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# Effectiveness of functional training versus resistance exercise in patients with psoriatic arthritis: randomized controlled trial

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## Abstract

**Objective** This study aims to evaluate the effect of functional versus resistance exercise training on the functional capacity and quality of life of psoriatic arthritis patients.

**Methods** Forty-one psoriatic arthritis patients (18 to 65 years old) were randomized into two groups: functional training group and resistance exercise group. The functional training group underwent functional exercises with elastic band and the functional training group underwent machine resistance exercise twice a week for 12 weeks. Outcome measures were: The Bath Ankylosing Spondylitis Functional Index (BASFI) and Health Assessment Questionnaire for the Spondyloarthropathies (HAQ-S) for functional capacity and functional status, one-repetition maximum test for muscle strength, the Short Form 36 health survey questionnaire (SF-36) for quality of life, and the Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) and the Disease Activity Score 28 (DAS-28) for disease activity. Analyzes were performed by a blinded evaluator at baseline (T0), six (T6) and twelve (T12) weeks after the beginning of the exercise.

**Results** At baseline, the groups were homogeneous in the clinical and demographic characteristics. There was a statistical intra-group improvement for both groups in the BASFI, BASDAI, HAQ-s, and DAS-28. In the quality-of-life assessment, both groups showed statistical intra-group improvements for all domains except the "emotional aspect" domain in the resistance exercise group. In the muscle strength, there was a statistical improvement for all exercises in both groups, except for the "alternate biceps (bilateral)" exercise.

**Conclusion** Functional training and resistance exercise are similarly effective in improving functional capacity, functional status, disease activity, general quality of life, and muscle strength in patients with psoriatic arthritis.

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**Keywords** Functional exercises, Strength training, Functional capacity, Spondyloarthritis, Quality of life

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## Background

Psoriatic arthritis (PSA) is a complex inflammatory joint disease that is present in 6 to 42% of patients with psoriasis [1–3]. PSA belongs to the heterogeneous group of spondyloarthritis, described by axial inflammatory pain associated to peripheral arthritis and enthesopathies. In

addition to pharmacological treatment, moderate evidence has been observed over the years regarding the benefits of exercise in the treatment of spondyloarthritis [4–6].

Exercise programs act as adjuvant interventions, primarily by alleviating symptoms of PSA, reducing pain, and improving function and quality of life. Physical training helps enhance the physical capacity of these patients through joint movement, targeted muscle group contraction, and activities that develop postural musculature, balance, and muscle stabilization. Furthermore, exercises have been shown to provide emotional and psychological benefits to patients with musculoskeletal conditions [7, 8]. Recently, a systematic review of 24 randomized controlled trials on the effects of physical exercise in patients with ankylosing spondylitis (AS) has been carried out. The authors found moderate evidence for physical exercise in improving physical function and disease activity. However, they concluded that the best exercise protocol for patients with AS is still unknown [7]. The impact of high-intensity interval training on disease activity and disease perception in patients with PSA was evaluated through a randomized controlled trial involving 67 subjects. The authors demonstrated that the exercise group reported less fatigue after the intervention, and the training program was found to be safe and well-tolerated by the patients [9]. Meanwhile, in another study, our research team found positive results in a 12-week resistance exercise intervention with improvement in the functional capacity and quality of life in PSA [8]. Perhaps, a program incorporating both aerobic and resisted exercises would improve the quality of life for patients with the disease; however, there is limited scientific evidence to support this assertion.

Functional exercise programs have been cited in studies as an effective rehabilitation method, aiming to improve ADL performance and develop stability, agility, proprioception, strength, and muscular endurance [10, 11]. While traditional strength training places emphasis on a gradual increase in load or weight, functional training seeks to increase the quality of movement by practicing skills related to the movement [12]. This study aims to evaluate the effectiveness of functional training versus resistance training in improving the functional capacity and quality of life of patients with PSA.

## Material and methods

This study is a 12-week, single-blind, parallel, randomized controlled trial.

The inclusion criteria were: having the PSA classification confirmed according to CASPAR criteria [4], aged between 18 and 65 years old of both genders and who agreed to sign the informed consent form; patients should have been on disease-modifying antirheumatic drugs and biological drugs therapy with stable doses for at least three months; stable non-steroidal anti-inflammatory drugs and corticosteroids for at least four weeks.

Patients with uncontrolled cardiovascular disease and diabetes mellitus, severe psychiatric illnesses, fibromyalgia, practice of regular exercise (at least 30 min twice a week) in the last 6 months, hip or knee arthroplasty in the last 12 months and any other medical treatment or condition that would prohibit the patient from performing exercises were excluded.

This study was approved by the Ethics Committee of the University.

### Population

Forty-one patients classified with PSA were recruited in the outpatient clinics of our institution. We randomized patients using an electronic randomization table, creating two distinct groups: the functional training group (FT) and the resistance exercise group (RE). Then, the allocation was placed in brown envelopes, so that we could keep the allocation concealment.

### Interventions

#### *Functional training*

FT patients performed functional exercises for upper, lower and trunk muscle groups. The exercises were performed with elastic bands.

For the performance of lower limb exercises, a common bench was used to perform knee extensor and hip extension exercises. For the performance of upper limb exercises, the triceps, biceps and frontal pull exercises were performed with an elastic band.

For the prescription of exercises, the recommendations of the American College of Sports Medicine were followed [13]. Two exercises were performed for large muscle groups and one exercise for small ones in three sets of 12 repetitions for each muscle group. The intensity of the exercises, assessed at the initial evaluation (T0) and after 6 weeks (T6), was performed according to the condition of each patient, including factors such as pain or any more limiting condition to reproduce the movement with quality. When patients reported a perceived exertion level of "somewhat hard" (still reasonably comfortable), the resistance exercise intensity was increased by advancing to the next color band (yellow for light, grey for medium, and green for strong). The training included the following exercises for muscle groups: Pectorals: elastic band crossover and supine; biceps: biceps curl; triceps: triceps pulley; back: seated row and handsaw; quadriceps: leg extension; gluteus: standing hip extension.

#### *Resistance exercise*

For the RE group, the choices of the exercise repertoire, as well as the sets, were made equally to the FT group, however, the elastic bands were replaced by weight machines.

Regarding the load, for the RE group, the 1RM test was performed at the first evaluation (T0) and after 6 weeks (T6), with the objective of working at an intensity of 60% and avoiding muscle injuries, considering that these patients were sedentary.

Both groups' training sessions were overseen by a physical education teacher with 10 years of experience in physical training. Each exercise session for both groups lasted approximately 55 min, occurring twice a week for 12 weeks. Each training session was attended by groups of 3 patients, and there was a 1–2 min rest interval between exercises.

### Assessment

Both groups were assessed by the same blinded evaluator, who had experience with the applied instruments. Evaluations were carried out individually, immediately before the patients were randomized (T0), 6 weeks (T6) and 12 weeks (T12) after the beginning of the training. The first evaluation (T0) occurred one to three days before the start of the exercise programs, and each assessment lasted about 30 min.

### Assessment tools

#### *Primary outcome*

HAQ-S (Health Assessment Questionnaire for the Spondyloarthropathies): modified for patients with AS, this is a questionnaire that evaluates the functional status of patients. It consists of 20 items subdivided into 8 categories. Each question ranges from zero (without functional impairment) to three (unable to perform the task) [14].

#### *Secondary outcome*

BASFI (The Bath Ankylosing Spondylitis Functional Index): consists of ten questions about the functional capacity of the patient with AS to perform daily activities. All items are evaluated with a visual analog scale (VAS) that has no marks, except for the indications "without any difficulty" and "unable to perform" at the beginning and end of the line, in order to indicate the direction of severity. The average of the results of the ten scales is the BASFI score (0–10) with the highest scores indicating greater impairment of capacity [15].

Muscle strength was assessed using the 1RM test, which determines the maximum load a muscle group can lift in a single repetition. The 1RM test was conducted at three time points: before randomization (T0), at 6 weeks (T6), and at 12 weeks (T12) after the initiation of training for each of the following movements (on a weight machine): Crucifix, seated supine, front pull, triceps pulley, hand saw (right and left), biceps (right and left), leg extension (right and left), and gluteus.The evaluator, a physical therapist, explained the test's objectives to the subjects and demonstrated the movements. The patients were properly positioned, and a warm-up of 6 to 10 repetitions with a moderate load was conducted in each position. The load was incrementally raised after each successful repetition, and the test concluded when failure occurred at the same load twice. Subjects had a 1-min rest between repetitions for recovery [16, 17].

#### *Disease activity*

BASDAI (The Bath Ankylosing Spondylitis Disease Activity Index): consists of six questions related to five symptoms in the previous week (fatigue, joint or spinal pain, aching pain and morning stiffness).

All items are evaluated on a 10-cm horizontal visual analog scale (VAS). The BASDAI score is obtained by adding the values of the first five questions and the higher scores reflect greater disease activity [18].

DAS 28: (Disease Activity Score 28). Clinical activity index that combines information from painful and inflamed joints (shoulders, elbows, wrists, metacarpophalangeal, proximal interphalangeal and knees); ESR in the first hour (in mm) or C-reactive protein; overall patient assessment measured in 100 mm VAS. The instrument allows to classify patients with PSA as in remission (less than 2.6), mild activity (2.6–3.2), moderate (3.2–5.1) or intense (above 5.1) [18].

Quality of life: The Short Form 36 health survey questionnaire (SF-36) was used, which consists of a generic questionnaire for quality of life. It consists of eight domains: functional capacity, limitation due to physical aspects, pain, general health, vitality, social and emotional aspects, and mental health. Scores range from 0 (zero) to 100 (one hundred), and the higher the score, the better the quality of life [19].

### Statistical analysis

Sample size: As a statistical method, we used the ANOVA, analysis of repeated measures, to calculate the sample size. A minimal sample of 20 individuals in each group was required to detect a difference of 0.4 points on the HAQ-S, with a standard deviation of 0.4, $\alpha$ of 5 and 80% test power.

SPSS software version 15.0 (Chicago, IL) was used to perform the statistical analysis of the data. Descriptive analysis (average, standard deviation, 95% confidence interval) was used to characterize patients in the groups. The initial continuous variables of both groups were

compared using the t-Student test (for variables with normal distribution) and the Mann–Whitney test (for variables with distribution not considered normal). Categorical variables were assessed using the chi-square test.

To analyze the response to the intervention, the intention-to-treat analysis was used. As many variables did not have a normal distribution, we used GLM (Generalized Linear Models) with varied probability distributions that best fit the data in order to assess the response to intergroup and intragroup treatment over time. The level of statistical significance adopted was 5%.

## Results

A total of 70 patients were contacted, but 29 did not want to participate in the study for different reasons, among them, patients who lived far from the training site and due to unavailability of schedules.

After the contact process, 41 patients were recruited and randomized, 20 in the FT group and 21 in the RE group. There was no dropout in both groups during the course of the study (Fig. 1). Adherence to the exercise programs was high and similar in both groups, with the functional training group achieving a frequency of 83.4%, while the resistance exercise group had a frequency of 91.7% over the 12-week period.

The average age of the patients included in the study was 52, there were no statistical differences in T0 in demographic characteristics, disease symptoms, duration of illness, associated diseases, and medications, except for the use of folic acid. When using Fisher's exact test, we found that the intervention group has a significantly higher proportion of patients using this medication than the RE group ($p=0.048$) (Table 1).

Table 2 shows the results of the BASFI, HAQ-S, BASDAI and DAS 28 assessments for both groups of patients at different times. We did not find statistical differences between the groups in the variables BASFI ($p=0.919$), BASDAI ($p=0.700$), HAQ-S ($p=0.932$) and DAS-28 ($p=0.106$). However, we found statistical differences between the times ($p$ intragrou$p=0.007$, $p$ intragroup $<0.001$, $p$ intragroup $<0.001$ and $p$ intragroup $<0.001$, valid for both groups) successively.

Table 3 shows the results of the evaluation of the general quality of life by SF 36 of both groups of patients. In the FT and RE groups, improvement was observed in all domains over time, except in the "social aspects" domain, there was improvement only for the FT group.

Table 4 shows the evaluation of muscle strength by the 1RM test. There was an increase in strength in the FT group in all exercises performed, except for biceps

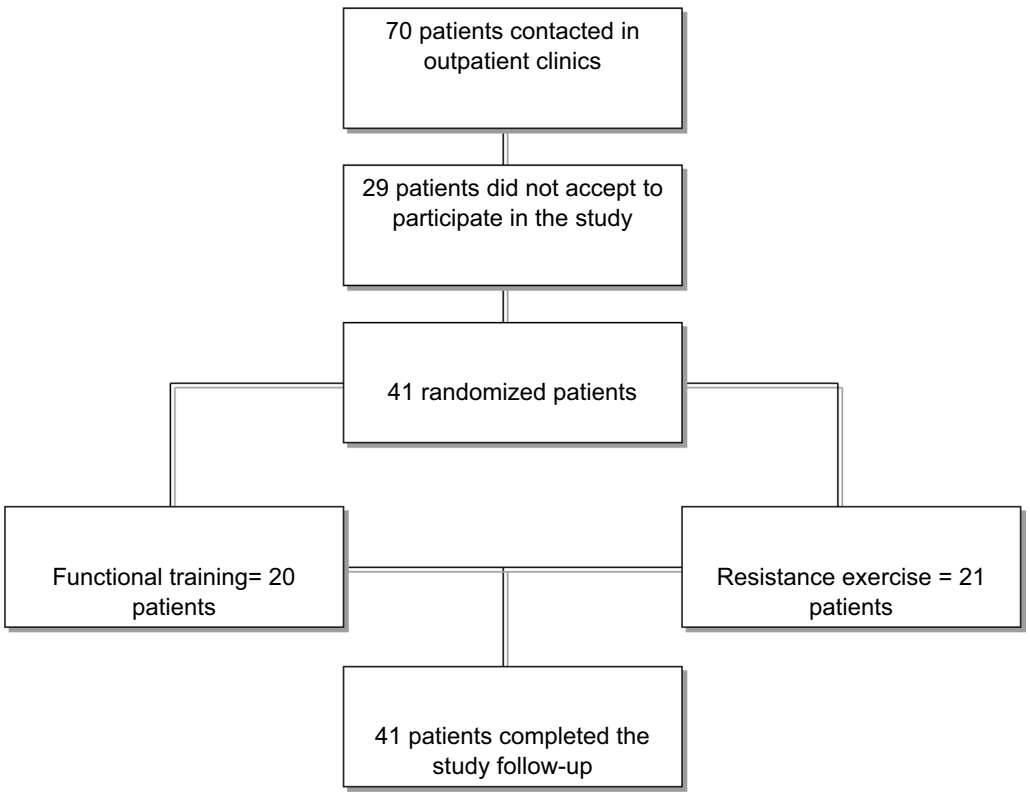


**Fig. 1** Flow diagram representing enrollment, allocation, procedures, and analysis

**Table 1** Demographic and clinical characteristics of the participants at baseline

| | FT (N = 20) | RE (N = 21) |
|---|---|---|
| Age—(years) mean (SD) | 52.4 (10.0) | 51.0 (11.6) |
| Gender (%) | | |
| Male | 10 (50%) | 9 (46%) |
| Female | 10 (50%) | 11 (54%) |
| Peripheral manifestation (%) | 4 (19.0%) | 17 (81%) |
| Axial + peripheral manifestation (%) | 1 (5.0%) | 4 (19%) |
| Disease duration—(years) mean (SD) | 12.8 (9.9) | 16.0 (10.8) |
| Associated diseases (%) | | |
| Systemic arterial hypertension | 15 (75%) | 10 (48%) |
| Diabetes Mellitus | 5 (25%) | 11 (52%) |
| Medications (%) | | |
| Methotrexate | 16 (80%) | 17 (80%) |
| Acetylsalicylicacid | 3 (15%) | 7 (33%) |
| Folicacid | 4 (20%) | 5 (23%) |
| Enalapril | 2 (10%) | 7 (33%) |
| Hydrochlorothiazide | 3 (15%) | 4 (19%) |
| Inflixmabe | 3 (15%) | 5 (23%) |
| Cyclosporine | 4 (20%) | 3 (14%) |
| Smoking n (%) | 0 (%) | 0 (%) |

FT: functional training; RE: resistance exercise; SD: standard deviation

**Table 2** Evaluation of BASFI, BASDAI, HAQs and DAS-28 of the two groups of patients with psoriatic arthritis, at different times of follow-up

| Outcomes | FT (N = 20) | RE (N = 21) | p-value between-group (GLM) |
|---|---|---|---|
| BASFI | | | $p = 0.919$ |
| T0 | 4.2 (2.6) | 3.8 (2.4) | |
| T6 | 3.3 (2.5)# | 3.3 (2.3)# | |
| T12 | 2.8 (2.1)# | 3.3 (2.1)# | |
| Intragroup (GLM) | *$p = 0.007$ | *$p = 0.007$ | |
| BASDAI | | | $p = 0.700$ |
| T0 | 5.2 (2.4) | 4.7 (2.2) | |
| T6 | 3.3 (2.4)# | 3.8 (2.2)# | |
| T12 | 3.2 (2.0)# | 3.8 (2.2)# | |
| Intragroup (GLM) | *$p < 0.001$ | *$p < 0.001$ | |
| HAQs | | | $p = 0.932$ |
| T0 | 0.71 (0.43) | 0.66 (0.4) | |
| T6 | 0.52 (0.41)# | 0.52 (0.4)# | |
| T12 | 0.44 (0.42)# | 0.52 (0.4)# | |
| Intragroup (GLM) | *$p < 0.001$ | *$p < 0.001$ | |
| DAS-28 | | | $p = 0.106$ |
| T0 | 4.0 (1.3) | 4.2 (1.1) | |
| T6 | 3.0 (1.1)# | 3.6 (0.9)# | |
| T12 | 3.0 (1.2)# | 3.8 (1.1)# | |
| Intragroup (GLM) | *$p < 0.001$ | *$p < 0.001$ | |

Data are mean (SD)

Generalized Linear models (GLM) between intervention groups at times T0, T6 and T12. *$p \leq 0.05$ in intragroup comparison. #: *$p < 0.05$ in relationship to T0 in the same group.

exercises (bilateral). In the RE group, there was an increase in strength in all exercises performed, however, there were no statistically significant improvements in exercises for "biceps (bilateral)" and "pull-ahead". When performing the intergroup analysis, no statistical differences were observed. No adverse events were found in either group.

## Discussion

This was the first study to implement a functional training and resistance exercise program in patients with PSA. In this study, the average age was 52, which contrasts with the literature, where the average age typically ranges from 35 to 45. [20]. Our sample was recruited through our outpatient clinics, in which the population, in general, has a higher age characteristic than most works.

The most frequent associated disease in this study was hypertension, 75% of the population in the FT and 47% in the RE group had this cardiovascular risk. These data are compatible with the study by Khraishi et al. [21], who evaluated the prevalence of cardiovascular risk factors in patients with PSA, resulting in the presence of systolic arterial hypertension in 32.7% of the studied population. Similarly, the same data are found in the study by Ahlehoff et al. [22], in which this prevalence has been increasing considerably between 22.9 to 49.3% for hypertension and 2.2 to 5.3% for diabetes. Diabetes was also present in the sample studied, 25% and 52.4% for FT and RE respectively.

With the increase in the prevalence of the disease, numerous studies have been carried out on pharmacological treatments in PSA. Singh et al. [23] describe for peripheral and / or axial manifestations, medications such as non-steroidal anti-inflammatory drugs, methotrexate, cyclosporine and biological therapy are indicated. In the present study, patients were using methotrexate, infliximab and cyclosporine, medications that are in accordance with international recommendations for the treatment of PSA [23].

Due to the scarcity of works of high methodological rigor, our data will be compared with studies of different rheumatic diseases, but with similar characteristics.

In 2018, we conducted a controlled, randomized, blind study, with the objective of test the effectiveness of resistance training in patients with PSA, it was a 12-week study. The results were positive for numerous variables studied; however, the control group was on the waiting list [8]. In this way, we decided to check if functional training would be as effective as resistance training.

**Table 3** Evaluation of SF-36 questionnaire of the two groups of patients with psoriatic arthritis, at different times of follow-up

| Domains—SF36 | FT N = 20 | RE N = 21 | p-value between-group (GLM) |
|---|---|---|---|
| Physical capacity | | | $p = 0.520$ |
| T0 | 60.8 (25.2) | 72.9 (15.5) | |
| T6 | 71.5 (23.0)$^{\#}$ | 71.7 (16.0)$^{\#}$ | |
| T12 | 77.2 (22.4)$^{\#\,\#\#}$ | 71.2 (18.4)$^{\#,\,\#\#}$ | |
| Intragroup (GLM) | *$p < 0.001$ | *$p < 0.001$ | |
| Role physical | | | $p = 0.517$ |
| T0 | 38.8 (44.0) | 39.3 (45.8) | |
| T6 | 63.8 (40.1)$^{\#}$ | 59.5 (41.4)$^{\#}$ | |
| T12 | 71.3 (45.4)$^{\#}$ | 56.0 (48.0)$^{\#}$ | |
| Intragroup (GLM) | *$p = 0.002$ | *$p = 0.002$ | |
| Pain | | | $p = 0.211$ |
| T0 | 47.4 (23.1) | 51.4 (19.3) | |
| T6 | 69.7 (21.0)$^{\#}$ | 60 (23.8)$^{\#}$ | |
| T12 | 72.4 (19.2)$^{\#\,\#\#}$ | 63.3 (23.8)$^{\#\,\#\#}$ | |
| Intragroup (GLM) | *$p < 0.001$ | *$p < 0.001$ | |
| General health status | | | $p = 0.674$ |
| T0 | 51.6 (10.2) | 50.2 (9.7) | |
| T6 | 64.2 (10.6)$^{\#}$ | 57.0 (14.2)$^{\#}$ | |
| T12 | 61.4 (13.1)$^{\#}$ | 60.6 (15.3)$^{\#}$ | |
| Intragroup (GLM) | *$p < 0.001$ | *$p < 0.001$ | |
| Vitality | | | $p = 0.325$ |
| T0 | 52.2 (18.4) | 62.4 (21.2) | |
| T6 | 66.3 (17.1)$^{\#}$ | 71.0 (17.1)$^{\#}$ | |
| T12 | 72.0 (11.4)$^{\#}$ | 72.1 (11.8)$^{\#}$ | |
| Intragroup (GLM) | *$p < 0.001$ | *$p < 0.001$ | |
| Social role | | | $p = 0.502$ |
| T0 | 67.9 (27.0) | 79.2 (25.4) | |
| T6 | 85.6 (25.2)$^{\#}$ | 79.8 (28.1) | |
| T12 | 78.3 (24.3) | 76.2 (31.1) | |
| Intragroup (GLM) | *$p = 0.005$ | $p = 0.701$ | |
| Emotional aspects | | | $p = 0.267$ |
| T0 | 46.4 (43.9) | 61.9 (43.8) | |
| T6 | 65.7 (42.4)$^{\#}$ | 81.0 (32.6)$^{\#}$ | |
| T12 | 80.5 (33.6)$^{\#}$ | 82.5 (37.8)$^{\#}$ | |
| Intragroup (GLM) | *$p = 0.002$ | *$p = 0.002$ | |
| Mental health | | | $p = 0.38$ |
| T0 | 61.6 (17.5)$^{\#}$ | 66.9 (17.4)$^{\#}$ | |
| T6 | 72.2 (11.8)$^{\#}$ | 72.2 (12.4)$^{\#}$ | |
| T12 | 72.0 (15.0) | 74.9 (14.8) | |
| Intragroup (GLM) | *$p = 0.002$ | *$p = 0.002$ | |

Data are mean (SD)

Generalized linear model (GLM) between intervention groups in the timesT0, T6 e T12. *$p \leq 0{,}05$ in intragroup comparison. #: *$p < 0.05$ in relationship T0 in the same group. ##: *$p < 0.05$ in relationship to T6 in the same group.

**Table 4** Evaluation of muscle strength by the one-repetition maximum test (1RM)

| Exercises | FT N = 20 (Kg) | RE N = 21 (Kg) | p-value Between-group (GLM) |
|---|---|---|---|
| Crucifix | | | $p = 0.639$ |
| T0 | 5.62 (2.27) | 5.45 (2.46) | |
| T6 | 6.50 (2.24)$^{\#}$ | 6.48 (2.09)$^{\#}$ | |
| T12 | 6.86 (1.68)$^{\#\,\#\#}$ | 7.30 (2.05)$^{\#\,\#\#}$ | |
| Intragroup (GLM) | *$p < 0.001$ | *$p < 0.001$ | |
| Seated supine | | | $p = 0.353$ |
| T0 | 21.1 (12.2) | 23.3 (12.5) | |
| T6 | 27.0 (8.9)$^{\#}$ | 26.0 (10.1)$^{\#}$ | |
| T12 | 28.4 (14.1)$^{\#\,\#\#}$ | 28.2 (11.0)$^{\#\,\#\#}$ | |
| Intragroup (GLM) | *$p < 0.001$ | *$p < 0.001$ | |
| Front pull | | | $p = 0.855$ |
| T0 | 27.6 (7.6) | 31.2 (7.9) | |
| T6 | 32.4 (7.2)$^{\#}$ | 31.5 (7.9) | |
| T12 | 32.9 (7.2)$^{\#}$ | 31.5 (6.4) | |
| Intragroup (GLM) | *$p < 0.001$ | $p = 0.971$ | |
| Tríceps pulley | | | $p = 0.825$ |
| T0 | 24.3 (8.9) | 26.3(8.4) | |
| T6 | 28.0 (8.6) | 27.4 (8.4)$^{\#}$ | |
| T12 | 31.3 (8.3)$^{\#}$ | 29.6 (8.9)$^{\#\,\#\#}$ | |
| Intragroup (GLM) | $p = 0.025$ | *$p < 0.001$ | |
| Hand saw (L) | | | $p = 0.917$ |
| T0 | 18.2 (9.7) | 20.0 (10.7) | |
| T6 | 23.5 (11.0)$^{\#}$ | 24.3 (13.4)$^{\#}$ | |
| T12 | 28.2 (14.8)$^{\#}$ | 25.9 (11.7)$^{\#}$ | |
| Intragroup (GLM) | *$p < 0.001$ | *$p < 0.001$ | |
| Hand saw (R) | | | $p = 0.715$ |
| T0 | 21.0 (10.3) | 22.8 (12.6) | |
| T6 | 23.5 (11.7)$^{\#}$ | 26.0 (13.9)$^{\#}$ | |
| T12 | 25.3 (12.2)$^{\#}$ | 26.6 (11.6)$^{\#}$ | |
| Intragroup (GLM) | *$p = 0.005$ | *$p = 0.005$ | |
| Biceps (L) | | | $p = 0.973$ |
| T0 | 7.5 (3.4) | 7.7 (3.1) | |
| T6 | 7.3 (2.5) | 7.5 (2.3) | |
| T12 | 7.5 (2.1) | 7.5 (2.6) | |
| Intragroup (GLM) | $p = 0.259$ | $p = 0.259$ | |
| Biceps (R) | | | $p = 0.795$ |
| T0 | 7.9 (4.1) | 8.3 (3.6) | |
| T6 | 7.2 (2.6) | 7.5 (2.4) | |
| T12 | 7.6 (2.5) | 7.6 (2.0) | |
| Intragroup (GLM) | $p = 0.253$ | $p = 0.253$ | |
| Leg extension (L) | | | $p = 0.232$ |
| T0 | 20.5 (9.1) | 20.4 (8.7) | |
| T6 | 25.6 (12.3)$^{\#}$ | 23.7 (7.7)$^{\#}$ | |
| T12 | 33.2 (15.0)$^{\#\,\#\#}$ | 27.5 (7.8)$^{\#\,\#\#}$ | |
| Intragroup (GLM) | *$p < 0.001$ | *$p < 0.001$ | |
| Leg extension (R) | | | $p = 0.185$ |
| T0 | 20.5 (7.1) | 21.0 (8.8) | |

**Table 4** (continued)

| Exercises | FT N = 20 (Kg) | RE N = 21 (Kg) | p-value Between-group (GLM) |
|---|---|---|---|
| T6 | 29.9 (11.7)$^{\#}$ | 24.0 (8.8)$^{\#}$ | |
| T12 | 36.1 (13.8)$^{\#\,\#\#}$ | 29.1 (8.9)$^{\#\,\#\#}$ | |
| Intragroup (GLM) | *$p < 0.001$ | *$p < 0.001$ | |
| Gluteus | | | $p = 0.727$ |
| T0 | 9.5 (2.3) | 10.4 (3.4) | |
| T6 | 10.3 (3.0)$^{\#}$ | 11.5 (3.0)$^{\#}$ | |
| T12 | 13.0 (3.1)$^{\#\,\#\#}$ | 12.3 (3.2)$^{\#\,\#\#}$ | |
| Intragroup (GLM) | *$p < 0.001$ | *$p < 0.001$ | |

Data are mean (SD)

Generalized linear model (GLM) between intervention groups in the times T0, T6 e T12. *$p \leq 0{,}05$ in intragroup comparison. #: *$p < 0.05$ in relationship T0 in the same group. ##: *$p < 0.05$ in relationship to T6 in the same group. (L) left side, (R) right side.

Functional training involves compound and complex movement patterns, with the goal of enhancing functional strength, endurance, balance, and coordination to support daily activities. It improves the ability to perform tasks safely and efficiently. Various tools, such as bands, exercise bars, and balls, can be used to achieve functional training goals. The main focus of functional programs is to improve movements rather than isolated muscles. Authors argue that strength training using weight machines would isolate muscular action in a single plane and restrict the range of motion, which reduces the effectiveness of the intervention [24, 25]. We opted to perform functional exercises with elastic bands, considering that they deliver comparable strength improvements compared to resistance training using weight machines [26].

To validate the effectiveness of the program, we used reproducible instruments, BASFI and HAQ-S, to assess functional capacity and functional status, and BASDAI and DAS 28 for disease activity [27].

In this study, we did not find significant differences in the patients' functional capacity and status through the BASFI and HAQ-S questionnaires between groups, however, FT and RE showed intragroup improvements, as the RE already had previous evidence of superiority to non-treatment, we can suggest that FT is effective for this population.

Similar results were found in the disease activity assessed by BASDAI and DAS 28 in the FT group when compared to the RE group, however, there were intragroup improvements in both groups. Similar findings were described, with other exercises, in patients with AS. Rosu et al. [28] evaluated the combined effects of Pilates and McKenzie exercises in patients with AS, concluding that these combined exercises significantly improve disease activity after 48 weeks of regular training, even though our intervention was performed in 12 weeks. However, in the study by Stavropoulos-Kalinoglou et al. [29], the findings were different from our study with regard to DAS-28. This difference may be related to the intervention time, which was six months, physical activity with aerobic predominance, high intensity exercises and the characteristics of rheumatoid arthritis, used in this case.

Interesting results were found when Sveaas et al. [30], after a controlled, randomized and blinded study with 100 patients classified with spondyloarthritis, performed high intensity cardiovascular and resistance exercises. After 12 weeks, there was an improvement in the exercise group in the disease activity, measured by BASDAI and ASDAS, physical function and cardiovascular health when compared to the control group, in this case, the waiting list. Similar findings to the present study were found for BASFI and HAQ-S and BASDAI and DAS-28 [8, 31].

When we observed the results of quality of life through the SF36 questionnaire in this study, no statistical differences were found between the groups, however, when we evaluated the intra-group evolution, in the FT and RE groups, improvement was observed in all domains over time, except in the "social aspects" domain, in which there was an improvement only for the FT group.

There is no defined consensus of gold standard to assess strength in the literature, the isokinetic test is cited, however, because it is expensive and difficult to access, the most used protocol to assess strength is still the 1RM test. This test is used in daily practice for the prescription of resistance and functional exercises due to its easy application and for presenting security in the performance of movements.

There was an increase in strength in the FT group in all exercises performed, except for biceps exercises (bilateral). In the RE group, there was an increase in strength in all exercises performed, however, exercises for "biceps (bilateral)" and "pull-ahead" did not show statistically significant improvements. When performing the intergroup analysis, no statistical differences were observed.

In order to be able to better interpret this work it is important to take into consideration two points of limitations. First consideration is our sample was recruited through our outpatient clinics, in which the population, in general, has a higher age characteristic than most works and second one is the results of the interventions after the study period were not followed up, suggesting further studies with this objective.

Numerous protocols and types of interventions have been studied to improve functional capacity, quality of life, muscle strength and disease activity in PSA, there

is no consensus on its effectiveness, nevertheless, we believe that our intervention is effective and satisfactory for this population, for demonstrating intragroup data changes over time and a result similar to another proven beneficial intervention.

## Conclusion

Based on the results of the present study, we can conclude that both FT and RE have similar effectiveness in improving functional capacity, functional status, disease activity, general quality of life, and muscle strength in patients with psoriatic arthritis.

### Abbreviations

| | |
|---|---|
| PSA | Psoriatic arthritis |
| FT | Training group |
| RE | Resistance exercise group |
| AS | Ankylosing spondylitis |
| VAS | Visual analog scale |
| HAQ-S | Health Assessment Questionnaire for the Spondyloarthropathies |
| BASFI | Bath Ankylosing Spondylitis Functional Index |
| 1RM | One-repetition maximum test |
| BASDAI | The Bath Ankylosing Spondylitis Disease Activity Index |
| DAS 28 | Disease Activity Score 28 |
| SF-36 | The Short Form 36 health survey questionnaire |

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### Author contributions

DRS: investigation, writing—original draft, project administration; CB: investigation, data curation; SMM: data curation, methodology; JN: conceptualization, methodology, supervision, writing—review & editing.

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### Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Declarations

### Ethics approval and consent to participate

The study was approved by the Universidade Federal de São Paulo UNIFESP ethics committee number 3.650.035 / CAAE 19355019.1.000.5505 and all participants read and signed the informed consent.

### Consent for publication

Not applicable.

### Competing interests

The authors declare that they have no competing interests.

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