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Review

# Contributions of physical exercise to motor symptoms and the balance of people with Parkinson's Disease: a systematic review

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ABSTRACT

*Objective:* The aim of the study was to conduct a systematic review evaluating the effects of physical exercise on balance and motor symptoms of Parkinson's Disease.
*Method:* The search was carried out on the PubMed, Scielo and PEDro databases. The articles were evaluated by two independent researchers, following the criteria: presenting a control group, having more than eight weeks of intervention, assessing motor symptoms (Unified Parkinson's Disease Rating Scale and Parkinson's Disease Questionnaire -39) and balance (Timed Up and Go and Berg Scale).
*Results:* The search resulted in 1377 articles, of which 11 were included in the study. The total number of participants was 925, in which 545 were allocated in the intervention groups and 380 in the control groups. The strength training and balance, performed alone or in combination, are highlighted in improvements related to balance. Exercise, regardless of type, improves motor symptoms.
*Conclusions:* Thus, physical exercise has a positive effect on both balance and motor symptoms of Parkinson's Disease, strength and balance modalities stand out.
*Keywords:* Aging; Health; Physical activity; Parkinson's Disease.

## Contribuciones del ejercicio físico para los síntomas motores y el equilibrio de las personas con Enfermedad de Parkinson: una revisión sistemática

RESUMEN

*Objetivo:* El objetivo de este estudio fue conducir una revisión sistemática evaluando los efectos del ejercicio físico en el equilibrio y los síntomas motores de la Enfermedad de Parkinson.
*Método:* Se realizó una búsqueda de artículos científicos en las siguientes bases: PubMed, Scielo y PEDro. Los artículos fueron evaluados por dos investigadores, siguiendo los criterios: presentar grupo control, contar con al menos ocho semanas de intervención, evaluar síntomas motores ( *Unified Parkinson's Disease Rating Scale* y el *Parkinson's Disease Questionnaire*-39) y equilibrio (*Timed Up and Go* y Escala de Berg).
*Resultados:* Se revisaron un total de 1377 artículos, de estos, 11 fueron incluidos. El número total de participantes fue de 925, 545 en el grupo experimental y 380 en el grupo de control. Los entrenamientos de fuerza y de equilibrio, realizados juntos o separados, indujeron mejoras del equilibrio. El ejercicio, de cualquier tipo, mejora los síntomas motores.
*Conclusiones:* Así, el ejercicio físico tiene efecto positivo, tanto en el equilibrio como en los síntomas motores de la Enfermedad de Parkinson, destacándose el entrenamiento de fuerza y equilibrio.
*Palabras clave:* Envejecimiento; Salud; Actividad física; Enfermedad de Parkinson.

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# Contribuições do exercício físico nos sintomas motores e no equílibrio de pessoas com Doença de Parkinson: uma revisão sistemática

RESUMO

*Objetivo:* O objetivo do estudo foi conduzir uma revisão sistemática avaliando os efeitos do exercício físico no equilíbrio e nos sintomas motores da Doença de Parkinson.
*Método:* Realizou-se a busca nas bases PubMed, Scielo e PEDro. Os artigos foram avaliados por dois investigadores independentes, seguindo os critérios: apresentar grupo controle, possuir mais de oito semanas de intervenção, avaliar sintomas motores (*Unified Parkinson's Disease Rating Scale* e *Parkinson's Disease Questionnaire*-39) e equilíbrio (*Timed Up and Go* e Escala de Berg).
*Resultados:* A busca resultou em 1377 artigos, destes, 11 foram incluídos no estudo. O total de participantes foi de 925, em que 545 alocados no grupo intervenção e 380 no grupo controle. Os exercícios de força e de equilíbrio, realizados de forma isolada ou combinada, se destacaram nas melhoras relacionadas ao equilíbrio. O exercício, independente da modalidade, melhora os sintomas motores.
*Conclusões:* Assim, o exercício físico tem efeito positivo tanto no equilíbrio quanto nos sintomas motores da Doença de Parkinson, destaca-se as modalidades de força e equilíbrio.
*Palavras-chave:* Envelhecimento; Saúde; Atividade física, Doença de Parkinson.

## Introduction

Parkinson's Disease (PD) is the second neurodegenerative pathology that affects the Central Nervous System with the greater incidence in the population.[1] It mainly affects people over 60 years, rarely occurring in young people.[2] Such degenerative illness was described by James Parkinson in 1817, in London, in a trial entitled "*An Essay on the Shaking Palsy*".[3] Initially known as shaking palsy, it is characterized by involuntary quivering movements, with decreased muscular strength and alteration in gait (festinating).[4] Currently, it is characterized by the cardinal signs of muscle stiffness, bradykinesia, resting tremors and postural instability.[5]

Muscle stiffness is observed due to hypertrophy of type I and type II muscle fibers, which occurs due to the low recruitment.[6] Bradykinesia is characterized by the decrease in strength that consequently reduces the velocity of movement.[7] Moreover, primary orthostatic tremor is observed during rest, which is reduced or stopped during movement, however, this rhythmic contraction influences on posture and balance.[8] These characteristics happen because PD affects the cells from the Substantia Nigra pars compacta, presented in the basal nuclei of the midbrain, deteriorating the neurons responsible for the dopamine production, which, among its functions, is responsible for commanding the movements.[9]

To minimize such symptoms, physical exercise practice is an alternative. Exercise has been showing to be essential in reducing motor symptoms (bradykinesia, gait disturbances and tremors), non-motor symptoms (cognitive, intestinal, etc.), and to decrease the degeneration of dopaminergic neurons of PD individuals.[10,11]

Most of the studies involve aerobic trainings, as walking in hilly terrains and treadmills with progressive loads.[12,13] There are also studies involving resistance training, presenting improvements in the conditions of PD patients.[14-16] Combined training has been showing to be effective in improving the symptoms of these patients.[17] Studies involving proprioception and balance trainings demonstrate significant improvement in motor aspects of experimental groups.[18] It is perceived that there are benefits from several physical exercise modalities, in both motor and non-motor symptoms. Therefore, the literature demonstrates a physical exercise efficacy for the symptoms, which can benefit the people diagnosed with PD, improving their quality of life. Even that physical exercise is not responsible for the cure, it has an important role in softening or delaying the onset of symptoms, as the worsening of balance, decreasing the dependence time. However, due to the great variety of physical exercise modalities tested in this population, it is not clear if there is one type of exercise that stands out more regarding the improvements in both balance and motor symptoms.

Therefore, the present study has as objectives (I) to conduct a systematic review of studies associating physical exercise and PD; and (II) to evaluate the influence of physical exercise on motor symptoms (bradykinesia, gait disturbances and tremors) and on balance in people with PD.

## Methods

This study consists in a systematic review of the literature about the influence of physical exercise on motor symptoms, as well as balance of people with Parkinson's Disease (PD).

The research was performed in the SciELO, PEDro and MEDLINE (PubMed) databases through consultation with the following terms: "exercise" and "Parkinson's Disease", along with its combinations.

The articles identified in the search strategy were independently evaluated by two researchers, strictly obeying to the inclusion criteria: to present more than eight weeks of intervention with physical exercise, to evaluate patients with PD, to be written in Portuguese or English languages and to have control group. In addition, the studies should include the outcomes evaluating motor symptoms and balance.

In the studies, the symptoms related to the disease symptoms should use the Unified Parkinson's Disease Rating Scale (UPDRS) and/or the Parkinson's Disease Questionnaire-39 (PDQ-39).

For the outcomes related to balance, the test of agility and dynamic balance – Timed Up and Go (TUG) was searched and the Berg Balance Scale was searched for the assessment of overall balance.

Risk of bias assessment of the included studies was performed through the PEDro scale, which is based on the Delphy scale, developed by Verhagen et al.[19], composed by 11 items including adequate sequence generation, eligibility criteria, allocation concealment, blinding of outcome assessments, intention-to-treat analysis, description of losses and exclusions, adequate presentation of results, among others. For each criterion, the studies were classified as high risk (+), low risk (-) and risk not reported (NR).

To show the systematic review results, a table was made with the characterization of each study, with information regarding the samples, interventions and outcomes. The results regarding the outcomes are showed in tables with the results presented in delta (post-intervention values minus pre-intervention values or control).

## Results

Through the searches, 1377 articles were found, of which 36 were excluded as duplicate. From these, 1298 articles were

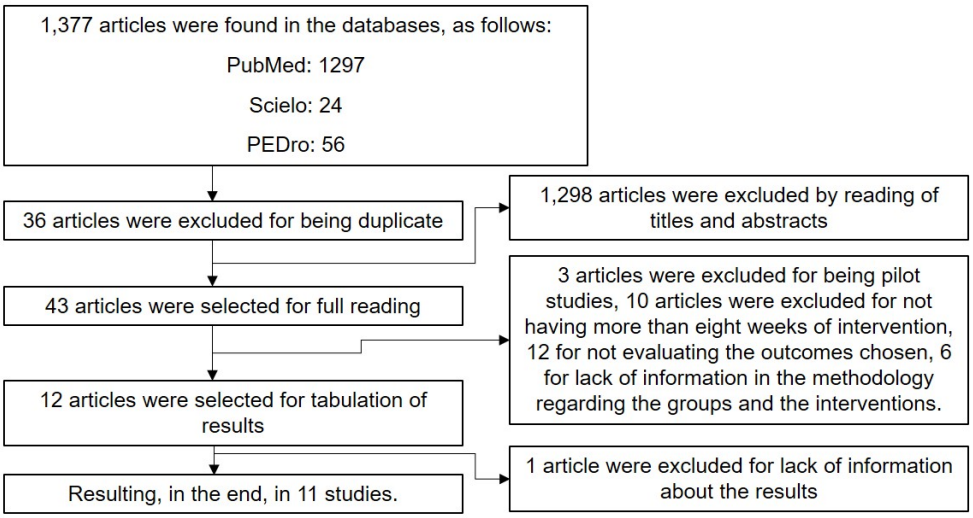


**Figure 1.** Flowchart of search and analysis of articles in the different phases of the review.

**Table 1.** Characteristics of the studies included.

| Study | Sample | Intervention | Outcome |
|---|---|---|---|
| Goodwin et al.[20] | 130 participants<br>*Experimental Group:* 64 individuals<br>*Control Group:* 66 individuals<br>*Stage of PD: EG:* 2.6 ± 09 / *CG:* 2.4 ± 0.4 | *Duration:* 10 weeks<br>*Frequency:* 2x/week<br>*Session:* 60 min<br>*Protocol:* Resistance training followed by balance exercises | BERG<br>TUG |
| Mollinedo-Cardalda et al.[21] | 26 participants; ≥ 60 years<br>*Experimental Group:* 13 individuals<br>*Control Group:* 13 individuals<br>*Stage of PD: EG:* 2.08 ± 0.49 /*CG:* 2.00 ± 0.82 | *Duration:* 12 weeks<br>*Frequency:* 2x/week<br>*Session:* 60 min<br>*Protocol:* Pilates | UPDRS<br>TUG |
| Margaret Schenkman et al.[22] | 128 participants; 40 to 80 years<br>*Intense Exercise (IG):* 43 individuals<br>*Moderate Exercise (ModG):* 45 individuals<br>*Control Group:* 40 individuals<br>*Stage of PD:* NI | *Duration:* 26 weeks<br>*Frequency:* 4x/week<br>*Session:* 50 min<br>*Protocol:* Aerobic training on the treadmill, intense and moderate | UPDRS |
| Nadeau et al.[23] | 93 participants; 40 to 80 years<br>*Velocity Group (VG):* 29 individuals<br>*Mixes Group (MG):* 30 individuals<br>*Control Group (CG):* 34 individuals<br>*Stage of PD:*<br>*VG:*1.92 ± 0.20 / *MG:*1.95 ± 0.15 / *CG:* 1.26 ± 0.23 | *Duration:* 24 weeks<br>*Frequency:* 3x/week and 2x/week<br>*Session:* 60 min<br>*Protocol:* Training on the treadmill, mixed (inclination) and velocity (intensity/velocity) | UPDRS<br>PDQ-39 |
| Santos et al.[24] | 28 participants;<br>*Experimental Group:* 13 individuals<br>*Control Group:* 15 individuals.<br>*Stage of PD: EG:* 1.92 ± 0.49 / *GC:* 1.86 ± 0.35 | *Duration:* 8 weeks<br>*Frequency:* 2x/week<br>*Session:* 60 to 70 min<br>*Protocol:* Resistance training | UPDRS<br>PDQ-39 |
| Collett et al.[25] | 105 participants; 60 years<br>*Experimental Group:* 53 individuals<br>*Control Group:* 52 individuals<br>*Stage of PD:* NI | *Duration:* 6 months<br>*Frequency:* 2x/weeks<br>*Session:* 60 min<br>*Protocol:* Exercise counseling involving a booklet, followed by resistance training | UPDRS<br>TUG |
| Sage et al.[26] | 53 participants; 60 years<br>*Proprioception training group (PG):* 18 individuals<br>*Aerobic Group (AG):* 13 individuals<br>*Control Group:* 15 individuals<br>*Stage of PD:* NI | *Duration:* 12 weeks<br>*Frequency:* 3x/week<br>*Session:* 60 min<br>*Protocol:* Aerobic training (AG) / Proprioceptive training (PG) | UPDRS<br>TUG |
| Allen et al.[27] | 48 participants; 30 to 80 years<br>*Experimental Group:* 24 individuals<br>*Control Group:* 24 individuals<br>*Stage of PD:* NI | *Duration:* 6 months<br>*Frequency:* 3x/week<br>*Session:* 40 to 60 min<br>*Protocol:* Resistance training followed by balance of lower limbs | PDQ-39 |
| Morris et al.[28] | 210 participants;<br>*Resistance training (RT):* 70 individuals<br>*Balance Training (BT):* 69 individuals<br>*Control Group (CG):* 71 individuals<br>*Stage of PD:* NI | *Duration:* 8 weeks<br>*Frequency:* 1x/week<br>*Protocol:* Resistance training (RT) / Balance training (BT) | UPDRS;<br>PDQ-39;<br>TUG. |
| M. Ni et al.[29] | 41 participants<br>*Power Training (PowT):* 14 individuals<br>*Yoga Group (YG):* 15 individuals<br>*Control Group (CG):* 12 individuals<br>*Stage of PD:*<br>*PowG:* 2.2 ± 0.6 / *YG:* 2.2 ± 0.7 / *CG:* 2.1 ± 0.7 | *Duration:* 12 weeks<br>*Frequency:* 2x/week<br>*Session:* 60 min<br>*Protocol:* Power training (PowT) / yoga training with basic exercises (YG) | UPDRS<br>BERG<br>TUG |
| I.S. Wong-Yu et al.[30] | 70 participants<br>*Control Group (CG):* 38 individuals<br>*Experimental Group (EG):* 32 individuals<br>*Stage of PD: EG:* 2.5 ± 0.3 / *CG:* 2.4 ± 0.3 | *Duration:* 8 weeks<br>*Frequency:* 2x/week<br>*Session:* 60 min<br>*Protocol:* Balance training followed by resistance training. | TUG |

NI: Not Indicated; PD: Parkinson's Disease; TUG: Timed up and go; UPDRS: Unified Parkinson's Disease Rating Scale; PDQ-39: Parkinson's Disease Questionnaire; BERG: Berg Balance Scale.

excluded by reading of titles and abstracts, resulting in 43 articles for full reading. Faced with that, three were excluded because they were pilot studies, 10 because they did not have more than eight weeks of intervention, 12 for not having evaluated the outcomes included, six due to lack of methodological information regarding the groups and interventions and one because of missing information about the results. In the end, 11 articles were selected for review (Figure 1).

A summary of the characteristics of the studies included can be viewed on Table 1, which presents the sample characteristics, the stage of PD evaluated by the scale of Hoehn & Yahr, information regarding the intervention and outcomes evaluated. In relation to the stage of the disease, most of the studies were on stage II in which the inability is considered light to moderate. The studies accumulate a total "n" of 925 participants, being 545 allocated in the intervention groups and 380 in the control groups.

Table 2 presents the results regarding the Berg's Balance Scale, TUG, UPDRS e PDQ-39. For the Berg Balance Scale, only two studies were included and it was observed that the group performing resistance training followed by exercises involving balance presented significant improvements, increasing its score in the scale. In addition, in another study, the groups that trained power and yoga separately also significantly improved, whereas the control group maintained their scores. In this way, it is highlighted that all exercises evaluated by the included studies were similarly efficient in improving balance.

Regarding the second outcome, agility and dynamic balance evaluated by TUG, only two studies presented significant improvements, one with Pilates training and other study demonstrated improvements with power training and yoga training performed alone. It is highlighted that the trainings with aerobic characteristics, even combined with other modalities, did not significantly influence on the improvement of dynamic balance and agility of the PD patients.

For the data regarding UPDRS, the higher values indicate greater severity of the disease. Some studies found a significant decrease in the motor domain results, which was the main focus of the present review. Only two studies found significant decrease, one showed improvement in the group training balance and the other in the groups training power and yoga alone. In a study, a significant increase was found with the exercises oriented through a booklet followed by resistance exercises.

Lastly, in relation to PDQ-39 data, some studies found significant improvements with different types of training. In this case, the improvement was observed by a decrease in the questionnaire score. In the study with aerobic training, the group training velocity on the treadmill and the group training mixed modalities, with increasing inclination and velocity, presented significantly decrease in their score. In the study which training protocol involved resistance exercise, the experimental group also presented significant decrease. In this way, it is observed that there is a possibility of improvement in the quality of life aspects regardless the type of exercise performed.

Risk of bias analysis of each study can be viewed on Table 3. Overall, the studies presented a good methodological quality and low risk of bias.

## Discussion

Of the 11 studies selected, two evaluated static balance and both found significant improvements, seven studies assessed agility and dynamic balance in which two presented significant

**Table 2.** Data regarding Berg Balance Scale, scale of agility and dynamic balance (Timed Up and Go) and motor domain evaluated by Unified Parkinson's Disease Rating Scale and Parkinson's Disease Questionnaire-39.

| Study | Protocol | Group | Intervention (Δ) |
|---|---|---|---|
| BERG BALANCE SCALE | | | |
| Goodwin et al.[20] | Resistance training followed by balance exercises | EG | +5* |
| | | CG | 0.5 |
| M. Ni et al.[29] | Power training (PowT) / Yoga training with basic exercises (YG) | PowG | +4.4* |
| | | YG | +4.2* |
| | | CG | 0.4 |
| AGILITY AND DYNAMIC BALANCE (TUG) | | | |
| Goodwin et al.[20] | Resistance training followed by balance exercises | EG | 0.3 |
| | | CG | +1.6 |
| Mollinedo-Cardalda et al.[21] | Pilates | CG | 0.12 |
| | | EG | -1.57* |
| Collett et al.[25] | Exercise counseling involving a booklet followed by resistance training | EG | 0.3 |
| | | CG | 0.8 |
| Sage et al.[26] | Aerobic training (AG) / Proprioceptive training (GP) | PG | -0.5 |
| | | AG | -0.7 |
| | | CG | 0.1 |
| Morris et al.[28] | Resistance training (RT) / Balance Training (BT) | CG | 4.5 |
| | | BT | 1.9 |
| | | RT | 2.4 |
| M. Ni et al.[29] | Power training (PowT) / Yoga training with basic exercises (YG) | PowT | -1.3* |
| | | YG | -2.3* |
| | | CG | 0.3 |
| I.S. Wong-Yu et al.[30] | Balance training followed by resistance training | EG | -0.7 |
| | | CG | -0.1 |
| MOTOR DOMAIN (UPDRS) | | | |
| Mollinedo-Cardalda et al.[21] | Pilates | CG | +3.5 |
| | | EG | -0.4 |
| Margaret Schenkman et al.[22] | Intense training on the treadmill (IG) / Moderate training on the treadmill (ModG) | IG | +2.0 |
| | | ModG | +3.0 |
| | | CG | +3.9 |
| Nadeau et al.[23] | Training on the treadmill with velocity (VG) / Mixed training on the treadmill (MG) | VG | +8.9 |
| | | MG | +9.6 |
| | | CG | +8.0 |
| Santos et al.[24] | Resistance training | EG | -0.5 |
| | | CG | +1.5 |
| Collett et al.[25] | Exercise counseling involving a booklet followed by resistance training | GE | +3.0* |
| | | GC | +1.5 |
| Sage et al.[26] | Aerobic training (AG) / Proprioceptive training (PG) | PG | -5.6 |
| | | AG | -1.8 |
| | | CG | +1.2 |
| Morris et al.[28] | Resistance training (RT) / Balance training (BT) | CG | +1.6 |
| | | BT | -0.2* |
| | | RT | +0.9 |
| M. Ni et al.[29] | Power training (PowT) / Yoga training with basic exercises (YG) | PowT | -10.7* |
| | | YG | -10.9* |
| | | CG | +0.4 |
| Parkinson's Disease Questionnaire-39 | | | |
| Nadeau et al.[23] | Training on the treadmill with velocity (VG) / Mixed training on the treadmill (MG) | VG | -3.6* |
| | | MG | -9.0* |
| | | CG | 0.0 |
| Santos et al.[24] | Resistance training | EG | -6.58* |
| | | CG | +4.62 |
| Allen et al.[27] | Resistance training and lower limbs balance | EG | -1.0 |
| | | CG | +4.9 |
| Morris et al.[28] | Resistance training (RT) / Balance training (BT) | CG | +2.0 |
| | | BT | +1.4 |
| | | RT | -0.8 |

EG: Exercise Group; CG: Control Group; *: represent a significant difference (p<0.05); TUG: Timed up and go; UPDRS: Unified Parkinson's Disease Rating Scale; PDQ-39: Parkinson's Disease Questionnaire; BERG: Berg Balance Scale.

**Table 3.** Risk of bias analysis of the studies included.

| STUDY | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Goodwin et al.[20] | - | - | - | - | + | + | NR | - | - | - | - |
| Mollinedo-Cardalda et al.[21] | - | - | - | - | + | + | - | - | + | - | - |
| Margaret Schenkman et al.[22] | NR | - | - | - | + | + | + | - | - | - | - |
| Nadeau et al.[23] | - | - | NR | - | - | - | - | - | + | NR | - |
| Santos et al.[24] | - | - | - | - | + | - | + | - | NR | - | - |
| Collett et al.[25] | - | - | - | - | + | + | - | - | - | - | - |
| Sage et al.[26] | - | NR | NR | - | + | + | - | - | - | - | - |
| Allen et al.[27] | - | - | - | - | + | + | - | - | - | - | - |
| Morris et al.[28] | - | - | - | - | + | + | - | - | - | - | - |
| M. Ni et al.[29] | - | - | NR | - | + | + | NR | - | + | - | - |
| I.S. Wong-Yu et al.[30] | - | - | - | - | + | + | - | - | + | - | - |

+: High risk of bias; -: low risk of bias; NR: not reported risk of bias.

improvements. In relation to the motor symptoms evaluated by UPDRS, eight studies were found and two presented positive responses, and one reported negatives responses. In addition, four studies evaluated motor symptoms using PDQ-9 and of these, two presented significant improvements. It is highlighted that the studies involving resistance and balance training, simultaneously performed or alone positively influenced on the improvement of balance in PD patients. Overall, aerobic exercise and/or combined are not as beneficial as it was expected for this outcome. However, for motor symptoms, any systematized and periodized exercise modality influences in a positive manner.

Studies such as that of Au-Yeung et al.[31] show that there is a positive analogy between the alterations of balance and decreased muscle strength. Berg Balance Scale, which evaluates overall balance, presented improvements in the modalities involving resistance strength along with balance, and power and yoga trainings alone. Both showed the importance of performing muscle strength for both upper and lower limbs, as well as trunk muscles in PD patients. Once that balance and risk of falls, which affects both PD patients and elderly, are associated to loss of muscle strength,[32] resistance training has been identified as an important factor to prevent falls in situations of body imbalance, due to the increase of lean mass and muscle strength.[33] According to Berg et al.[34] the average score of Berg Scale, when above 45, indicates that the subjects have a low risk of falls. Faced with that, it is highlighted that the study involving resistance training followed by balance exercises found an average score of 49 and the study performing power and yoga training alone, found an average score of 53.2 and 53.4 for both training groups, respectively, Therefore, the results found demonstrate that the elderly evaluated finished the interventions classified as having low risk of falls.

By analyzing the results regarding agility and dynamic balance, assessed by TUG test, the studies showed significant improvements in the groups training Pilates and the groups training power and yoga alone. According to Chen et al.[35], such results indicate that the inclusion of exercises that work strength in modalities as Pilates alone as well as including power training increase functional independence and consequently improves balance.

Regarding the motor symptoms results, UPDRS data, when assessed after intervention with exercise counseling involving booklets with non-periodized functional exercises, a significant increase in the score of the scale was observed. In addition, resistance training is a method recognized by offering improvement in functional performance and has been recommended as auxiliary treatment for PD.[36] However, in the study involving resistance and balance trainings separately, the group training balance presented significant improvements, whereas the resistance training group maintained their levels. It is believed that the training involving specific balance exercises may be more specific in improving the motor symptoms evaluated by this scale.

Another study shows that both an eight-week program of home-based exercises and a supervised exercise program by a professional significantly improved motor symptoms in PD individuals with light to moderate impairment.[37] Such study, which involves Yoga practice, suggests that the improvement in motor function with the practice of this modality may be explained by the improvements in balance, strength, posture and gait.[37] Besides that, Lopes[16] shows that resistance, flexibility and overall gymnastics exercises performed three times per week, and each training performed once a week shows a decrease in motor impairment.

The PDQ-39, which assesses quality of life, was significant for aerobic and resistance trainings. According to Filippin et al.[38], the results show that training on the treadmill allowed the improvement of motor aspects related quality of life and motor function of PD patients. In relation to resistance training, which significantly decreased, improving the patients' quality of life of these patients, Schlenstedt et al.[39] confirms that such modality also induces significant improvements in a group with PD. Therefore, resistance training emerges as alternative for improving quality of life. Thus, Simão et al.[40] highlight that physical exercise is one of the best manners of maintaining quality of life during aging process, inducing a favorable influence on the functional condition of the organism.

Lastly, it is reported that the present review has a limitation factor regarding the lack of standardization of the stage of the disease, which can be identified by H&Y scale. However, even without limiting this aspect, most of the included studies presented patients in the stage II of the disease, due to the facility of working with the population in this stage. With that, the importance of studies with patients in more advanced stages is shown.

It is concluded that resistance and balance trainings improve static balance, dynamic balance and agility, both performed in combination or alone. For motor symptoms, any exercise modality, as long as it is periodized and systematized, positively influences on the improvement of PD patients.

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## References

1. Reichmann H, Schneider C, Löhle M. Non-motor features of Parkinson's disease: depression and dementia. Parkinsonism Relat Disord. 2009;15(3):87-92.
2. Barbosa MT, Caramelli P, Maia DP, Cunninghan MC, Guerra HL, Lima MF, et al. Parkinsonism and Parkinson's disease in the elderly: a community-based survey in Brazil (the Bambuí study). Mov Disord. 2006;21:800-8.
3. Parkinson J. An Essay on The Shaking Palsy. London, Whittingham & Rowland, 1817.
4. Teive HAG, Meneses MS. Histórico. In Meneses MS, Teive, HAG. Doença de Parkinson: aspectos clínicos e cirúrgicos. Rio de Janeiro: Guanabara Koogan; 2003. p. 3-4.
5. O'sullivan SB, Schimitz TJ. Doença de Parkinson. Fisioterapia: avaliação e tratamento. São Paulo: Manole; 2004. p. 747-73.
6. Rossi B, Siciliano G, Carboncini C, Manca ML, Massetani R, Viacava E, et al. Muscle Modifications In Parkinson's Disease: Myoelectric Manifestations. Electroencepha Clin Neurophys. 1996;101:211-8.

7. Nogaki H, Kakinuma S, Morimatsu M. Muscle Weakness in Parkinson's Disease: A Follow-Up Study. Parkinsonism Relat Disord. 2001;8:57-62.
8. Yarrow K, Brown P, Gresty MA, Bronstein AM. Force Platform Recordings in the Diagnosis of Primary Orthostatic Tremor. Gait Posture. 2001;13:27-34.
9. Gonçalves LHT, Alvarez AM, Arruda MC. Pacientes Portadores da Doença de Parkinson: Significado de suas Vivências. Acta Paul Enferm. 2007;20(1):62-8.
10. Smith AD, Zigmond MJ. Can the Brain be protected through exercise? Lesson from an animal model of the parkinsonism. Experim Neuro. 2003;184:31-9.
11. Rubert VA, Reis DC, Esteves AC. Doença de Parkinson e exercício físico. Rev Neurocienc. 2007;15(2):141–6.
12. Miyai I, Fujimoto Y, Ueda Y, Yamamoto H, Nozaki S, Saito T, et al. Treadmill Training with Body Weight Support: Its Effect on Parkinson's. Arch Phys Med Rehabil. 2000;81(7):849-52.
13. Pohl M, Rockstroh G, Rückriem S, Mrass G, Mehrholz J. Immediate Effects of Speed-Dependent Treadmill Training on Gait Parameters in Early Parkinson's Disease. Arch Phys Med Rehabil. 2003;84(12):1760-6.
14. Hirsch MA, Toole T, Maitland CG, Rider RA. The Effects of Balance Training and High-Intensity Resistance Training on Persons with Idiopathic Parkinson's Disease. Arch Phys Med Rehabil. 2003;84:1109-17.
15. Scandalis TA, Bosak A, Berliner JC, Helman LL, Wells MR. Resistance training and gait function in patients with Parkinson's disease. Arch Phys Med Rehabil. 2001;80:38-43.
16. Lopes AG. Efeitos do treinamento físico sobre o nível de atividade física, capacidade funcional e comprometimento motor na doença de Parkinson [Dissertação de mestrado]. Rio Claro: Instituto de Biociências-UNESP; 2006.
17. Braga A, Xavier ALIL, Machado RP, Marques MB. Benefícios do treinamento resistido na reabilitação da marcha e equilibrio nos portadores da doença de Parkinson. Vida Saúde. 2003;2(2):1-9.
18. Sage M, Almeida Q. A positive influence of vision on motor symptoms during sensory attention focused exercise for Parkinson's disease. Mov Disord. 2010;25:64-9.
19. Verhagen AP, de Vet HC, de Bie RA, Kessels AG, Boers M, Bouter LM, et al. The Delphi list: a criteria list for quality assessment of randomized clinical trials for conducting systematic reviews developed by Delphi consensus. J Clin Epidemiol. 1998;51(12):1235-41.
20. Goodwin VA, Richards SH, Henley W, Ewings P, Taylor AH, Campbell JL. An exercise intervention to prevent falls in people with Parkinson's disease: a pragmatic randomised controlled trial. J Neurol Neurosurg Psychiatry. 2011;82:1232-8.
21. Mollinedo-Cardalda I, Cancela-Carral JM, Vila-Suarez MH. Effect of a Mat Pilates program with theraband on dynamic balance in patients with Parkinson's disease: feasibility study and randomized controlled trial. Rejuvenation Res. 2018;20(20):423-30.
22. Schenkman M, Moore CG, Kohrt WM, Hall DA, Delitto A, Comella CL, et al. Effect of High-Intensity treadmill exercise on motor symptoms in patients with Parkinson's Disease: A phase 2 randomized clinical trial. JAMA Neurology. 2018;75(2):219-26.
23. Nadeau A, Pourcher E, Corbeil P. Effects of 24 weeks of treadmill training on gait performance in Parkinson's Disease. Med Sci Sports Exerc. 2013;46(4):645-55.
24. Santos L, Fernandez-Rio J, Winge K, Barragán-Pérez B, González-Gómez L, Rodríguez-Pérez V, et al. Effects of progressive resistance exercise in akinetic-rigid Parkinson's disease patients: a randomized controlled trial. Eur J Phys Rehab Med. 2017;53(5):65
25. Collett J, Franssen M, Meaney A, Wade D, Izadi H, Tims M, et al. Phase II randomised controlled trial of a 6-month self-managed community exercise programme for people with Parkinson's disease. J Neurol Neurosurg Psychiatry. 2016;88(3):204-11.
26. Sage MD, Almeida QJ. Symptom and Gait Changes After Sensory Attention Focused Exercise vs Aerobic Training in Parkinson's Disease. Mov Disord. 2009;24(8):1132–8.
27. Allen NE, Canning CG, Sherrington C, Lord SR, Latt MD, Close JCT, et al. The Effects of an Exercise Program on Fall Risk Factors in People with Parkinson's Disease: A Randomized Controlled Trial. Mov Disord. 2010;25(9):1217–25.
28. Morris ME, Menz HB, McGinley JL, Watts JJ, Huxham FE, Murphy AT, et al. A Randomized Controlled Trial to Reduce Falls in People with Parkinson's Disease. Neurorehabil Neural Repair. 2015;29(8):777–85.
29. Ni M, Signorile JF, Mooney K, Balachandran A, Potiaumpai M, Luca C, et al. Comparative Effect of Power Training and High-Speed Yoga on Motor Function in Older Patients with Parkinson's Disease. Arch Phys Med Rehabil. 2016;97(3):345-54.
30. Wong-Yu IS, Mak MK. Task- and Context-Specific Balance Training Program Enhances Dynamic Balance and Functional Performance in Parkinsonian Nonfallers: A Randomized Controlled Trial with Six-Month Follow-Up. Arch Phys Med Rehabil. 2015;96(12):2103-11.
31. Au-Yeung SS, Ng JT, Lo SK. Does balance or motor impairment of limbs discriminate of ambulatory status of stroke survivors? Am J Phys Med Rehabil. 2003;82(4):279-83.
32. Tinetti M, Gordon C, Sogolow E, Lapin P. Fall risk evaluation and management: challenges in adopting geriatric care practices. The Gerontologist. 2006;46(6):715-25.
33. Maior AS. Relação sarcopenia e treinamento de força. Maior AS. Relação sarcopenia e treinamento de força.
34. Berg KO, Maki BE, Willians JI, Holliday PJ, Wood-Dauphinee SL. Clinical and laboratory measures of postural balance in an elderly population. Arch Phys Med Rehabil. 1992;73(11):1073-80.
35. Chen MC, Chen KM, Chang CL, Chang YH, Cheng YY, Huang HT. Elastic band exercises improved activities of daily living and functional fitness of wheelchair-bound older adults with cognitive impairment: A cluster randomized controlled trial. Am J Phys Med Re
36. Falvo MJ, Schilling BK, Earhart GM. Parkinson's disease and resistive exercise: rationale, review, and recommendations. Mov Disord. 2008;23(1):1-11.
37. Lun V, Pullan N, Labelle N, Adams C, Suchowersky O. Comparison of the effects of a self-supervised home exercise program with a physiotherapist supervised exercise program on the motor symptoms of Parkinson's disease. Mov Disord. 2005;20(8):971-5.
38. Filippin NT, Costa PHL, Mattioli R. Effects of treadmill-walking training with additional body load on quality of life in subjects with Parkinson's disease. Rev Bras Fisio. 2010;14(4):344-50.
39. Schlenstedt C, Paschen S, Kruse A, Raethjen J, Weisser B, Deuschl G. Resistance versus Balance Training to Improve Postural Control in Parkinson's Disease: A Randomized Rater Blinded Controlled Study. PLoS ONE. 2015;10(10):1-17.
40. Treinamento de força para idosos [Internet]. 2009. CDOF; [cited 2018 Nov 25]; Available from: http://cdof.com.br/Treinamento%20de%20Forca%20Para%20Idosos.pdf