise without lipodystrophy (n = 21; EX + NoLIP); control and lipodystrophy (n = 27; NoEX + LIP); control without lipodystrophy (n = 27; NoEX + NoLIP). Subjects from exercised groups (EX+LIP and EX+NoLIP) participated in a 24-week REAC program. Anthropometric, strength and cardiorespiratory fitness tests were assessed at baseline and 24 weeks after intervention. Results: Body circumferences ($P < 0.0001$) and waist-hip ratio ($P = 0.017$) changed after 24 weeks of REAC in both exercised groups. The sum of seven skinfolds assessed, body fat percentage, body fat mass, total fat, central fat and peripheral subcutaneous fat reduced ($P < 0.0001$) in response to REAC. Lean body mass increased ($P < 0.0001$) in exercised groups, regardless of the outcome (LIP or NoLIP). Strength and cardiorespiratory fitness increased ($P < 0.0001$) in both exercised groups in response to REAC. Conclusion: 24 weeks of REAC prevented the manifestation of changes arising from HIVLDS and contributed to their reduction.

Keywords: exercise, therapeutics, body composition, muscular strength, physical fitness.

INTRODUCTION

The highly active antiretroviral therapy results in remarkable suppression of the HIV and consequently, increase of survival in infected individuals[1]. However, it has been reported that HIV patients submitted to HAART may develop a syndrome of body fat redistribution, named HIV lipodystrophy syndrome (HIVLDS). HIVLDS is characterized by loss of subcutaneous body fat, increase of visceral fat, presence of dorsal gibbosity, gynecomastia, and breasts increase in women, loss of facial and extremities subcutaneous fat and severe metabolic collateral effects, including dyslipidemia, insulin resistance, blood hypertension and hence, higher risk of cardiovascular disease[2].

Loss of lean body mass (LBM) occurs in HIV patients with relative maintenance of total body mass[3]. These alterations are associated with reduction of the capacity in generating strength and limitation of the functional status[4]. The antiretroviral therapy (ART) is not associated with increase of LBM in HIV patients[5]; hence, anabolic therapies should be incorporated to the routine of these individuals. To name some, pharmacological agents, including the human recombinant growth hormone (hrGH), nandrolone decanoate, testosterone and oxandrolone have been tested. Some investigations report metabolic collateral effects associated with drugs exposure, including increase of blood glucose[6] and negative alterations in the lipid profile[7]. However, Grinspoon *et al.*[8] reported that, independently, both progressive strength training and therapy involving testosterone increase muscle mass of HIV patients.

The HAART involved in the HIV treatment, defined as nucleoside analog reverse-transcriptase inhibitors (NARTIs), has been related to lipodysthophic alterations like lipoatrophy[9], mitochondrial toxicity[10] and reduction of the activity of oxidative enzymes[11]. Thus, the HIV and the HAART negatively influence on the oxygen kinetics (O_2), limiting hence the extraction/use of O_2 in the peripheral musculature[12]. Lower oxygen use capacity directly affects physical fitness, and consequently, the individual's motivation to perform routine activities. Few assays have been performed to test the effects of resistance exercise with aerobic component (REAC) in cardiorespiratory fitness. Robinson *et al.*[13] reported improvement of

10% of maximum oxygen consumption (VO_{2max}) after 16 training weeks. Perez-Moreno *et al.*[14] also tested the combination of aerobic and resistance exercises in inmates, for 16 weeks; nevertheless, they did not report VO_{2max} values. Controlled and random studies with longer intervention time are needed.

Brazil has a unified health system which provides assistance and free and universal access to the ART the HIV positive individuals. Until the end of 2009, over 197,000 HIV^+ individuals received ARTr from the Brazilian government[15]. However, until the present moment, no randomized and controlled study has investigated the effects and safety of the REAC in the anthropometric and functional parameters in Brazilian HIV^+ individuals submitted to HAART. Thus, the present study had the aim to analyze the effects of six months of REAC on the anthropometric and functional parameters of HIV patients submitted to HAART.

METHODS

Sample

29 men (39.7 ± 9.3 years) and 51 women (38.8 ± 11.6 years) from the Center of Health Promotion (CPS) of Conselheiro Lafaiete, Minas Gerais participated in the study. They have been physically inactive for at least six months preceding the study, did not present contraindication for physical exercises practice and were undergoing HAART for at least one year. The patient who made use of drugs and those with acute infection or opportunistic diseases were excluded. This study was previously approved by the Ethics in Research with Humans Committee of the Federal University of Viçosa and the subjects signed the Free and Clarified Consent Form.

Experimental procedures

Initially, 45 patients with lipodystrophy and 54 without it were randomly sorted in four groups: exercise and lipodystrophy (n = 24; EX+LIP); exercise without lipodystrophy (n = 21; EX+NoLIP); control and lipodystrophy (n = 27; NoEX+LIP); control without lipodystrophy (n = 27; NoEX+NoLIP) with the use of the *software* (GraphPad StatMate, version 1.01, San Diego – USA). Nineteen individuals dropped the study (13 from the EX group and six from the NoEX group) for lack of interest, problems with commuting to the CPS, family problems or for having reached 30% of absence for the exercised group. The anthropometric parameters and cardiorespiratory fitness were evaluated in the pre and post 24 weeks of intervention moments. An additional measurement for muscular strength was performed in week 12 for training load adjustment. All measurements were performed after 24 h of suppression of heavy exercise and 12 h-fasting.

Lipodystrophy diagnosis

All volunteers underwent individual medical evaluation for diagnosis of lipodystrophy (LIP)[16].

Nutritional control

During the whole experimental period, the volunteers had their diet controlled. The evaluation of the eating habits and dietetical prescription were done by a nutritionist from the CPS. The eating habits were evaluated through habitual record of the diet. All the volunteers received customized dietetical prescription[17]. The diets were calculated using the Diet-Pro program, version 4.0[18].

Anthropometric measurements

Anthropometric data of body mass, stature, perimeters and skinfolds were collected according to procedures described in the *Anthropometric Standardization Reference Manual* by Lohman *et al.*[19]. All measurements were taken three times and their mean value was considered. The body perimeters were obtained with a non-elastic measuring tape (Sanny®) with precision of 1cm. The neck, thorax, waist, hip, arm forearm, thigh and calf perimeters were obtained. The waist measure was performed on the median point between the iliac crest and the last rib. The waist/hip ratio (WHR) was obtained by the division of the waist perimeter (cm) by the hip perimeter (cm). The body mass and stature were measured using a mechanical scale with an attached stadiometer, brand name Filizola®, with 0.1kg and1cm of precision, respectively. The body mass index (BMI) was calculated using body mass (kg) divided by the square of the stature (m^2). Skinfolds were measured with the use of the scientific adipometer brand name Lange®, with precision of 0.1mm. The following anatomic points were used: tricipital (TR), bicipital (BI), subscapular (SB), suprailiac (SI), chest (C), abdominal (AB), midaxillary (MA), thigh (T), midcalf (MC).

Arm muscle area

It was obtained using the circumference of the relaxed arm (CRA) and TR thickness[20].

Body fat distribution

Body fat distribution was evaluated using the methodology described by Florindo *et al.*[21]. Total subcutaneous fat (TSF) was estimated from the sum of the BI, TR, SB, MA, SI, AB and MC skinfolds. Central subcutaneous fat (CSF) was estimated by the sum of the SB, MA, SI and AB skinfolds. Peripheral subcutaneous fat (PSF) was estimated by the sum of the BI, TR and MC skinfolds.

Body fat estimation

After calculation of body density (Bd) for women[22] and men[23], the estimation of the body fat percentage (%BF) was calculated for women and men[24]. The sum of seven skinfolds (∑ 7 SF) TR, SB, C, MA, SI, AB and T was also used.

Strength test

Tests of one repetition maximum (1-RM) were performed by a certified professional in six exercises: squat, bench press, hamstrings extension, triceps, back pulley, knee flexion and barbell curl.

Cardiorespiratory fitness test

It was measured by the modified multi-stage fitness test (20mMST)[25] in the pre and post-intervention moments. The total number of completed stages during voluntary exhaustion, or when the individual was not able to follow the "audio signal" in three consecutive occasions, was used to calculate the peak velocity. Afterwards, the maximum oxygen consumption (VO_{2max}) was estimated.

Intervention with exercise

The resistance exercise with aerobic component (REAC) program consisted of 24 weeks of supervised exercise performed three times per week in non-consecutive days. The subjects were submitted to two weeks of adaptation before the beginning of the REAC. Each training session was composed of warm-up and stretching exercises (10 min), aerobic training (15-20 min), resistance training (40 min) and return to calmness (10 min). The REAC program started after the interpretation of the results obtained in the 1-RM and 20mMST tests. Three sets of 8-10 repetitions were performed at 80% of 1-RM. Six exercises involving the large muscle groups were performed in the following order: squat, bench press, hamstring extension, back pulley, knee flexion, calf on bench. The prescription of the aerobic training was based on the reserve heart rate (HRres)[26]. Aerobic exercise was performed on treadmill or cycle ergometer, according to the individuals' adaptation, with intensity increase range from 50 to 80% of HRres. Heart rate was monitored during all the sessions to guarantee maintenance of training intensity.

STATISTICAL ANALYSIS

All analyses were performed using the SPSS (version 17.0, SPSS Inc., Chicago, IL). Data normality was checked by the Kolmogorov--Smirnov test. Student's *t* test for independent samples was used to investigate differences between means of the LIP *vs.* NoLIP individuals in the pre moment for the continuous variables with normal distribution and Mann-Whitney for not normally distributed data. Two-way ANOVA considering the repeated measures was used to determine the effects of the exercise (treatment), lipodystrophy (closing) and interaction in the pre and post-intervention moments after 24 weeks of intervention. In case of statistical significance for effects or interactions, the paired *t* test was used to investigate differences between means for the pre and post moments. Subsequently, the Cohen d coefficient was calculated to estimate the effect magnitude (EM) of the intervention, interpreted as small (EM = 0.2), medium (EM = 0.5) or big (EM = 0.8). The type d effect magnitude is the standard quantification of increase, increment, improvement or benefit which is observed due to the studied intervention. Significance level adopted was of up to 5% in all procedures.

RESULTS

The individuals infected by the HIV and suffering from LIP presented narrower thigh (T = 0.021) and calf perimeter (P < 0.0001), wider neck (P = 0.023) thorax (P = 0.039) and waist perimeter (P = 0.016) and wider WHR (P < 0.005) compared with the HIV^+ NoLIP in the pre-intervention moment (table 1). Twenty-four weeks of exercise significantly altered all the evaluated body perimeters (P < 0.0001) and the WHR (P = 0.017). Reduction in the neck, thorax and waist perimeters and increase in the arm, forearm and calf perimeters have been observed in the EX groups. The waist perimeter and the WHR increased and the arm, forearm and calf perimeters reduced only in the NoEX+LIP group (P < 0.05) after the intervention. Although the body mass and the BMI have not significantly reduced (P > 0.05) after the intervention, the body composition was considerably modified (table 2). Reduction in (P < 0.0001) in ∑ 7 SF (EM = 0.762), in %F (EM = 0.784) and FBM have been observed, as well as (EM = 0.409) increase in LBM (EM = 0.198) between the EX groups after the intervention, It is worth mentioning that the ∑ 7 SF, %F and FBM increased in the NoEX+LIP and NoEX+NoLIP groups (P < 0.05). Twenty-four weeks of intervention were effective in reducing (P < 0.0001) the TSF, BSF and PSF, regardless of the ending (LIP or NoLIP) (figure 1). TSF and BSF significantly increased for the NoEX+LIP and NoEX+NoLIP groups (P < 0.0001). Lipodystrophy effect in the PSF reduction was only observed (P < 0.0001, EM = 0.313) in the NoEX+LIP group (P < 0.0001). Twenty-four weeks of exercise resulted in significant strength improvement, regardless of the ending (LIP or NoLIP) for all selected muscle groups (P < 0.0001) (table 3). Although lipodystrophy had significantly interacted with the bench press responses (P = 0.042, EM = 0.047) and hamstring extension (P < 0.0001, EM = 0.173) along the time, only the EX groups significantly increased strength (P < 0.0001) after the intervention. The mean increase in strength of lower limbs for squat, hamstring extension and knee flexion was of 59.4 ± 28.8%, 77.5 ± 37.5% and 55.4 ± 26.1%, respectively. Concerning the exercises for upper limbs: bench press, triceps, back pulley and dumbbell curl, increase was of 44.9 ± 24.9%, 82 ± 37.4%, 55.2 ± 19.4% and 44.7 ± 19.6%, respectively. MAArm significantly increased after 24 weeks of REAC (P < 0.0001, EM = 0.252).

Table 1. Body perimeters of the individuals for the exercise and control groups, before (pre) and after (post) 24 weeks of intervention.

Perimeters (cm)	Groups	Pre	Post	ANOVA (P) EX	LIP	Interaction
Neck	EX+LIP	36.5 ± 8.3†	35.81 ± 7.8	0.0001	0.835	0.688
	NoEX+LIP	36.1 ± 3.6†	35.9 ± 3.3			
	EX+NoLIP	34.8 ± 3.5	34 ± 3.3			
	NoEX+NoLIP	33.6 ± 1.8	33.4 ± 1.8			
Thorax	EX+LIP	95.6 ± 10.1†	91.9 ± 8.8	0.0001	0.062	0.648
	NoEX+LIP	100.3 ± 9.8†	99.6 ± 10.1			
	EX+NoLIP	94.4 ± 10	89.6 ± 8.3			
	NoEX+NoLIP	94.3 ± 5.4	92.9 ± 4.8			
Waist	EX+LIP	85.9 ± 9.7†	82.0 ± 8.6‡	0.0001	0.0001	0.551
	NoEX+LIP	93.2 ± 14†	96.9 ± 13.9‡			
	EX+NoLIP	86.9 ± 15.1	79.8 ± 12‡			
	NoEX+NoLIP	80 ± 10	79.5 ± 10‡			
Arm	EX+LIP	29.2 ± 4.5	30 ± 4.5	0.0001	0.265	0.018
	NoEX+LIP	31.3 ± 4.1	30.3 ± 3.7‡			
	EX+NoLIP	29.8 ± 4.2	30.2 ± 3.9			
	NoEX+NoLIP	29.2 ± 3.6	29.2 ± 3.4			
Forearm	EX+LIP	24.8 ± 3.4	25.4 ± 3.6‡	0.0001	0.045	0.082
	NoEX+LIP	26.6 ± 2.3	26 ± 2.1‡			
	EX+NoLIP	25.5 ± 2.9	26.1 ± 3.0‡			
	NoEX+NoLIP	25.2 ± 2.0	25.3 ± 2.0			
Thigh	EX+LIP	50.3 ± 8.0†	52.5 ± 7.7‡	0.0001	0.0001	0.217
	NoEX+LIP	56.4 ± 7.0†	56.8 ± 6.9			
	EX+NoLIP	56 ± 8.0	56.4 ± 7.4			
	NoEX+NoLIP	57.3 ± 4.4	56.8 ± 3.7			
Midcalf	EX+LIP	34 ± 3.5†	34.6 ± 3.7‡	0.0001	0.137	0.025
	NoEX+LIP	36.2 ± 2.4†	35.7 ± 2.3‡			
	EX+NoLIP	37.1 ± 3.3	37.6 ± 3.2‡			
	NoEX+NoLIP	37.9 ± 1.7	38 ± 1.5			
WHR	EX+LIP	0.90 ± 0.08†	0.87 ± 0.08	0.017	0.891	0.223
	NoEX+LIP	0.91 ± 0.09†	0.94 ± 0.09			
	EX+NoLIP	0.87 ± 0.10	0.83 ± 0.10			
	NoEX+NoLIP	0.84 ± 0.08	0.82 ± 0.08			

†significant difference between LIP vs. NoLIP in the pre moment (P < 0.05); ‡significant difference between pre and post (P < 0.05); EX = exercise; NoEX = exercise control; LIP = lipodystrophy; NoLIP = lipodystrophy control; WHR = waist hip ratio. Values expressed in mean ± SD.

Table 2. Body composition of the individuals of the exercise and control groups before (pre) and after (post 24 weeks of intervention.

	Groups	Pre	Post	ANOVA (P)		
				EX	LIP	Interaction
Body mass (kg)	EX+LIP	69.0 ± 13.2	68.5 ± 10.5	0.360	0.617	0.209
	NoEX+LIP	74.0 ± 15.1	75.4 ± 14.3			
	EX+NoLIP	69.6 ± 13.6	67.8 ± 11.3			
	NoEX+NoLIP	66.2 ± 9.8	66.1 ± 9.2			
BMI (kg/m²)	EX+LIP	25.6 ± 4.9	25.3 ± 2.5	0.226	0.708	0.194
	NoEX+LIP	28.2 ± 7.6	28.7 ± 7.3			
	EX+NoLIP	25.4 ± 4.8	25.3 ± 3.3			
	NoEX+NoLIP	24.8 ± 4.1	24.7 ± 3.9			
∑ 7 SF (mm)	EX+LIP	151.5 ± 55.6	127.2 ± 44.3‡	0.0001	0.496	0.001
	NoEX+LIP	162.8 ± 61.4	172.1 ± 60.3‡			
	EX+NoLIP	140.2 ± 51.3	122.7 ± 44.0‡			
	NoEX+NoLIP	152.2 ± 41.2	157.0 ± 41.0‡			
% G	EX+LIP	28.8 ± 7.8	25.5 ± 6.5‡	0.0001	0.675	0.001
	NoEX+LIP	30.5 ± 8.5	31.9 ± 8.0‡			
	EX+NoLIP	27.3 ± 7.5	24.8 ± 6.8‡			
	NoEX+NoLIP	29.0 ± 5.4	29.7 ± 5.3‡			
Fat mass(kg)	EX+LIP	20.4 ± 8.8	17.6 ± 6.0‡	0.0001	0.922	0.026
	NoEX+LIP	23.4 ± 10.3	24.7 ± 9.9‡			
	EX+NoLIP	19.7 ± 8.8	17.7 ± 7.3‡			
	NoEX+NoLIP	19.5 ± 6.3	19.9 ± 6.0‡			
Lean mass (kg)	EX+LIP	48.6 ± 8.0	51.0 ± 8.4	0.0001	0.444	0.744
	NoEX+LIP	50.6 ± 7.9	50.6 ± 7.3			
	EX+NoLIP	49.9 ± 7.4	52.0 ± 6.6			
	NoEX+NoLIP	46.7 ± 5.5	46.2 ± 5.0			

‡significant difference between pre and post (P < 0.05); EX = exercise; NoEX = exercise control; LIP = lipodystrophy; NoLIP = lipodystrophy control; BMI = body mass index; % F = body fat percentage; ∑7SF = sum of seven skinfolds; values expressed in mean ± SD.

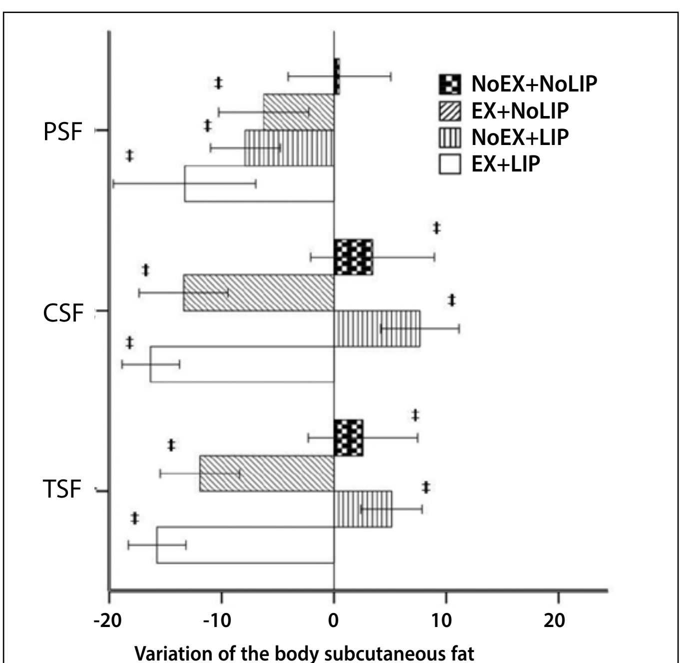

Figure 1. Body subcutaneous fat for the exercise and control groups, before and after 24 weeks of intervention.

Values expressed in mean ± SD; ‡ significant difference between pre and post intervention (P < 0.05); EX = exercise; NoEX = exercise control; LIP = lipodystrophy; NoLIP = lipodystrophy control; TSF = total subcutaneous fat (mm); CSF = central subcutaneous fat (mm); PSF = peripheral subcutaneous fat (mm). ANOVA - TSF: effect of the EX (P < 0.0001, EM = 0.763), effect of the LIP (P = 0.095, EM = 0.032), interaction (P < 0.0001, EM = 0.183); CSF: effect of the EX (P < 0.0001, EM = 0.765), effect of the LIP (P = 0.453, EM = 0.007), interaction (P < 0.0001, EM = 0.203); PSF: effect of EX (P < 0.0001, EM = 0.275), effect of LIP (P < 0.0001, EM = 0.313), interaction (P = 0.876, EM < 0.0001).

Table 3. Muscular strength of the individuals of the exercise and control groups, before and after 24 weeks of intervention.

	Groups	Pre	Post	ANOVA (P)		
				EX	LIP	Interaction
Squat (kg)	EX+LIP	20.8 ± 4.6	31.2 ± 5.5	0.0001	0.301	0.316
	NoEX+LIP	21.4 ± 5.3	21.6 ± 5.3			
	EX+NoLIP	19.6 ± 4.0	31.3 ± 5.5			
	NoEX+NoLIP	19.8 ± 4.2	20.0 ± 4.0			
Bench press (kg)	EX+LIP	18.7 ± 4.2	24.2 ± 4.3‡	0.0001	0.042	0.016
	NoEX+LIP	14.2 ± 5.8	14.5 ± 5.4			
	EX+NoLIP	15.8 ± 5.0	24.0 ± 7.5‡			
	NoEX+NoLIP	16.4 ± 4.2	16.5 ± 4.7			
Hamstring extension (kg)	EX+LIP	26.8 ± 7.9	40.2 ± 8.7‡	0.0001	0.0001	0.0001
	NoEX+LIP	25.8 ± 7.3	26.3 ± 7.8			
	EX+NoLIP	25.2 ± 8.6	46.9 ± 11.6‡			
	NoEX+NoLIP	27.9 ± 7.9	27.5 ± 7.0			
Triceps (kg)	EX+LIP	18.7 ± 6.2	34.4 ± 8.5	0.0001	0.098	0.380
	NoEX+LIP	22.1 ± 7.0	22.6 ± 7.0			
	EX+NoLIP	19.4 ± 5.7	32.8 ± 7.5			
	NoEX+NoLIP	24.2 ± 7.3	24.0 ± 7.4			
Back pulley (kg)	EX+LIP	28.1 ± 7.3	43.9 ± 10.3	0.0001	0.555	0.907
	NoEX+LIP	32.4 ± 9.3	31.8 ± 9.6			
	EX+NoLIP	30.0 ± 8.5	45.2 ± 11.6			
	NoEX+NoLIP	33.5 ± 10.1	32.5 ± 9.5			
Knee flexion (kg)	EX+LIP	18.8 ± 3.5	29.0 ± 4.0	0.0001	0.439	0.234
	NoEX+LIP	20.5 ± 4.7	20.4 ± 4.5			
	EX+NoLIP	18.0 ± 4.7	27.0 ± 5.7			
	NoEX+NoLIP	21.4 ± 5.9	21.5 ± 5.4			
Dumbbell curl (kg)	EX+LIP	13.5 ± 2.5	18.9 ± 3.5	0.0001	0.778	0.274
	NoEX+LIP	13.5 ± 3.4	13.0± 2.9			
	EX+NoLIP	13.5 ± 3.4	19.5 ± 4.8			
	NoEX+NoLIP	13.5 ± 3.7	13.0 ± 3.0			
MAArm (cm²)	EX+LIP	39.2 ± 16.6	45.7 ± 18.0‡	0.0001	0.627	0.015
	NoEX+LIP	48.2 ± 13.7	45.5 ± 11.4			
	EX+NoLIP	39.9 ± 15.6	42.9 ± 14.4‡			
	NoEX+NoLIP	35.6 ± 12.8	35.2 ± 11.6			

‡ significant difference between pre and post (P < 0.05); EX = exercise; NoEX = exercise control ; LIP = lipodystrophy; NoLIP = lipodiystrophy control; Values expressed in mean ± SD.

The individuals infected by the HIV with LIP presented lower VO_{2max} compared with the NoLIP ones in the pre-moment (P = 0.027). The VO_{2max} significantly increased (P < 0.0001, EM = 0.548) in the EX+LIP (from 28.6 ± 7.1 to 34.0 ± 6.7 $mL.kg.min^{-1}$) and EX+NoLIP groups (from 32.0 ± 7.6 to 36.3 ± 7.9 $mL.kg.min^{-1}$) after 24 weeks of intervention (figure 2). In NoEX+LIP and NoEx+NoLIP groups there was no significantly difference (P > 0.05) between the pre and post-moments, which reinforces the exercise effect as a single modulator of VO_{2max}.

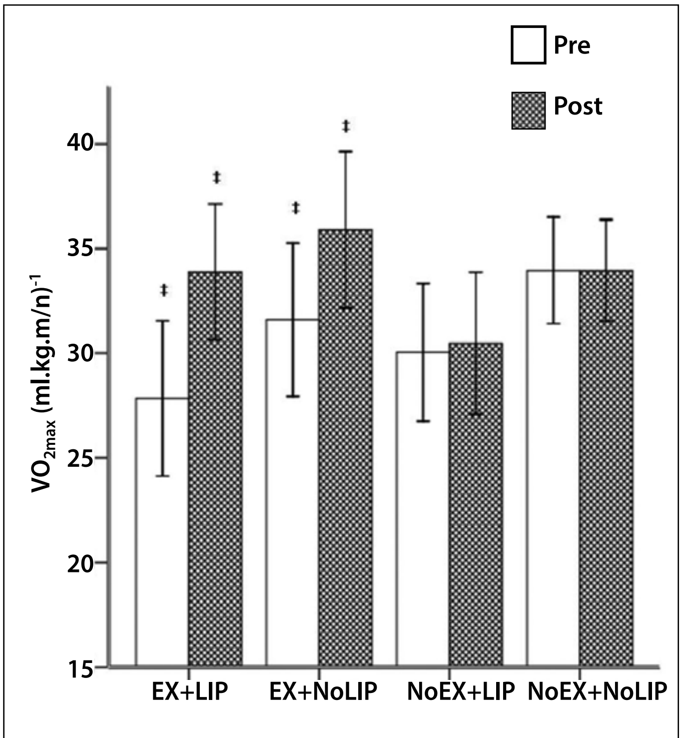

Figure 2. Maximum oxygen consumption (VO_2max) of the individuals of the exercise and control groups, before (pre) and after (post) 24 weeks of intervention.
Values expressed in mean ± SD; †significant difference between LIP vs. NoLIP in the pre moment ($P < 0.05$); ‡significant difference between pre and post ($P < 0.05$); EX = exercise; NoEX = exercise control; LIP = lipodystrophy; NoLIP = lipodystrophy control; ANOVA: Ex effect ($P < 0.0001$, EM = 0.586); LIP effect ($P = 0.083$, EM = 0.039); interaction ($P = 0.656$, EM = 0.003).

DISCUSSION

Our findings indicate that 24 weeks of REAC positively modulated the body perimeters, body composition, strength of upper and lower limbs and maximum oxygen consumption in HIV^+ individuals submitted to HAART. This is the first random and controlled study to demonstrate that REAC is a safe, practical and effective method in controlling the anthropometric and functional alterations of HIV^+ individuals submitted to HAART, in the southeast of Brazil. WE believe that our results are especially important due to the wide access of the HIV^+ Brazilian population to the HAART[15].

Exercised HIV-infected individuals, regardless of the ending (LIP orNoLIP), presented significant reduction of the thorax and waist measurements and increase of arm, forearm, thigh and calf measurements. Reduction in waist perimeter and WHR observed in the present study corroborates previous findings[27,28], besides aiding in reducing the risk for cardiovascular disease[29]. On the other hand, our data show increase in waist perimeter and WHR only for the not exercised group with lipodystrophy, indicating hence that the sedentary condition added to lipodystrophy may contribute to the development of risk of cardiovascular disease[30]. Moreover, although the REAC has not influenced on body mass and BMI, positive alterations were confirmed by the increase of lean body mass and reduction of fat body mass, effects previously reported for strength exercise[31] and aerobic exercise[28].

REAC was effective in reducing TSF, CSF and PSF. Similar result was observed for reduction of trunk body fat [13] and visceral one[32]. Additionally, our results indicate increase of TSF and CSF and reduction of PSF during the 24 weeks for not exercised individuals HIV-infected. Thus, it is worth mentioning that besides contributing to the reduction of body fat, exercising prevents its build-up in HIV^+ individuals [33]. Alterations in the fat compartments in the central region of the body have been associated with insulin resistance, dyslipidemia, hypercholesterolemia and risk of cardiovascular disease. Although radiological image methods have not been used, the exercised women reduced waist perimeter (from 88.6 ± 12.7 cm to 81.2 ± 11.6 cm) to a value below the recommended cohort point (≤ 88 cm)[34]. Waist perimeter also reduced in men (83.8 ± 10.4 cm to 81.3 ± 8.5 cm) being below the recommended cohort point (≤ 102 cm)[34].

Maximal voluntary muscular strength increased in the muscle groups evaluated. This fact can be explained by the increase of LBM and MAArm, as previously reported[35]. Muscular strength is an essential component to the performance of activities of daily living, besides being strongly related to physical and motor independence. The muscular strength increase observed in the present study was not related to the ending (LIP or NoLIP); that is to say, regardless of the distribution of body fat, REAC prevails and acts in a decisive manner in strength increase. Although the strength training prescription follows the recommendation for healthy adults [36], the training loads were well-tolerated and promoted morphological adaptations for the sample involved in the study. Similar results were reported for assays involving progressive strength exercise [31,37,38] and combined exercise[13,14] for HIV^+ individuals. Thus, 12 to 24 weeks of progressive strength training guaranteed significant increase of muscular strength when performed at least three times per week, 6-12 RM per exercise, at approximately 70-85% of 1-RM.

In the initial intervention moment, it was observed that HIV^+ individuals with lipodystrophy presented lower VO_{2max} when compared with the HIV^+ individuals without lipodystrophy. It has been observed, in a decreasing scale, that compromising with the extraction capacity and use of oxygen by the muscle fiber occurs in a higher level in the HIV^+ individuals submitted to HAART, then in the infected ones without use of HAART and finally in the HIV^- [12]. Possibly, the mechanisms involved in this process are related to the HIV infection and inflammation, with HAART or with a combination of these factors [39]. Our data, like others [28,40] involving not trained HIV^+ individuals, have revealed low estimated value of VO_{2max} (~ 30 ml/kg/min) and increase after intervention with aerobic training [28] and combined training[40]. Although only 1/3 of the intervention time consisted in aerobic exercise, the increase in the oxygen consumption (16.5%) was very close to the one found for African individuals (19%) who participated in an aerobic training program for 24 weeks[28]. This result may be explained by the increase of lean mass (2.2 ± 3.2 kg) and by the fact that, after the HIV infection diagnosis, problems related to depression result in social isolation, a situation favorable to limitation of aerobic capacity.

CONCLUSION

Regular physical exercise acts in a decisive manner in the control of anthropometric and functional alterations in HIV patients submitted to HAART. Twenty-four weeks of REAC avoided the manifestation of alterations derived from the SLHIV and contributed to their reduction. REAC was an effective, practical and low-cost method to be incorporated in programs of basic health care, especially in fields with limited resources.

All authors have declared there is not any potential conflict of interests concerning this article.

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