# Progressive resistance exercise improves strength and physical performance in people with mild to moderate Parkinson's disease: a systematic review

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**Question**: Does progressive resistance exercise improve strength and measures of physical performance in people with Parkinson's disease? **Design**: Systematic review with meta-analysis of randomised and quasi-randomised controlled trials. **Participants**: People with Parkinson's disease, regardless of gender or level of disability. **Intervention**: Progressive resistance exercise, defined as involving repetitive, strong, or effortful muscle contractions and progression of load as the participant's abilities changed. **Outcome measures**: Measures of muscle strength (maximum voluntary force production) – either continuous (force, torque, work, EMG) or ordinal (manual muscle test) – and physical performance measures: sit-to-stand time, fast and comfortable walking speeds, 6-min walk test, stair descent and ascent, the Activities-specific Balance Confidence scale, Timed Up and Go test, and the Short Physical Performance Battery. **Results**: Four (quasi-) randomised trials were included, three of which reported data that could be pooled in a meta-analysis. Progressive resistance exercise increased strength, with a standardised mean difference 0.50 (95% CI 0.05 to 0.95), and had a clinically worthwhile effect on walking capacity, with a mean difference of 96 metres (95% CI 40 to 152) among people with mild to moderate Parkinson's disease. However, most physical performance outcomes did not show clinically worthwhile improvement after progressive resistance exercise. **Conclusion**: This review suggests that progressive resistance exercise can be effective and worthwhile in people with mild to moderate Parkinson's disease, but carryover of benefit does not occur for all measures of physical performance. The current evidence suggests that progressive resistance training should be implemented in Parkinson's disease rehabilitation, particularly when the aim is to improve walking capacity. **Review registration**: PROSPERO CRD42012002194. **[Lima LO, Scianni A, Rodrigues-de-Paula F (2013) Progressive resistance exercise improves strength and physical performance in people with mild to moderate Parkinson's disease: a systematic review. *Journal of Physiotherapy* 59: 7–13]**

**Key words**: Parkinson's disease, Rehabilitation, Systematic Review, Muscle weakness, Physical therapy techniques

## Introduction

Parkinson's disease is a chronic neurodegenerative condition that leads to progressive disability (Poewe and Mahlknecht 2009), reduced health-related quality of life, and high healthcare costs (Weintraub et al 2008, Kaltenboeck et al 2011). It is expected that more than 8 million people worldwide may develop Parkinson's disease in the coming decades (Dorsey et al 2007).

The clinical hallmarks of Parkinson's disease include bradykinesia, postural instability, pathological tremor (5–6 Hz), and stiffness in the limbs and trunk (Kwakkel et al 2007). In addition, several studies have provided evidence that people with Parkinson's disease have reduced muscle strength compared to age-matched controls (Allen et al 2009, Cano-de-la-Cuerda et al 2010, Inkster et al 2003, Nallegowda et al 2004). The dopaminergic deficit in Parkinson's disease causes reduction in the excitatory drive of the motor cortex (Lang and Lozano 1998), which can affect motor unit recruitment and results in muscle weakness (David et al 2012). Correlation studies have demonstrated that muscle strength is related to measures of physical performance such as sit-to-stand (Inkster et al 2003, Pääsuke et al 2004) and gait (Nallegowda et al 2004), and to risk of falls (Latt et al 2009) in people with Parkinson's disease.

Progressive resistance exercise has been suggested as a treatment option to preserve function and health-related quality of life in Parkinson's disease (David et al 2012, Dibble et al 2009, Falvo et al 2008). Consequently, some studies have reported increases in strength after progressive resistance exercise training in patients with Parkinson's disease, and that increased strength can translate into improved measures of physical performance such as gait (6-minute walk and gait velocity), stair-climbing and Timed Up and Go test (Dibble et al 2006, Dibble et al 2009). On

**What is already known on this topic**: Parkinson's disease causes tremor and reduces mobility and functional performance. People with Parkinson's disease also have reduced strength compared to age-matched controls. Progressive resistance exercise improves strength but it is unclear how large this effect is and whether functional performance is also improved.

**What this study adds**: Progressive resistance exercise has a moderate effect on strength in people with Parkinson's disease. Some measures of mobility and functional performance also improve, including walking capacity and sit-to-stand time. However, this evidence is derived mainly from trials involving people with Parkinson's disease of mild or moderate severity.

the other hand, a recent study has reported improvements in muscle strength without carryover to gait (6-minute walk), mobility (Timed Up and Go test) and balance (Activities-specific Balance Confidence scale) (Schilling et al 2010).

Recent reviews established a rationale for the use of resistance training and highlight findings related to positive effects of progressive resistance exercise in people with Parkinson's disease. However, meta-analysis was not performed, limiting the conclusions about these effects in such patients (Falvo et al 2008, David et al 2012).

Progressive resistance exercise will only be widely implemented in clinical practice as a therapy for Parkinson's disease if it is found to be effective and worthwhile in terms of improvements in physical performance. Therefore, the research questions of this systematic review were:

1. Does progressive resistance exercise increase muscle strength in people with Parkinson's disease?
2. Does progressive resistance exercise improve functional measures of physical performance?

## Method

### Identification and selection of trials

Searches of CINAHL (1982 to November 2011), PEDro (to November 2011), LILACS (to November 2011), and MEDLINE databases were conducted without language restrictions. Searches were performed using terms recommended by the Cochrane Collaboration related to Parkinson's disease and randomised or quasi-randomised controlled trials and words related to progressive resistance training (see Appendix 1, available on the eAddenda). Titles and abstracts (where available) were displayed and screened by a single reviewer to identify potentially relevant trials. Full text copies of potentially relevant trials were retrieved and their reference lists were screened. The retrieved papers were assessed for eligibility by two independent researchers blinded to authors, journal, and outcomes, using predetermined criteria (Box 1). Disagreements were resolved by discussion with a third reviewer.

**Box 1**. Inclusion criteria.

**Research design**
- Randomised controlled trial, or quasi-randomised controlled trial

**Participants**
- Patients with Parkinson's disease (any level of severity – Hoehn & Yahr)
- No surgery

**Interventions**
- Progressive resistance exercise
- Repetitive effortful muscle contractions

**Outcomes**
- Measure of muscle strength (voluntary force production)
- Measure of physical performance (sit-to-stand time, fast and comfortable walking speeds, 6-min walk test, stair ascent and descent, the Activities-specific Balance Confidence scale, Timed Up and Go test, and the Short Physical Performance Battery)

**Comparisons**
- Progressive resistance exercise versus no intervention/placebo
- Progressive resistance exercise plus other therapy versus other therapy

### Assessment of characteristics of trials

***Quality***: The quality of included trials was assessed by extracting scores from the Physiotherapy Evidence Database (PEDro) website. Rating of trials in PEDro is carried out by two trained independent raters, with disagreements resolved by a third rater. The PEDro scale assesses the methodological quality and statistical reporting of a randomised trial against 11 individual criteria (Maher et al 2003). One item relates to external validity and the remaining 10 items can be tallied to give a score from 0 to 10 (de Morton 2009).

***Participants***: Trials involving patients with Parkinson's disease, regardless of gender or level of disability, were eligible. Age, gender, and severity of the disease was recorded using the Hoehn and Yahr Scale, where reported.

***Intervention***: The experimental intervention had to be progressive resistance exercise, defined as movement against progressively increased resistance. It had to be of a dose that could be expected to improve strength, ie, it had to involve repetitive, strong, or effortful muscle contractions, and it had to be stated or implied that the intensity was progressed as ability changed.

***Outcome measures***: Continuous measures of muscle strength (eg, force, torque, work, EMG) and physical performance (sit-to-stand time, fast and comfortable walking speeds, 6-min walk test, stair descent and ascent, the Activities-specific Balance Confidence scale, Timed Up and Go test, and the Short Physical Performance Battery) were used in the analysis where available. Otherwise, ordinal measures of strength (eg, Manual Muscle Test) were used. When both limbs were trained, the most affected limb was used in the analysis.

### Data analysis

Data were extracted from the included trials by a single reviewer and cross-checked by a second reviewer. Information about the method (design, participants, intervention, and measurements) and outcome data (number of participants and mean and standard deviations of strength and measures of physical performance) were extracted. Where information was not available in the published trials, details were requested from the author listed for correspondence.

All trials reported pre-and post-intervention scores. Post-intervention scores were used in the meta-analysis. When the same methods of measurement were used, the effect size was reported as a weighted mean difference with a 95% CI. When different methods were used, the effect size was reported as Cohen's standardised mean difference with a 95% CI. After confirmation of low heterogeneity with the $I^2$ statistic, the analyses were performed using The MIX–Meta-Analysis Made Easy program (Bax et al 2006, Bax et al 2008) and pooled estimates were obtained using a fixed effects model.

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