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ORIGINAL ARTICLE

Effect of resistance training on balance and postural control in people with Parkinson's: A systematic review☆

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KEYWORDS
Resistance training;
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Abstract
Background: Physical exercise has contributed significantly to the quality of life of the population. Therefore, countless specialists have established relationships between t people who perform physical exercise and success in the treatment of diseases, such as Parkinson's disease in older adults.
Objective: The aim of this research is to analyse the influence of resistance training in the correlation of balance and postural control in people with Parkinson's disease.
Method: A systematic review was conducted according to the recommendations of the Preferred Reporting Items for Systematic Reviews And Meta-Analyses (PRISMA), in consultation with the PubMed, Scielo, BVS (Lilacs), ScienceDirect and Cochrane databases, based on the influence of resistance training on postural balance and control in older adults with Parkinson's disease, highlighting as the main assessment tool the Movement Disorders Society — Unified Parkinson's Disease Rating Scale.

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Results: After searching the selected databases and considering the inclusion and exclusion criteria of this study, 10 studies were selected to compose this review and a total of 556 participants were pooled. It was observed that most of the interventions (60%) had a duration of approximately 30—45 min over eight to twelve weeks, the most used measuring instruments were the BESTest (Balance Evaluation System Test), FOG-Q (Freezing of Gait Questionnaire) and the MDS-UPDRS (Movement Disorders Society-Unified Parkinson's Disease Rating Scale).
Conclusion: Physical exercise plays a fundamental role in the intervention and prevention of Parkinson's disease symptoms with regard to balance, strength, and quality of life.

PALABRAS CLAVE
Entrenamiento de resistencia;
Ejercicio físico;
Equilibrio postural;
Enfermedad de Parkinson

Efecto del entrenamiento resistido sobre el equilibrio y control postural en personas con párkinson: una revisión sistemática

Resumen
Introducción: La práctica de ejercicio físico ha contribuido significativamente a la calidad de vida de la población, por ello, innumerables especialistas han establecido relaciones entre los practicantes de ejercicio físico y el éxito en el tratamiento de enfermedades, como es el caso de la enfermedad de Parkinson en el anciano.
Objetivo: El objetivo de esta investigación es analizar la influencia de la práctica del entrenamiento de resistencia en la correlación del equilibrio y el control postural en personas con párkinson.
Método: Revisión sistemática de acuerdo con las recomendaciones de los artículos Preferred Reporting Items for Systematic Reviews And Meta-Analyses (PRISMA), en consulta con las bases de datos PubMed, Scielo, BVS (Lilacs), ScienceDirect y Cochrane, basados en la influencia del entrenamiento de resistencia en el equilibrio y el control postural en ancianos con párkinson, destacando la principal herramienta de evaluación del Movimiento Sociedad de Trastornos, escala unificada de calificación de la enfermedad de Parkinson.
Resultados: Después de realizar búsquedas en las bases de datos seleccionadas y considerar los criterios de inclusión y exclusión de este estudio, se seleccionaron 10 estudios para componer esta revisión y se acumularon un total de 556 participantes. Se observó que la mayoría de las intervenciones (60%) tuvieron una duración de aproximadamente 30–45 min durante 8 a 12 semanas, los instrumentos de medición más utilizados fueron las puntuaciones Balance Evaluation System Test (BESTest), Freezing of Gait Questionnaire (FOG-Q) y Movement Disorders Society-Unified Parkinson's Disease Rating Scale (MDS-UPDRS).
Conclusión: El ejercicio físico desempeña un papel fundamental en la intervención y prevención de los síntomas de la enfermedad de Parkinson en lo que respecta al equilibrio, la fuerza y la calidad de vida.

Introduction

Parkinson's disease is a neurodegenerative progression that affects the mechanisms controlling cognitive and motor tasks.[1–3] There are more than 6 million people with the disease world-wide, with greater incidence in individuals aged over 50 years old, and with higher prevalence in the elderly.[4] For stabilising symptoms, it is fundamental to do physical exercise, such as programmes of resistance training; physical exercise conditions the physical skills related to balance and posture control.[5–8]

Postural instability becomes an aggravating factor in patients with Parkinson's disease. In addition, the disease itself, in the majority of the cases, is diagnosed in the elderly, so the disease and aging accentuate even more the problems of balance and postural control. Establishing resistance training programmes can be a treatment alternative[9,10] and can help in some aspects of the disease, such as improving functional capacity, quality of life, neuropsycological stimuli and musculoskeletal strengthening and resistance. In general, physiological behaviour consequently shows positive results to these training programmes.[11,12]

Based on these antecedents, the following question arises: what are the effects of resistance training on postural balance and control in patients with Parkinson's?

One of the main intentions of care is to contribute to making the quality of life of the elderly with Parkinson's disease better progressively. Consequently, the objective of this study was to analyse the influence of carrying out resistance training on improving balance and postural control in patients with Parkinson's.

Method

This review was registered in the PROSPERO platform (CRD42021232890). The literature search was conducted in the PubMed, Scielo, BVS (Lilacs), ScienceDirect and Cochrane databases, in order to identify articles on the subject matter of this study. Articles published through 31 December 2020 were included, without an initial cut-off date; that is, this study has considered all of the articles published up to the search date. The keywords used in English were ''elderly'', ''senior'', ''old man'', ''old'', ''aging'', ''aged'', ''strength training'', ''resistance training'', ''weight training'', ''endurance training'', ''balance'', ''postural control'' and ''parkinson''. Review articles were not included, so the term ''review'' was included in the search line in a specific way. The search lines used in this study are shown in Table 1.

Only 1 characteristic of the digital plataforms was used immediately after the search line. That was the ''Clinical Trial'' characteristic of the PubMed database, the Lilacs ''Controlled clinical trial'' resource in the BVS database (Lilacs), the ''Article search'' function in the Science Direct database, and the ''Trials'' function in the Cochrane database. The articles were found using keywords and database resaources, and were then exported to the EndNote® programme (Clarivate) with their abstracts/summaries. PRISMA, proposed by Liberati et al.,[13] was the systematisation used.

The first screening phase of the articles consisted of reading the titles and the abstracts/summaries of the citations exported. In this initial screening, the criteria for inclusion and exclusion presented in Fig. 1 and in Table 2 were used. After the first selection, the files of the remaining articles were downloaded and eliminated in the EndNote® programme to undergo a second selection based on a complete reading of the article content. In this phase, the articles were independently selected by 2 researchers; if there was any disagreement about including a specific study in this review, the decision of a third researcher was accepted.

For the first and second phase of screening, the criteria for inclusion and exclusion shown in Table 2 were established. The criteria used aim to find articles related to physical resistance exercise programmes in which the results are related to balance and postural control in elderly individuals with Parkinson's. Articles not related to this subject were discarded. Resistance training is widely extended among the various forms of physical excercise. It involves movement of the skeletal muscles to shift or try to move a resistance, and features the use of equipment/machines, free weights or the weight of the body. Such resistance training leads to a series of neurophysiological, structural and bioenergetic changes in the organism.

From the articles selected after the screening phases, 9 parameters were extracted. These included the author, year of publication, article title, objectives, sample characteristics, methods adopted, tests used, results obtained and main conclusions of each study. After exportation, 29 references were identified that did not represent articles by using the specification of ''Selection of books''; these references were excluded. A total of 14 duplicated references were identified, which were eliminated.

Screening was divided into 2 stages. After the first stage, which consisted of applying the criteria for inclusion and exclusion by means of reading the titles and abstracts/summaries, through which 22 references were selected. After the second stage of screeing, which consisted of applying the criteria for inclusion and exclusion by reading the complete text of the articles, 10 articles were selected to form the basis of this study.

Results

The main characteristics (author, year, title, objective or objectives and principal conclusions) of the articles selected are shown in Table 3. In this table, you can see that the oldest article was published in 2003 and the most recent, in 2019.

All the studies, generally speaking, evaluated walking speed. Two studies analysed step length; there was only 1 that did not evaluate cadence; 3 studies assessed stride length; only 5 used the Unified Parkinson's Disease Rating Scale (UPDRS)[14] before and after the interventions; and some other studies used this scale, but only for characterising the sample (1 of them evaluating the scale completely). In addition, resistance training, strength and balance were principally characterised by studies with more than 40 participants.

The studies accumulated a total of 556 participants, as Table 4 shows. In the studies, most trials used methods to measure gait parameters such as speed, cadence, stride and stride length, freezing with the Freezing of Gait Questionnaire (FOG-Q), and psychomotor effort using the UPDRS. These studies, representing approximately 50% of all the studies, were analysed.

As for the intervention period, a mean of 19.16 therapies were carried out, ranging from 10 to 28; scores (Balance Evaluation System Test [BESTest], FOG-Q, UPDRS) were the main way to measure symptoms, as can be seen in Table 5. In these studies, it also appears that the majority (60%) had sessions that lasted approximately 30—45 min for 8–12 weeks. In some studies, in the minority, the therapies were carried out, on average, for 1 h (30%). Just 1 study used merely 20 min to apply the tests ordered in the previous and posterior interventions.

Discussion

As a result of the search carried out according to the methods reported, we obtained a total of 10 articles that involved strength training in patients with Parkinson's disease.

Table 1 Search terms by keywords and databases.

Keywords by database
PubMed (elderly) OR (senior)) OR (old man)) OR (old)) OR (aging)) OR (aged)) AND ((((strength training) OR (resistance training)) OR (weight training)) OR (endurance training))) AND (balance)) AND (postural control)) AND (parkinson) NOT (review)
Scielo; BVS (Lilacs) (elderly) OR (senior)) OR (old man)) OR (old)) OR (aging)) OR (aged)) AND ((((strength training) OR (resistance training)) OR (weight training)) OR (endurance training))) AND (balance)) AND (postural control)) AND (parkinson) NOT (review)
Science Direct (elderly) OR (senior)) OR (aging)) AND ((((''strength training'') OR (''resistance training'')) OR (''weight training''))) AND (balance)) AND (postural control)) AND (parkinson) NOT (review)
Cochrane elderly OR aging OR aged AND strength training OR resistance training OR weight training OR endurance training AND balance AND postural control AND parkinson OR parkinson's disease NOT review

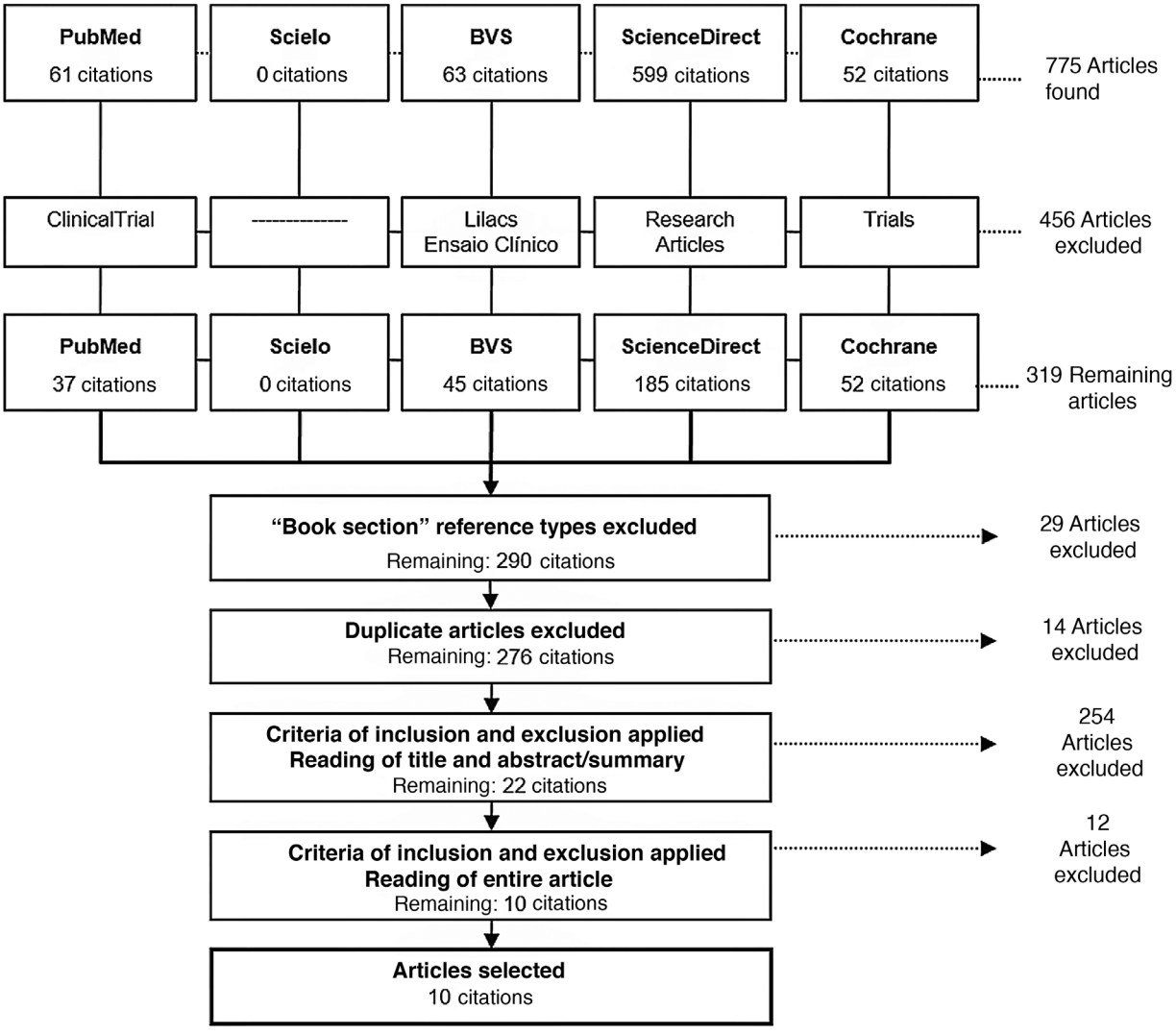

Figure 1 PRISMA flowchart and selection process.

Table 2 Criterios de inclusion y exclusion.

Criteria of inclusion	Criteria of exclusion
Only studies involving resistance training in the elderly with Parkinson's disease	Studies with animal samples, articles on positioning, guidelines and directives
Only studies involving analysis of balance and postural control in the sample	When older people with Parkinson's are used for a test study assessing physical characteristics other than balance and postural control
Complete original articles on studies of clinical trials published in a scientific journal	Interventions of physical exercise programmes that, specifically, do not form part of what is considered resistance training

To answer the questions that guided this review, the articles were discussed based on their presentation of methods. Next, we discussed the description and presentation of the principal conclusions of the authors with respect to the datos gathered on balance and postural control of older individuals with Parkinson's.

Various of the studies use results related to the symptoms of the disease, such as the Unified Parkinson's Disease Rating Scale (UPDRS) for classification.[8,15–18]

The UPDRS, for example, assesses the signs, symptoms and specific activities of the patients by means of a self-report and observation. The scale consists of 42 items, divided into 4 parts: mental activity, behaviour and sense of humor; daily living activities; motor examination; and complications from drug therapy. The maximum score value indicates greater compromise from the disease.[8,15–18]

According to Filippin et al., the results showed that training using a treadmill and increasing the body load made it possible to improve the motor aspects related to quality of life and motor function of patients with Parkinson's.[19] Schlenstedt et al. confirm that this method also induces significant improvements in a group of individuals with Parkinson's. Consequently, resistance training seems to be an alternative for improving quality of life in these circumstances.[17] Siddique et al. indicate that physical exercise is one of the best ways to maintain quality of life during the aging process, influencing the functional condition of the organism favourably.[20]

As for the motor symptoms assessed by the UPDRS, we found 5 studies: 4 showed positive responses[15–17,21] and 1, a negative response.[18] When the UPDRS was used to assess results after an exercise-oriented intervention that included leaflets with functional exercises without regular repetition, there was a significant increase in the scale score. This translates to a non-beneficial result, possibly demonstrating the importance and periodised and systematic training for the improvement of motor symptoms.[22]

Systematic training is a method recognised as improving functional performance; it has been recommended as adjuvant treatment in Parkinson's disease.[23] Consequently, it is seen that training that involves specific balance exercises can have greater specificity for improving the motor symptoms assessed by this scale.[24] We can emphasise that the studies involving strength and balance trainings (whether simultaneously or separately) affect balance positively in patients with Parkinson's disease. In contrast, aerobic or combined exercises were not generally so beneficial as expected for this result. Nevertheless, for motor symptoms, any type of exercise, as long as it is systematic and periodised, has a positive influence.

Other studies related to balance used the dynamic balance of agility test —Timed Up and Go. This tests consists of having an individual get up from a chair with a backrest without using their arms, walk 3 m at a comfortable speed and then return to the chair and sit down. The result is considered normal when the individual finishes the test in less than 10 s; a time above 10 s is indicative of a problem with mobility and balance. The Berg Balance Scale was used to assess general balance.[16,18]

An analysis of the results with respect to agility and dynamic balance showed that the studies indicated a statistically significant improvement in the groups that trained resistence and strength and that carried out balance training by itself, as Schlenstedt et al. indicated.[17] According to Shen et al.,[24] these results demonstrate that including exercises that work in other modalities (such as yoga, Tai Chi or Pilates, including power training) increases functional independence and improves balance.[24] The Barker et al. study with older individuals consolidates this information, showing that a protocol based on training that includes other modalities such as Pilates demonstrated significant improvements in balance.[25] Interventions provoking the motor deficits caused by hypoactivity in the basal ganglia, such as the use of external signals, are extremely important for patients with Parkinson's disease. Ni et al. show that there is a positive analogy between changes in balance and reduction in muscle strength.[18] The Berg Balance Scale, which assesses general balance, showed improvements in the modalities that involved strength training together with balance and power training, and with other modalities (yoga, Tai Chi, Pilates). Both show the importance of working muscle strength in the upper and lower limbs and in the abdominal area in patients with Parkinson's disease. Given that balance and the risk of falls (which affect both patients with Parkinson's and the elderly) are linked to the loss of muscle strength,[26] strength training has been identified as an important factor in preventing falls in situaciones of body imbalance, due to the increase in lean mass and muscle strength.[27]

Likewise, Hirsch et al. support the hypothesis that a balance and resistance training programme, carried out under appropriate supervision, is pleasant and effective and a relatively safe way to improve muscle strength and balance in individuals with Parkinson's; such a programme can also reduce the risk of falls in the home and in the comunity, with a greater likelihood of long-term independence.[28] The

Table 3 Authors, title, objectives and main conclusions of the studies selected.

Author (year)	Title	Objectives	Main conclusions of the the study
Hass et al (2012)	Progressive resistance training improves gait initiation in individuals with Parkinson's disease	Examine the possible benefits of resistance training on postural performance in people with Parkinson's disease, before and after the intervention	The results of this preliminary research suggest that resistance training is an effective non-pharmacological and non-surgical treatment that improves postural performance
Santos et al (2017)	Efects of progressive resistance exercise in akinetic-rigid Parkinson's disease patients: A randomized controlled trial	Assess the effects of resistance training on patients with Parkinson's	Resistance training in rehabilitation improves gait and quality of life. In addition, the training scores have shown that exercise in people with Parkinson's is a tool
Cherup et al (2019)	Power vs strength training to improve muscular strength, power, balance and functional movement in individuals diagnosed with Parkinson's disease	Compare the effects of using exercises of strength, power, balance and functional movement in people with Parkinson's	Efficacy in the measures of strength and balance to reduce neuromuscular deficits associated with Parkinson's; however, the use of these interventions to improve functional tasks was not supported
Hirsch et al (2003)	Effects of balance training and high-intensity resistance training on persons with idiopathic Parkinson's disease	Evaluate the immediate and short-term effects of 2 physical training programmes for people with idiopathic Parkinson's disease	Muscle strength improved in the balance group and the combined group, and this effect lasted for at least 4 weeks. Balance can be improved in people with Parkinson's using high-intensity resistance training and training
Schlenstedt et al (2015)	Resistance versus balance training to improve postural control in Parkinson's disease: A randomized rater blinded controlled study	Compare resistance training and balance training to improve postural control in people with Parkinson's disease	The difference between resistance and balance training to improve postural control in people with Parkinson's disease was small and not significant with the sample size. There is a relationship between increasing the rate of development of strength and improving postural control

Table 3 (*Continued*)

Author (year)	Title	Objectives	Main conclusions of the the study
Ni et al (2016)	Comparative effect of power training and high-speed yoga on motor function in older patients with Parkinson's disease	Compare the effects of power training and a high-speed yoga programme on the physical performance of elderly patients with Parkinson's disease	Both the yoga programme and the strength training have been specially designed to improve physical performance significantly in older people with Parkinson's
Silva-Batista et al (2018)	Balance and fear of falling in subjects with Parkinson's disease is improved after exercises with motor complexity	Evaluate exercises of high motor complexity that put high postural control and cognitive demands on individuals with Parkinson's disease	Resistance training with instability is an innovative intervention that improves balance and fear of falling in people with Parkinson's to improve the cognitive function
Santos et al (2017)	Balance versus resistance training on postural control in patients with Parkinson's disease: A randomized controlled trial	Evaluate the effects of resistance training in patients with Parkinson's	Resistance training in the rehabilitation of individuals with Parkinson's improves static posturography, gait and quality of life. In addition, the resistance training scores showed that people with Parkinson's consider that resistance training requires only slight efforts
Picelli et al (2014)	Robot-assisted gait training is not superior to balance training for improving postural instability in patients with mild to moderate Parkinson's disease: A single-blind randomized controlled trial	Compare robotic gait training and balance training for reducing postural instability in patients with Parkinson's	Robatic gait training was ineffective when compared against balance training to improve instability in patients with Parkinson's
Li et al (2012)	Tai Chi and postural stability in patients with Parkinson's disease	Evaluate the techniques of Tai Chi for postural stability in a patient with Parkinson's disease	Tai Chi has been shown to be an effective technique and behavioural intervention for greater postural stability, in addition to functional capacity in patients with Parkinson's

Table 4 Characteristics of the sample, design and evaluation tools used in the articles selected.

Author (year)	Characteristics of the sample	Experimental design	Assessment tools
Hass et al (2012)	18 people diagnosed with Parkinson's	Biomechanical assessment after medication using a motion-capture system	Knee extension 1 RM
			Knee flexion 1 RM
Santos et al (2017)	28 people diagnosed with Parkinson's with initial and intermediate akinesia	Randomized clinical trial	TMWT (m/s)
			FOG-Q
			MDS-UPDRS
Cherup et al (2019)	35 people with a diagnosis of moderate Parkinson's disease	Application of resistance training in 2 different groups through strength training and traditional strength	BBA
			DMA
			MFES
Hirsch et al (2003)	15 people diagnosed with idiopathic Parkinson's	Randomized clinical trial	Knee extension 1 RM
			Knee flexion 1 RM
			Ankle extension 1 RM
Schlenstedt et al (2015)	32 people diagnosed with idiopathic Parkinson's	Application of balance and resistance training	FAB
			MDS-UPDRS
			TUG
Ni et al (2016)	41 people diagnosed with Parkinson's	High-speed exercises administered to 2 different groups: controlled and controlled without exercises	MDS-UPDRS
			BBS
			Mini BESTest
			SLS
			PPw
Silva-Batista et al (2018)	39 people diagnosed with Parkinson's	Application of resistance training with instability based on motor complexity	MoCA
			BESTest
			FES-I
Santos et al (2017)	42 people diagnosed with Parkinson's	Application of exercises in 2 groups: 1 with balance training and 1 with resistance training	BESTest
Picelli et al (2014)	66 people diagnosed with Parkinson's	Randomized clinical trial	BBS
			ASBCS
			TUG
			MDS-UPDRS
Lie t al (2012)	195 people diagnosed with Parkinson's	Application of exercise sessions for 3 groups: Tai Chi, resistance training and strength training	MDS-UPDRS
			TUG

ASBCS: Activity-Specific Balance Confidence Scale; BBA: Beat Balance Assessment; BBS: Berg Balance Scale; BESTest: Balance Evaluation System Test; DMA: Dynamic Movement Analysis; FAB: Fullerton Advance Balance; FES-I: Falls Efficiency Scale-International; FOG-Q: Freezing of Gait Questionnaire; MDS-UPDRS: Movement Disorders Society-Unified Parkinson's Disease Rating Scale; MFES: Modified Falls Efficacy Scale; MoCA: Montreal Cognitive Assessment; PPw: Peak Power; 1 RM: One Repetition Maximum; SLS: Single Leg Stance; TMWT: prueba de caminata de 10 m; TUG: Timed-Up-and-Go-Test.

Table 5 Results obtained in the articles selected.

Author (year)	Test	Intervention		*P* value
		Pre-test Mean ± standard deviation	Post-test Mean ± standard deviation	
Hass et al (2012)	Knee extension 1 RM (kg)	43.0 ± 6.1	75.9 ± 8.5	.01[a]
	Knee flexion 1 RM (kg)	26.4 ± 3.3	41.5 ± 4.4	.01[a]
Santos et al (2017)	TMWT (m/s)	.85 ± .15	.85 ± .12	.05[a]
	FOG-Q	3.84 ± 3.15	3.46 ± 3.07	.05[a]
	MDS-UPDRS	7.61 ± 5.28	7.07 ± 4.59	.05[a]
Cherup et al (2019)	BBA	50.91 ± 6.32	49.23 ± 6.87	.007[a]
	DMA	978.00 ± 163.60	934.31 ± 128.21	.15 ns
	MFES	8.25 ± 1.9	7.99 ± 2.10	.14 ns
Hirsch et al (2003)	Knee extension 1 RM (kg)	35.0 ± 4.9	36.6 ± 4.4	.05[a]
	Knee flexion 1 RM (kg)	23.8 ± 1.9	26.6 ± 1.7	.05[a]
	Ankle extension 1 RM (kg)	26.9 ± 2.3	30.1 ± 3.0	.05[a]
Schlenstedt et al (2015)	FAB	22.5 ± 5.3	22.5 ± 5.1	.767 ns
	MDS-UPDRS	40.7 ± 15.0	39.4 ± 12.0	.797 ns
	TUG	11.4 ± 3.6	10.0 ± 2.1	.699 ns
	MDS-UPDRS	32.9 ± 12.0	−10.7 ± −13.1	.000[a]
Ni et al (2016)	BBS	48.8 ± 5.8	4.4 ± 2.9	.000[a]
	Mini-BESTest	17.6 ± 4.6	3.4 ± 2.3	.014[a]
	SLS	4.2 ± 4.1	8.4 ± −2.8	.000[a]
	TUG	10.8 ± 5.5	−1.3 ± −2.4	.536 ns
Silva-Batista et al (2018)	MoCA	22.7 ± 5.7	21.6 ± 6.5	.05[a]
	BESTest	75.9 ± 13.3	71.9 ± 13.5	.05[a]
	FES-I	32.6 ± 7.7	35.2 ± 8.3	.05[a]
Santos et al (2017)	BESTest	81.6 ± 7.8	80.7 ± 7.0	.01[a]
Picelli et al (2014)	BBS	4.82 ± 2.36	4.27 ± 2.72	.01[a]
	ASBCS	4.63 ± 6.95	5.03 ± 8.91	.00[a]
	TUG	−.95 ± 1.74	−.84 ± 1.57	.01[a]
	MDS-UPDRS	−4.48 ± 2.92	−4.73 ± 2.8	.05[a]
Li et al (2012)	MDS-UPDRS	15.3 ± 5.6	8.9 ± 4.1	.001[a]
	TUG	8.6 ± 2.9	7.5 ± 2.7	.006[a]

ASBCS: Activity-Specific Balance Confidence Scale; BBA: Beat Balance Assessment; BBS: Berg Balance Scale; BESTest: Balance Evaluation System Test; DMA: Dynamic Movement Analysis; FAB: Fullerton Advance Balance; FES-I: Falls Efficiency Scale-International; FOG-Q: Freezing of Gait Questionnaire; MDS-UPDRS: Movement Disorders Society-Unified Parkinson's Disease Rating Scale; MFES: Modified Falls Efficacy Scale; MoCA: Montreal Cognitive Assessment; ns: non-significant value; PPw: Peak Power; 1 RM: One Repetition Maximum; SLS: Single Leg Stance; TMWT: Ten-metre walk test; TUG: Timed-Up-and-Go-Test.
[a] Statistically significant values.

objective of the study was to evaluate the immediate short-term effects of 2 exercise programmes and establish how a specific rehabilitation programme could affect the muscle strength and balance in individuals with Parkinson's.

When the core deficit of each patient with Parkinson's is analysed, the physiopathology of the disease also has to be considered so that the most coherent intervention is used.[29] For example, patients with bradykinesia find it hard to carry out repetitive tasks or sequences of movements, as can be seen in people with Parkinson's that have gait hypokinesia, who evolve.[30] Various trials were carried out taking into consideration the special features of each individual with Parkinson's. Among these, the BESTest,[18,21,22] Beat Balance Assessment,[31] one repetition maximum (1 RM)[32,33] and 10-m walk test[8] presented the best statistically-significant results ($P < .05$) in the articles selected.

From this perspective, in these studies, when compared with healthy elderly people without evident physiopathology, the patients with Parkinson's presented important gait disorders. Examples are reduced step length, speed and increased cadence (speed 116 cm/s–99 cm/s, step length 121 cm–106 cm, cadence 115 steps/min–125 steps/min, comparing healthy elderly individuals with elderly individuals with Parkinson's, respectively).[22] Furthermore, the more advanced the state of the disease was, the greater the motor alterations were; this intensifies the loss of quality of life in this population.[31]

So that these liabilities are minimised, at least within the home, Silva-Batista et al. propose that the training should take place in the places where the movement disorders cause the most impact, which is usually the patient's own home.[22] In spite of this, gait training in the community (such as where streets cross and how to get around barriers) also affect this population's quality of life negatively.[30,34] Nevertheless, if the therapies are carried out in the patient's own

home surroundings, the transfer and retention of strategies will be improved.[35]

Finally, we should point out that this review has the limiting factor of the lack of standardisation of the disease status, which can be identified using the Hoehn and Yahr Scale. However, even without limiting this aspect, the majority of the studies included presented patients in Stage II of the disease, because it is easier to work with the population in this stage. In short, of the 10 studies selected, 2 evaluated static balance and both of them found statistically significant improvements.[32,33] The other studies assessed agility and dynamic balance, also finding statistically significant improvements in the patients pre- and post-intervention.

Conclusion

Based on our review, it can be concluded that intervention related to Parkinson's disease yields good results when it focuses on increasing physical exercise and mobility. To improve motor activities in people with Parkinson's, resistance training is an effective alternative. As for balance, specific training to increase postural control and reduce instability should be carried out. This study has emphasised that resistance training and balance training significantly improve static balance, dynamic balance and the parameters of postural instability. This holds true whether the programme works on these factors together, in isolation or adapted to another type of physical exercise, which lead other individuals to present positive results more quickly, because they begin to have a routine of movements, which is key to progress.

We would like to suggest that the scientific community carry out further studies that involve strength training protocols aimed at people with Parkinson's disease, especially clinical trials. This would enable ascertaining the best strength training protocols for improving postural control and balance in individuals with Parkingson's.

Conflict of interests

The authors have no conflicts of interest to declare.

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