

ORIGINAL ARTICLE

Can Functional Training Influence Physical Aspects in People With Parkinsonism?

A Randomized Trial

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Highlights

1. Functional training has been shown to be a safe and viable complementary treatment for people with Parkinson's disease.
2. Physical exercise can have a positive effect on the motor symptoms of Parkinson's disease.
3. Functional training has a positive effect on strength, range of motion and flexibility.

ABSTRACT

Introduction: Physical exercise is considered a complementary form of treatment to medication and has been shown in the literature to improve some motor symptoms in People with Parkinson. **Objective:** To analyze the effect of a functional training intervention on the Unified Parkinson's Disease Scale III score, balance, flexibility, lower and upper limb strength, and functional mobility in people with Parkinson's disease. **Methods:** The study included a functional training intervention group (n=12) and control group (n=12), totaling 24 participants of both sexes (64.08 ± 10.1 years). Information was collected on personal and clinical characteristics, and the following tests were applied; the Unified Parkinson's Disease Scale – part III, balance test (MiniBESTest), lower limb flexibility (Sitting and Reaching), shoulder range of motion (Goniometry), lower limb muscle strength (isokinetic dynamometer), handgrip strength (Dynamometry), and functional mobility (Timed Up & Go). **Results:** After the intervention there were significant intragroup improvements in the intervention group for the variables left shoulder range of motion in abduction (p= 0.014) and flexion (p= 0.018), right and left lower limb flexibility (p=0.013; p=0.002), right and left leg extension strength (p=0.028; p=0.017), and right and left leg flexion strength (p=0.006; p=0.002). In addition, intra-group statistical differences in the worsening of the control group in the Unified Parkinson's Disease Scale III (p=0.023), right shoulder range of motion in flexion (p=0.000), and left lower limb flexibility (p=0.043). None of the variables demonstrated an intergroup effect, and the variables balance, functional mobility, and handgrip presented no significant intragroup effects. **Conclusion:** A functional training program can positively influence physical aspects related to strength, range of motion, and flexibility, and was shown to be a safe and viable complementary treatment for people with Parkinson's disease.

Keywords: physical exercise; Parkinson's Disease; postural balance; muscle strength; gripping strength.

O TREINAMENTO FUNCIONAL PODE INFLUENCIAR NOS ASPECTOS FÍSICOS DE PESSOAS COM PARKINSON? UM ENSAIO CLÍNICO RANDOMIZADO CONTROLADO

RESUMO

Introdução: O exercício físico é considerado uma forma de tratamento complementar ao medicamentoso, comprovado na literatura principalmente na melhora de alguns sintomas motores. **Objetivo:** Analisar o efeito de uma intervenção de treinamento funcional sobre o escore da Escala Unificada da Doença de Parkinson III, equilíbrio, flexibilidade, força de membros inferiores e superiores e mobilidade funcional em pessoas com doença de Parkinson. **Métodos:** O estudo incluiu um grupo de intervenção de treino funcional (n=12) e um grupo de controle (n=12), totalizando 24 participantes de ambos os sexos (64,08 ± 10,1 anos). Foram recolhidas informações sobre as características pessoais e clínicas e aplicados os seguintes testes: Escala Unificada da Doença de Parkinson – parte III, teste de equilíbrio (MiniBESTest), flexibilidade dos membros inferiores (Sentar e Alcançar), amplitude de movimento dos ombros (Goniometria), força muscular dos membros inferiores (dinamômetro isocinético), força de preensão manual (Dinamometria) e mobilidade funcional (Timed Up & Go)²⁵. **Resultados:** Após a intervenção verificaram-se melhorias significativas intragrupo no grupo de intervenção para as variáveis amplitude de movimento do ombro esquerdo em abdução (p= 0,014) e flexão (p= 0,018), flexibilidade dos membros inferiores direito e esquerdo (p=0,013; p=0,002), força de extensão da perna direita e esquerda (p=0,028; p=0,017) e força de flexão da perna direita e esquerda (p=0,006; p=0,002). Além disso, diferenças estatísticas intragrupo no agravamento do grupo de controle na Escala Unificada da Doença de Parkinson III (p=0,023), na amplitude de movimento do ombro direito em flexão (p=0,000) e na flexibilidade do membro inferior esquerdo (p=0,043). Nenhuma das variáveis demonstrou efeito intergrupo e as variáveis equilíbrio, mobilidade funcional e preensão manual não apresentaram efeitos significativos intragrupo. **Conclusões:** Um programa de treinamento funcional pode influenciar positivamente aspectos físicos relacionados à força, amplitude de movimento e flexibilidade, e mostrou-se um tratamento complementar seguro e viável para pessoas com doença de Parkinson.

Palavras-chave: exercício físico; Doença de Parkinson; equilíbrio postural; força muscular; força de preensão.

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INTRODUCTION

The symptomatology of Parkinson's disease (PD) is usually divided into motor and non-motor symptoms, the motor part is directly impacted because the disease affects the dopaminergic neurons¹. People with Parkinson's disease (PwP) undergo pharmacological treatments to reduce these symptoms, usually Levodopa (gold standard drug for the treatment of Parkinson's disease), which is used to replace dopamine in the body, controlling bradykinetic symptoms². However, there is scientific evidence showing that in the long term these treatments can have side effects, such as apathy, fatigue, sleepiness, hallucinations, and motor fluctuations³.

Based on this, it is important to join alternative or non-pharmacological treatments to compensate for the side effects of drug treatment, and also to alleviate the symptoms resulting from the disease. In this sense, physical exercise treatments have been a great ally for PwP being studied in the modalities of resistance training, functional training, aerobic training, and mind-body training have previously been analyzed and shown to be effective in improving some motor and non-motor symptoms of PD⁴⁻⁷. Functional training, a modality that contemplates physical capacities such as strength, muscular power, and cardiorespiratory resistance⁸ presents a viable option for PwP, as it acts in a multifactorial manner on the motor skills. This modality was chosen for the study precisely because it is a physical exercise program based on movement patterns used in activities of daily living, aimed at promoting multisystemic adaptations and ensuring autonomy during the performance of daily functions⁸. To date, there are few data on interventions with this modality in PwP, and there is not enough information about the safety of the modality in this public, however, Ernst et al.⁷ in their meta-analysis, reported on exercise modalities similar to functional training, such as resistance and balance training, as relatively safe in PwP.

Thus, little is found in the scientific literature on functional training in PwP, and the most current article to date is the study by Strand et al.⁶ which showed the effectiveness of resistance training periodized with functional training, obtaining improvements in balance, strength and functional capacity in PD. As there is a scarcity of articles, we can observe the similarity of functional training with other exercise modalities that are in a similar context, as seen in the clinical trial of Leal et al.⁹ demonstrated that low-volume resistance training with a weekly frequency of twice a week, after 6 months of intervention, significantly improves flexibility, aerobic endurance, gait speed, handgrip strength, and balance in PwP. It should be mentioned that this population presents reduced range of motion of the spine to maintain the center of gravity within the limits of stability, directly affecting balance¹⁰. Balance deficits and loss of postural control are the result of the interaction between motor impairment, functional abilities, and fear of falling in PD¹¹, therefore, improvement in balance can have positive effects on the other motor symptoms.

The abovementioned reports demonstrate the importance of physical exercise to alleviate the symptoms of this disease. Therefore, the current study aimed to investigate functional training in isolation on the motor symptoms of PD, with an updated and specific protocol that is easy to replicate for this public¹². Furthermore, the present study can be used as a basis to help professionals in prescribing exercises in PwP and in future scientific research. Thus, the objective was to analyze the effect of a functional training intervention on the Unified Parkinson's Disease Rating Scale III (UPDRS III), balance, flexibility, lower and upper limb strength, and functional mobility in people with Parkinson's disease.

METHODS

Study Design

This two-arm randomized clinical trial, developed according to the recommendations of Consort 2010 (Consolidated Standards of Reporting Trials)¹³ followed the recommendations and guidelines of the Declaration of Helsinki, was approved by the Research Ethics Committee (CEPSH) of Udesc (4.602.029) and registered in the Rebec Platform (Brazilian Registry of Clinical Trials) under number 3.613.483. Written consent was obtained from all participants.

Participants

The study was composed of individuals clinically diagnosed with PD, of both sexes, who lived in a city in southern Brazil, with a total sample of 24 participants (64.08±10.1 years). The sample was recruited through the Parkinson's Association of Santa Catarina (Apasc), in addition to the delivery of pamphlets in settings such as health centers, churches, and teaching centers, with media dissemination on the university website and social networks. The collection and intervention were conducted at the public institution of higher education in southern Brazil. Participants were recruited in the period from October 2021 to January 2022 and allocated for data collection in February 2022 and the functional training intervention was performed from March to May 2022, lasting 12 weeks. The post intervention collection was applied in the months of June and July 2022.

The following inclusion criteria were adopted: a) clinical diagnosis of PD, following the UK brain bank criteria¹⁴; b) subjects of both sexes; c) aged 45 years or older; d) with stable and unchanged doses of levodopa medication for four weeks (ON state of medication), since PwP treated with this medication tend to have two known ON/OFF states¹⁵, with the ON medication status defined as substantial improvement in parkinsonian motor clinical symptoms due to the action of the medication in the body; and e) without performing any type of physical exercise for at least two months. The exclusion criteria were: a) individuals who did not reach the cut-off point of the MoCA (22 points)¹⁶; b) were classified in PD stage 5¹⁷; c) did not finish all the stages of the study; d) who performed combined practice of any physical exercises; and e) were not present in at least 75% of the classes.

Interventions

The participants were randomized into two groups, control group and intervention group with functional training.

Control group (CG)

The participants in this group were instructed to maintain their routine activities and not to engage in physical exercise during the 12 weeks. Contact was made monthly on the first day of the month via telephone at a time scheduled by the researchers from the Research Laboratory of Leisure and Physical Activity – Laplaf/CNPq (AG, JM, KH) with the organization described in worksheets, in order to verify that the participants were maintaining their routine activities.

During the intervention period, the control group was invited to participate in a lecture on the theme self-care, with the objective of emphasizing the importance of practicing physical exercises and caring for their health in general. At the end of the 12-week intervention, all participants received an invitation to participate in an exercise program in a PD extension project at a public higher education institution in a city in southern Brazil.

Intervention Group (IG)

The functional training intervention followed the protocol of Moratelli et al.¹² which was prepared according to the SPIRIT recommendations (Standard Protocol Items: Recommendations for Interventional Trials)¹⁸ and applied by a physical education professional.

The participants of this group received 12 weeks of functional training intervention for PwP following the proposed study protocol, lasting 60 minutes each session/class, with an evolving intensity, and a frequency of twice a week. Each session had the following division: a) warm-up (15 min); b) main part (40 min); and c) back to calm (5 min). The initial warm-up started with natural movements, such as walking, running, and displacements, followed by general and specific joint movements, performing movements in different joint axes (flexion, extension, abduction, adduction, and rotation), and progressing from the upper to the lower body. The main part of the session focused on the gradual evolution of the difficulty of functional training movements, including the gain in limb and trunk muscle strength through squatting, stepping, sitting down and getting up from a chair, abduction/adduction, hip extension/flexion, and activation of the abdominal muscles when performing flexions, extensions, and trunk rotations. Finally, the training returned to calm, with the goal of relaxing the muscles worked during the session, by performing static stretching movements, slow walking, massages, and myofascial release.



Figure 1 – Illustration of some basic movements included in the functional training.

Source: Produced by the authors (2023).

The materials used during the phases of the classes were varied according to the proposed activities (figure 2), allowing for variations in the exercises and increased intensity.



Figure 2 – Materials used in the classes.

Source: Produced by the authors (2023).

Outcomes

The outcome endpoint for this study was balance and the secondary outcomes were UPDRS III, flexibility, strength, and functional mobility.

As a requirement for participation in the study, participants took the Montreal Cognitive Assessment (MoCA). Individuals who did not meet the cut-off point of 22 points were excluded¹⁶. In addition, one point was added at the end of the test for individuals with 12 years or less of schooling.

Data were collected pre and post-intervention, using a questionnaire in the form of an individual interview, administered by researchers and staff of LAPLAF/CNPq. The questionnaire was divided into two parts: 1) Sociodemographic and clinical information: A) Sex; B) Education; C) Marital status; D) Body Mass Index (BMI); E) Hoehn and Yahr Disability Stages Scale; F) Affected side; and G) Past physical activity; 2- Motor Symptoms: A) Unified PD Rating Scale (UPDRS III); B) Balance; C) Functional mobility; D) Shoulder range of motion in abduction and flexion; E) Lower limb flexibility; F) Handgrip strength; and G) Lower limb muscle strength in extension and flexion.

1. Sociodemographic and clinical information.

A form constructed by the researcher was applied, containing information about sex (male/female), age (years), marital status (with partner/without partner), schooling, BMI, side affected by the disease, general status (Hoehn and Yahr Disability Stages Scale -HY), and previous physical activity.

- The general status of the PwP was measured using the Hoehn and Yahr Disability Scale (HY-Degree of Disability Scale): which consists of five classification stages to assess the severity of PD, with I, II, and III indicating mild to moderate disability, and stages IV and V presenting more severe disability. The classification of the level of disability is by means of global measures of signs and symptoms of postural instability, rigidity, tremor, and bradykinesia¹⁷.
- The body mass index (BMI) was calculated by dividing body mass (Kg) by the square of the height (m²) and classified according to the WHO protocol, as: thinness (BMI<18.5); eutrophy (BMI 18.5-24.9); overweight (BMI 25.0-29.9); and pre-obesity and obesity (BMI>30.0). Grouping was performed in the table for statistical purposes, with the classification "Normal

weight” including those who were identified with thinness and eutrophy and “Overweight” including those who were classified with overweight, pre-obesity, and obesity. To collect the body mass data a Plenna Wind MEA 07710 digital scale was used, and for height a compact MD stadiometer.

2. Motor symptoms

- The Unified Parkinson’s Disease Scale III (UPDRS III) is used to evaluate various aspects in individuals with PD. The scale consists of 42 questions and is divided into four parts: 1 – Mental state, behavior and emotional state; 2 – Activities of daily living; 3 – Motor exploration; and 4 – Complications of therapy.
- In this study, only part 3, Motor Exploration, was used. This section contains 14 items, listed from 18 to 31. The items assess motor symptoms of PD, such as tremor, bradykinesia and rigidity, and the limitations in motor functions of gait, hand and foot movement, speech, facial expression, and posture¹⁹.
- Balance was measured by the MiniBESTest, a quick test, validated in Brazil, that can be applied in around 10 to 15 minutes, and which allows reliable tracking of balance alterations. The test consists of 14 items focusing on dynamic balance, specifically on anticipatory transitions, postural responses, sensory orientation, and dynamic gait. Each item is scored from (0-2); with a score of 0 indicating that the person is unable to perform the task and 2 a score indicating normality of balance in movement. The maximum score for this test is 28²⁰.
- Lower limb flexibility was measured by the “Sit and Reach” test. The test begins with the individual sitting on a chair with one leg extended and the other with the knee flexed - at approximately 90° - and the foot resting on the floor. The arms should be extended with the middle fingers touching each other. From the aforementioned position, the participant is required to perform hip flexion on the extended leg, reaching the maximum point possible, and holding the position for two seconds while the evaluator takes the measurement. The measurement taken is the distance between the middle finger and the tip of the foot, being considered negative anterior to the tip of the foot and positive the distance where the fingers pass the tip of the foot²¹.
- Shoulder range of motion was assessed using a digital goniometer (Absolute Axis 360°), to measure shoulder flexion and abduction movements²². The participant is in a sitting position for the abduction movements, and in dorsal decubitus for the flexion movements.
- Handgrip strength was assessed with a hydraulic dynamometer, adjusted to the second position, due to the size of the hand, to measure the force produced by an isometric contraction registered in kilograms or pounds. The individual is seated on a chair with the back supported but without support for the upper limbs, with the shoulder of the tested limb adducted, elbow in 90° flexion, forearm in neutral position, and the wrist varying between 0° and 30° of extension and between zero and 15° of ulnar deviation. The score was defined by the average of the three attempts made²³.
- Lower limb muscle strength was assessed with a Biodex System 4 PRO isokinetic dynamometer (BiodexTM Medical Systems Inc., Shirley, NY), used in individuals with PD for the isokinetic measurements²⁴. The test begins with a warm-up at a speed of 120°/second, with a series of five submaximal repetitions with progressive application of force, followed by a 30-second rest and another five repetitions at a speed of 60°/second. At the end of the warm-up, another 30-second break is allowed before starting the main part, which consists of a series of three maximum repetitions at a speed of 60°/s with CON/CON contraction. The individuals received verbal stimuli from the researcher during the test to encourage

them to perform with as much effort as possible. The shorter the time used, the better the performance in the test.

- Functional mobility with Timed Up & Go (TUG), translated and validated in Brazil²⁵. The TUG measures the time it takes an individual to get up from a chair, (approximately 46 cm), walk in a straight line for 10 feet away (at a self-selected but safe pace), turn around, walk back, and sit down again. A trajectory time of less than 20 seconds represents a low risk for falls; 20 to 29 seconds is a medium risk for falls; 30 seconds or more represents a high risk for falls.

Data collection took place at two points in both groups, the period before the start of the intervention, baseline (T0), and the moment after the intervention stage (T1), remembering that the intervention lasted 12 weeks and the functional training protocol¹² was followed. The collection lasted an average of 60 minutes, and both times sociodemographic and clinical characteristics, Hoehn and Yar Disability Scale, UPDRS III, Balance (MiniBESTest), Lower limb flexibility (Sit and Reach), Shoulder range of motion (Digital goniometer), Handgrip strength (Hydraulic dynamometer) and Lower limb muscle strength (Isoknetic dynamometer) were collected. Those who didn't complete the minimum number of sessions (75%) didn't show up for the post-collection moment, so it wasn't possible to carry out the intention-to-treat analysis.

3. Sample Size

The sample size calculation was performed a priori with the software G*Power 3.1.9.228, considering the primary outcome of the study, balance. According to Cohen (1988), we used an effect size of 0.34, a significance level of 5%, and a test power of 95%. Thus, 16 individuals were assigned to each of the two groups (GTF; CG) according to the sample calculation, totaling 32 participants²⁶.

Randomization

After consent and completion of the terms, the selected individuals were randomized by researchers also from LAPLAF/CNPq (IAN and KHA), using the randomization.org program, to allocate the participants into two groups: intervention group and control group. All individual information was stored in a non-identifiable form. There was no blinding of the researchers in the data collection. There was also no blinding of the applied intervention because it was an exercise intervention.

Statistical Analysis

The data were tabulated in a spreadsheet in the Microsoft Excel® program and transferred and analyzed in the statistical package SPSS - IBM version 20.0. Initially, descriptive statistics (mean, standard deviation, and percentage) were used through the Chi-square test and Fisher's exact test, as well as one way Anova to calculate the mean age. Subsequently, comparative analyses were performed between the pre and post intragroup and intergroup results, using the two-way Anova test with repeated measures and Sydak's comparison. A significance level of 5% was adopted.

Adherence to the intervention protocol

The adherence to classes was obtained by calculating the number of prescribed sessions completed/planned sessions x 100, generating a percentage of the activities over the 12 weeks.

RESULTS

Flow Diagram CONSORT 2010

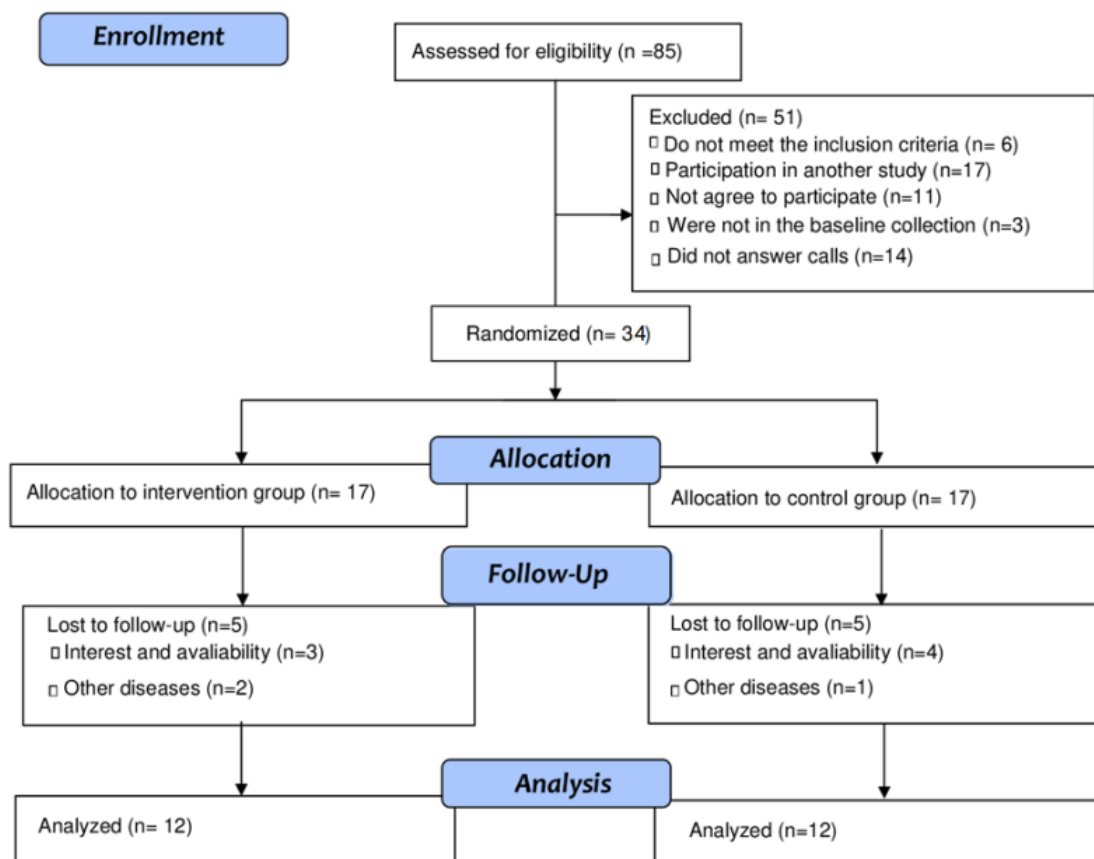


Figure 3 – Flowchart of the study participants.

Figure 3 – Shows the flowchart according to the recruitment of participants.

Source: Produced by the authors (2023).

According to the sociodemographic and clinical characteristics in the baseline period shown in Table 1, it can be observed that there were no statistical differences between the groups, demonstrating a homogeneous sample. Most of the participants were male (54,2%), with complete college education (58,3%), with a partner (58,3%), with a mild level of disability (62,5%), practiced previous physical activity (58,3%), and the most affected limb was the left one (58,3%).

Adherence to the activities in the study was 81.6% (data not shown in the tables).

Table 1 – Sociodemographic and clinical characteristics of participants at baseline (n= 24)

| | Total n (%) | CG (n=12) n (%) | IG (n=12) n (%) | p-value |
|------------------|----------------|--------------------|--------------------|---------|
| Sex | | | | |
| Male | 13 (54.2) | 5 (41.7) | 8 (66.7) | 0.414 |
| Female | 11 (45.8) | 7 (58.3) | 4 (33.3) | |
| Schooling | | | | |

| | | | | |
|-----------------------------------|-----------|----------|----------|-------|
| Elementary School Complete | 5 (20.8) | 2 (16.7) | 3 (25.0) | 0.819 |
| High School Complete | 5 (20.8) | 3 (25.0) | 2 (16.7) | |
| Higher Education Complete | 14 (58.3) | 7 (58.3) | 7 (58.3) | |
| Marital Status | | | | |
| With partner | 14 (58.3) | 6 (50.0) | 8 (66.7) | 0.680 |
| Without partner | 10 (41.7) | 6 (50.0) | 4 (33.3) | |
| BMI | | | | |
| Normal weight | 12 (50.0) | 4 (33.3) | 8 (66.7) | 0.220 |
| Overweight | 12 (50.0) | 8 (66.7) | 4 (33.3) | |
| Disability level (H&Y) | | | | |
| Light | 15 (62.5) | 6 (50.0) | 9 (75.0) | 0.390 |
| Moderate | 7 (29.2) | 5 (41.7) | 2 (16.7) | |
| Severe | 2 (8.3) | 1 (8.3) | 1 (8.3) | |
| Affected side | | | | |
| Right | 8 (33.3) | 5 (41.7) | 3 (25.0) | 0.287 |
| Left | 14 (58.3) | 7 (58.3) | 7 (58.3) | |
| Both | 2 (8.3) | 0 (0.0) | 2 (16.7) | |
| Previous physical activity | | | | |
| Yes | 14 (58.3) | 7 (58.3) | 7 (58.3) | 0.660 |
| No | 10 (41.7) | 5 (41.7) | 5 (41.7) | |

Note: CG = Control Group; IG = Intervention Group; n= frequency; Fisher's Exact Test; H&Y= Hoehn and Yahr.

It can be seen in table 2 that there were significant positive intragroup changes in the IG in the variables of left shoulder range of motion in abduction ($p=0.014$) and flexion ($p=0.018$), and flexibility of both right ($p=0.013$) and left ($p=0.002$) lower limbs. However, there were statistically significant intra-group differences in the CG in the worsening of the UPDRS III ($p=0.023$), right shoulder range of motion in flexion ($p=0.000$), and left lower limb flexibility ($p=0.043$). The variables balance and functional mobility presented no significant effects; however, the data showed an improvement in balance (1 point increase) in the IG, and a reduction in the CG values (1.2 points decrease) in the post-intervention intragroup period. It is worth mentioning that even though there were no significant differences in the range of motion of the right shoulder in abduction, there was an important intragroup score change in the IG (7.1 point increase). There were no intergroup differences in any of these variables.

Table 3 shows significant changes in both groups. In the IG there were favorable intragroup differences in right ($p=0.028$) and left ($p=0.017$) leg extension strength, as well as in right ($p=0.006$) and left ($p=0.024$) leg flexion strength. In the CG, negative intragroup differences were observed in left leg extension strength ($p=0.002$). There were no relevant statistical differences in handgrip. In addition, no significant intergroup differences were observed in any of these variables.

Table 2 – Comparison of UPDRS III, balance, functional mobility, shoulder range of motion in flexion and extension, and lower limb flexibility between study groups at baseline and post-intervention (n= 24)

| Variables | CG (n=12) | | | | IG (n=12) | | | | Post |
|---|----------------|-------------------|--------------|-------|----------------|-------------------|--------------|------|-------|
| | Baseline | Post-intervention | p* | cs | Baseline | Post-intervention | p* | cs | p# |
| | \bar{X} (SD) | \bar{X} (SD) | | | \bar{X} (SD) | \bar{X} (SD) | | | |
| UPDRS III | 8.7 (1.62) | 12.0 (2.06) | 0.023 | 3.3 | 12.0 (1.62) | 9.4 (2.06) | 0.062 | -2.6 | 0.371 |
| Balance | 25.6 (1.84) | 24.4 (2.10) | 0.098 | -1.2 | 28.1 (1.84) | 29.1 (2.10) | 0.181 | 1.0 | 0.125 |
| Functional Mobility | 1.3 (0.15) | 1.3 (0.14) | 1.000 | 0.0 | 1.1 (0.15) | 1.0 (0.14) | 0.171 | -0.1 | 0.273 |
| Range of motion shoulder abduction | | | | | | | | | |
| Right | 149.7 (7.71) | 145.9 (6.07) | 0.438 | -3.8 | 144.9 (7.71) | 152.0 (6.07) | 0.161 | 7.1 | 0.482 |
| Left | 147.7 (7.81) | 150.1 (6.28) | 0.615 | 2.4 | 141.6 (7.81) | 154.5 (6.28) | 0.014 | 12.9 | 0.625 |
| Range of motion shoulder flexion | | | | | | | | | |
| Right | 157.0 (5.39) | 143.8 (5.54) | 0.000 | -13.2 | 151.1 (5.39) | 153.0 (5.54) | 0.538 | 1.9 | 0.253 |
| Left | 148.2 (7.15) | 147.4 (6.97) | 0.852 | -0.8 | 142.8 (7.15) | 153.5 (6.97) | 0.018 | 10.7 | 0.538 |
| Lower limb flexibility | | | | | | | | | |
| Right | -9.5 (2.32) | -5.7 (2.97) | 0.106 | 3.8 | -4.4 (2.32) | 1.7 (2.97) | 0.013 | 2.7 | 0.089 |
| Left | -10.7 (2.35) | -6.7 (2.71) | 0.043 | 4 | -6.3 (2.35) | 0.0 (2.71) | 0.002 | 6.3 | 0.092 |

X= mean; SD= standard deviation; cs= change score *p value for comparison between baseline and post-intervention periods for CG and IG; p# value for comparison between CG and IG in the post-intervention period. Two way ANOVA test with repeated measures and Sydak's comparison test were used. Significant p values (p < 0.05) are highlighted in bold

Table 3 – Comparison of handgrip, and leg strength in extension and flexion, between study groups at baseline and post-intervention (n= 24)

| CG (n=12) | | | | | IG (n=12) | | | Post | |
|------------------------|----------------|-------------------|--------------|-------|----------------|-------------------|--------------|------|-------|
| | Baseline | Post-intervention | | | Baseline | Post-intervention | | | |
| Variables | \bar{X} (SD) | \bar{X} (SD) | p* | cs | \bar{X} (SD) | \bar{X} (SD) | p* | cs | p# |
| Hand Grip | | | | | | | | | |
| Right | 24.2 (2.04) | 24.2 (2.36) | 0.945 | 0.0 | 23.7 (2.04) | 24.5 (2.36) | 0.400 | 0.8 | 0.937 |
| Left | 22.4 (2.12) | 22.5 (2.03) | 0.753 | 0.1 | 21.3 (2.12) | 21.5 (2.03) | 0.740 | 0.2 | 0.723 |
| Extension leg strength | | | | | | | | | |
| Right | 114.0 (12.77) | 102.8 (12.31) | 0.145 | -11.2 | 95.0 (12.77) | 112.4 (12.31) | 0.028 | 17.4 | 0.586 |
| Left | 122.8 (16.18) | 102.6 (15.36) | 0.002 | -20.2 | 107.4 (16.18) | 122.2 (15.36) | 0.017 | 14.8 | 0.376 |
| Flexion leg strength | | | | | | | | | |
| Right | 41.9 (5.88) | 42.0 (6.35) | 0.975 | 0.1 | 28.3 (5.88) | 41.7 (6.35) | 0.006 | 13.4 | 0.971 |
| Left | 42.5 (7.02) | 41.0 (6.10) | 0.630 | -1.5 | 34.3 (7.02) | 42.1 (6.0) | 0.024 | 7.8 | 0.893 |

X= mean; SD= standard deviation; cs= change score *p value for comparison between baseline and post-intervention periods for CG and IG; p# value for comparison between CG and IG in the post-intervention period. Two way ANOVA test with repeated measures and Sydak's comparison test were used. Significant p values (p < 0.05) are highlighted in bold.

DISCUSSION

The objective of the current study was to analyze the effect of a functional training intervention on the UPDRS III, balance, flexibility, lower and upper limb strength, and functional mobility in people with Parkinson's disease. The positive effect of the intervention was observed in the significant intragroup differences in the IG in the variables of left shoulder range of motion in abduction and flexion, in flexibility of both right and left lower limbs, in right and left leg extension strength, as well as in right and left leg flexion strength. There were also significant negative differences in the CG in the reduction of the variables of right leg extension strength, right shoulder range of motion in flexion, and UPDRS III, and in the increase in left lower limb flexibility. In balance, functional mobility, and handgrip there were no relevant intragroup differences. It is noteworthy that, despite the intragroup changes, there were no significant intergroup differences in the variables studied.

In the current research only section III of the UPDRS scale was used, which deals specifically with the motor symptoms that are the object of this study. The CG demonstrated significant negative effects in the score, and the IG demonstrated positive effects when analyzing the change in scores, although not statistically relevant. This suggests that the intervention can help maintain motor symptoms of dyskinesia, tremor, and stiffness, even if not statistically significant, and that not performing the intervention may be a risk factor for worsening these symptoms. Differently from this finding, other studies report positive statistical differences in this variable, as shown by Soke et al.⁵ with the circuit training intervention combined with aerobic training also showed efficacy in improving the UPDRS III score and balance, however, it is worth noting that their intervention was performed more frequently than in the current study (3 times a week), which may have been a factor that led to greater improvements.

Physical exercise in PwP can improve balance⁹, however, the primary outcome of this study, did not show significant changes. However, when analyzing the score changes, improvement in the IG and worsening in the CG were observed, which indicates that the intervention had positive effects on the practitioners, even though they were not significant. Although there are no studies to date with functional training in isolation, the study by Strand et al.⁶ showed that resistance training periodized with functional training improves balance, strength, and functional capacity in PD, demonstrating that continued work on this theme is necessary, because balance is not only associated with PD, but with the aging process, among other associated diseases. The hypothesis may be that the functional training intervention was not sufficient to lead to changes in these aspects, perhaps due to the weekly volume or intensity of the training, or the necessity to associate it with another physical exercise concomitantly.

Considering the functional capacity variable, there were no statistical differences in the IG. However, a study of similar duration to the current study (12 weeks) by Duchesne et al.⁴ found that aerobic training three times a week at high intensity can be an effective non-pharmacological intervention to promote better motor learning ability in everyday activities. It is conjectured that functional capacity is a complex variable for significant improvements to occur in a short time of intervention, due to the complications of the disease, together with aging, which would justify the lack of improvement in the IG in this study. However, it is important to emphasize the adherence of 81.6% of the participants, so that despite the lack of significant differences, the improvement in daily life reported by participants is noticeable, along with the frequency and adherence to classes, and the reports of feeling safe and not falling, resulting from the practice of the intervention.

In the shoulder range of motion in abduction and flexion, there were significant improvements in the IG in the left shoulder, a relevant finding since the left limb is the most affected limb of the participants, and in the CG, there was a significant reduction in right shoulder flexion. This finding

indicates that the functional training intervention can improve the shoulder range of motion of the most affected limb, and that not practicing physical exercises could lead to a smaller range of motion of the shoulder, especially in flexion. There is a lack of studies on the effect of physical exercise and shoulder range of motion to corroborate this finding; however, there is evidence that physical exercise helps to improve the motor functions of the upper limbs, even if the evidence does not specify the shoulder in PwP²⁷.

Like the range of shoulder motion, flexibility is also a little studied variable in PD. In the current study, there were significant improvements in the IG intragroup in both limbs, and the most affected side (left) demonstrated the most improvement. The CG also presented a significant improvement in the left lower limb; it is believed that this is due to the fact that the daily life activities also help in gaining flexibility, even if in a slower and less specific way. Corroborating this finding, in the study by Leal et al.⁹ the resistance training applied in PwP was effective in improving the flexibility of the participants' lower limbs. When looking for evidence on flexibility in people with disabilities, there are few findings; thus, it is possible to observe the need for more studies investigating this variable in people with disabilities for a more in-depth discussion.

Handgrip strength may be related to the severity of PD; the weaker the grip strength, the greater the severity²⁸. In the current study there were no significant gains in this variable, however, when analyzing the change in scores, it is clear that there was an increase in the values in the IG, with the right hand having the highest value, possibly because it is the less affected side in the sample of the present study. Corroborating this, a study involving physical exercise obtained positive gains in handgrip in PwP but made it clear that the specific mechanisms underlying these improvements are still unknown²⁹.

In the current study, the leg strength in extension and flexion presented relevant statistical intragroup differences in the IG, with the greatest gains in the left leg in extension and the right leg in flexion. In the CG group there was a significant negative difference in left leg strength in extension. That is, the results indicate that the intervention was beneficial in improving lower limb muscle strength. These findings are in agreement with the study by Chung, Thilarajah and Tan³⁰ reported that resistance training applied in the intervention group obtained positive effects on the muscle strength of the lower limbs, as well as highlighting the need for a multidisciplinary approach in exercise therapy for patients with PD, including the combination of resistance training with other exercise modalities, such as aerobic and balance training. This conclusion is interesting for our study, since functional training encompasses all these modalities.

In addition, it is known that the practice of long-term physical exercise is associated with clinical improvement in the general condition of PD⁷. Therefore, this study supports the conduct of professionals in the prescription and indication of functional training to alleviate the motor symptoms of PD, and the clinical applicability of the study is the possibility of replicating what was studied in practical experience by professionals in the field, managing to take the modality to different environments, promoting an improvement in the clinical condition of PwP. The intervention was safe and no adverse events such as falls or any other risk situation were reported, due to the protocol being easy to apply and having been applied by professionals in the area, besides being adequately adapted to the public. Among the limitations of the study, we mention that blinding did not occur, because it is not possible to blind participants in relation to physical exercise or the researchers who are following the intervention. It was not possible to carry out the Intention to Treat, because the participants did not show up for the post-intervention collection. Other limitations were that most participants had a mild degree of disease according to the H&Y classification in addition, it was not possible to control for the effect of medication during exercise and the total sample at the end of the study was small due to losses to follow-up in both groups.

CONCLUSION

In conclusion, a functional training program lasting 12 weeks, with a weekly frequency of twice a week, lasting 60 minutes, can beneficially influence the physical aspects in PwP, improving the symptoms of left shoulder range of motion in abduction and flexion, lower limb flexibility, and leg extension and flexion strength. Further studies are still needed to verify the adaptations necessary to obtain gains in the UPDRS III variables, balance, functional mobility, and handgrip strength.

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