Physiotherapy for Parkinson's disease: a comparison of techniques (Review)

Tomlinson CL, Herd CP, Clarke CE, Meek C, Patel S, Stowe R, Deane KHO, Shah L, Sackley CM, Wheatley K, Ives N

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[Intervention Review]

Physiotherapy for Parkinson's disease: a comparison of techniques

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ABSTRACT

Background

Despite medical therapies and surgical interventions for Parkinson's disease (PD), patients develop progressive disability. The role of physiotherapy is to maximise functional ability and minimise secondary complications through movement rehabilitation within a context of education and support for the whole person. The overall aim is to optimise independence, safety and wellbeing, thereby enhancing quality of life. Trials have shown that physiotherapy has short-term benefits in PD. However, which physiotherapy intervention is most effective remains unclear.

Objectives

To assess the effectiveness of one physiotherapy intervention compared with a second approach in patients with PD.

Search methods

Relevant trials were identified by electronic searches of numerous literature databases (for example MEDLINE, EMBASE) and trial registers, plus handsearching of major journals, abstract books, conference proceedings and reference lists of retrieved publications. The literature search included trials published up to the end of January 2012.

Selection criteria

Randomised controlled trials of one physiotherapy intervention versus another physiotherapy intervention in patients with PD.

Data collection and analysis

Data were abstracted independently from each paper by two authors. Trials were classified into the following intervention comparisons: general physiotherapy, exercise, treadmill training, cueing, dance and martial arts.

Main results

A total of 43 trials were identified with 1673 participants. All trials used small patient numbers (average trial size of 39 participants); the methods of randomisation and concealment of allocation were poor or not stated in most trials. Blinded assessors were used in just over half of the trials and only 10 stated that they used intention-to-treat analysis.

A wide variety of validated and customised outcome measures were used to assess the effectiveness of physiotherapy interventions. The most frequently reported physiotherapy outcomes were gait speed and timed up and go, in 19 and 15 trials respectively. Only five of the 43 trials reported data on falls (12%). The motor subscales of the Unified Parkinson's Disease Rating Scale and Parkinson's Disease Questionnaire-39 were the most commonly reported clinician-rated disability and patient-rated quality of life outcome measures, used in 22 and 13 trials respectively. The content and delivery of the physiotherapy interventions varied widely in the trials included within this review, so no quantitative meta-analysis could be performed.

Authors' conclusions

Considering the small number of participants examined, the methodological flaws in many of the studies, the possibility of publication bias, and the variety of interventions, formal comparison of the different physiotherapy techniques could not be performed. There is insufficient evidence to support or refute the effectiveness of one physiotherapy intervention over another in PD.

This review shows that a wide range of physiotherapy interventions to treat PD have been tested . There is a need for more specific trials with improved treatment strategies to underpin the most appropriate choice of physiotherapy intervention and the outcomes measured.

PLAIN LANGUAGE SUMMARY

Physiotherapy for the treatment of Parkinson's disease

In spite of various medical and surgical treatments for Parkinson's disease (PD) patients gradually develop significant physical problems. Physiotherapists aim to enable people with PD to maintain their maximum level of mobility, activity and independence through the provision of the appropriate treatment. A range of approaches to movement rehabilitation are used, which aim to enhance quality of life by maximising physical ability and minimising secondary complications over the whole course of the disease. Evidence has shown that physiotherapy has short-term benefits in PD, however which approach of physiotherapy is most effective remains unclear.

Only randomised controlled trials were included in this review. These were studies where a group of participants were given one physiotherapy intervention and were compared with another group who received a different physiotherapy intervention. The participants were assigned to a group in a random fashion to reduce the potential for bias.

A total of 43 randomised trials involving 1673 participants (average trial size of just 39 participants) were identified as suitable for this review. The trials assessed various physiotherapy interventions, so they were grouped according to the type of intervention being used (general physiotherapy, exercise, treadmill training, cueing, dance or martial arts). However, despite this grouping, the physiotherapy interventions delivered and the outcomes assessed varied so much that the results of the individual trials could not be combined.

This review highlights that a wide range of different physiotherapy techniques have been tested to treat PD. Considering the small number of participants, the wide variety of physiotherapy interventions and the outcomes assessed, there is insufficient evidence to support the use of one approach of physiotherapy intervention over another for the treatment of PD.

BACKGROUND

Parkinson's disease (PD) is a complex neurodegenerative disorder (Rubenis 2007) with wide reaching implications for patients and their families. Whilst disability can occur at all stages of the disease (Deane 2001a), PD is progressive in nature. Patients face increased difficulties with activities of daily living (ADL) (Kwakkel 2007) and mobility such as gait, transfers, balance and posture (Keus 2007). Ultimately this leads to decreased independence, inactivity

and social isolation (Keus 2007), resulting in reduced quality of life (Schrag 2000).

The management of PD has traditionally centred on drug therapy with levodopa viewed as the 'gold standard' treatment (Rascol 2002). However, even with optimal medical management, patients with PD still experience a deterioration of body function, daily activities and participation (Nijkrake 2007). For this reason there has been increasing support for the inclusion of rehabilitation therapies as an adjuvant to pharmacological and neurosurgical treatment (Gage 2004; Nijkrake 2007) and a call for the move towards multidisciplinary management of this multidimensional condition (Robertson 2003; Rubenis 2007).

The physiotherapist is a member of the multidisciplinary team (Robertson 2008; Rubenis 2007) and strives to maximise functional ability and minimise secondary complications through movement rehabilitation within a context of education and support for the whole person (Deane 2001a; Plant 2000). Physiotherapy for PD focuses on transfers, posture, upper limb function, balance (and falls), gait, physical capacity and (in)activity utilising cueing strategies, cognitive movement strategies and exercise to optimise the patient's independence, safety and wellbeing, thereby enhancing quality of life (Keus 2004; Keus 2007).

Referral rates to physiotherapy for people with PD have historically been low (Mutch 1986; Yarrow 1999). However, in recent years the number of referrals has increased, with a survey by Parkinson's UK in 2008 reporting that 54% of the 13,000 members surveyed had seen a physiotherapist, compared with 27% in a survey undertaken in 1998 (PDS 2008; Yarrow 1999). This rise in referrals may be attributed to two factors. Firstly, guidelines such as those published by the National Institute for Health and Clinical Excellence (NICE) (NICE CG35 2006) recommend that physiotherapy be made available throughout all stages of the disease, raising the profile of the intervention. This has been further supported by the publication of Dutch physiotherapy guidelines (Keus 2004) (updated guidelines were due for publication in 2013), which provide specific information for physiotherapists involved in the management of PD. Secondly, there has been a substantial increase in the number of trials completed over the last decade (particularly in the last five years), offering supportive evidence for the inclusion of physiotherapy in the management of PD (Keus 2009).

A recent Cochrane review (Tomlinson 2012) assessed the effectiveness of physiotherapy intervention versus no physiotherapy intervention in patients with PD. The review provided evidence for the short-term benefit (< three months) of physiotherapy intervention in the treatment of PD. Further, it suggested that there was no difference in treatment effect between the different types of physiotherapy interventions being used, though this was based on indirect comparisons. This now needs to be confirmed by examining head-to-head trials of physiotherapy interventions. This would be of interest to both clinicians and patients so that appropriate physiotherapy interventions which provide greater benefit can be delivered to PD patients (Tomlinson 2012).

The present Cochrane review was first published in 2001, and included only seven randomised controlled trials with a total of 142 participants (Deane 2001b). The methods of physiotherapy varied so widely across the trials that the data could not be combined. This, along with the presence of methodological flaws, small sample sizes, and the possibility of publication bias, led Deane et al to conclude that there was insufficient evidence to support or refute the efficacy of any given approach of physiotherapy over another in PD (Deane 2001b). This review updates the previous Cochrane review. It aims to compare the effectiveness of one approach of physiotherapy intervention versus another approach of physiotherapy intervention in patients with PD.

OBJECTIVES

To assess the effectiveness of one physiotherapy intervention compared with a second approach in patients with PD.

METHODS

Criteria for considering studies for this review

Types of studies

All randomised controlled trials (including the first phase of cross-over trials) comparing a physiotherapy intervention with another physiotherapy intervention were considered for inclusion in the review. Only trials that implemented random methods of treatment allocation were included.

Types of participants

Participants with a diagnosis of PD (as defined by the authors of the studies).

- PD of any disease stage (i.e. early or diagnostic, maintenance, or complex phase).
- Any duration of PD.
- All ages.
- Any drug therapy.
- Any duration of physiotherapy treatment (although trials of less than one day of treatment were excluded).

Types of interventions

Physiotherapy interventions aim to maximise functional ability and minimise secondary complications through movement rehabilitation within a context of education and support for the whole

person. Physiotherapy encompasses a wide range of techniques, so we were inclusive in our definition of physiotherapy intervention (including those not directly delivered by a physiotherapist) with trials of general physiotherapy, exercise, treadmill training, cueing, dance and martial arts being included.

Types of outcome measures

1. Gait outcomes such as:
a. two- or six-minute walk test (m), measures the number of metres a person can walk in two or six minutes thereby providing a measurement of walking endurance (Kersten 2004);
b. walking speed:
i. 10- or 20-metre walk test (s), measures the time in seconds that a person takes to walk 10 or 20 metres thereby providing a measurement of gait speed (Kersten 2004),
ii. velocity (m/s), measures the rate of change of position, recorded in metres per second (Trew 2005);
c. cadence (steps/min), measures the number of steps taken in a given period of time, which is then converted into the number of steps taken per minute (Trew 2005);
d. stride length (m), measures the average distance (in metres) between two successive placements of the same foot (Whittle 1996);
e. step length (m), measures the average distance (in metres) between successive foot to floor contact with the opposite feet (Trew 2005);
f. Freezing of Gait Questionnaire, a validated questionnaire for the assessment of freezing of gait. The questionnaire consists of six items and scores range from 0 to 24, with higher scores corresponding to more severe freezing of gait (Giladi 2000).
2. Functional mobility and balance outcomes such as:
a. timed up and go (s), measures the time taken in seconds for a person to get up from a chair, walk a certain distance (usually three metres), turn around and walk back to the chair and sit down (Podsiadlo 1991);
b. Functional Reach Test (cm), "the maximal distance one can reach forward beyond arm's length, while maintaining a fixed base of support in the standing position" (Duncan 1990);
c. Berg Balance Scale, a validated questionnaire designed to measure functional standing balance of the older adult. The measure consists of 14 items and score ranges from 0 to 56; with 0 to 20 = high fall risk; 21 to 40 = medium fall risk; and 41 to 56 = low fall risk (Berg 1992; Qutubuddin 2005);
d. Activity Specific Balance Confidence. a 16-item self-report questionnaire that asks individuals to rate their confidence that they will maintain their balance in the course of daily activities. Each item is rated from 0% (no confidence) to 100% (complete confidence) (Powell 1995; Talley 2008).
3. Data on falls such as:
a. number of patients falling, e.g. falls diary;
b. Falls Efficacy Scale, a 10-item patient-reported questionnaire that measures how confident a person is at carrying out various ADL. Items are rated from 1 to 10, with higher scores correlating with lower levels of confidence, and a total score of 70 or more indicating that a person has a fear of falling (Tinetti 1990);
c. Falls Efficacy Scale International, a 16-item questionnaire that includes the 10 original items of the standard Falls Efficacy Scale as well as six items regarding higher functioning and social activities. Each item is rated on a scale of 1 to 4, with 1 being 'not concerned at all' and 4 being 'very concerned' (maximum score out of 64) (Yardley 2005).
4. Clinician-rated impairment and disability measures such as:
a. Hoehn and Yahr, a scale used to describe how symptoms of Parkinson's disease progress. Scale ranges from 0 to 5, with higher levels indicating greater disability (Hoehn 1967);
b. Unified Parkinson's Disease Rating Scale (UPDRS), designed to assess motor impairment and disability in Parkinson's disease. Higher scores correspond to greater disability (Fahn 1987):
i. total, score ranges from 0 to 176,
ii. mental, score ranges from 0 to 16,
iii. ADL, score ranges from 0 to 52,
iv. motor, score ranges from 0 to 108;
c. Webster Rating Scale, an assessment of severity of disease and clinical impairment against 10 items using a scale of 0 = normal to 3 = maximum impairment (bradykinesia, rigidity, posture, upper extremity swing, gait, tremor at rest, facies, seborrhoea, speech, and self care). Scores ranges from 0 to 30, with higher scores indicating greater disease severity and disability (Webster 1968);
d. Columbia University Rating Scale, an assessment of motor impairment and ADL against 13 items, using a five-point scale for each to give a total score between 0 = normal to 65 = maximum disability (Yahr 1969).
5. Patient-rated quality of life such as:
a. Parkinson's Disease Questionnaire-39 (PDQ-39), a PD specific health-related quality of life questionnaire containing 39 items divided into eight domains. Scores range from 0 to 100 with higher scores corresponding to poorer quality of life (Jenkinson 1997; Peto 1995);
b. PDQUALIF, a PD specific health-related quality of life questionnaire containing 32 items in seven dimensions and one item of global health-related quality of life. The total score ranges from 0 to 128 with higher scores indicating poorer quality of life (Welsh 2003);
c. PDQL, a PD specific health-related quality of life questionnaire containing 37 items grouped into four subscales. Item scores range from 1 to 5. The PDQL-Summary Index ranges from 37 to 185, with higher scores reflecting better quality of life (Deboer 1996);
d. Short Form-36 (SF-36) or 12 (SF-12), a generic short form health survey consisting of 36 or 12 questions. The SF-36 consists of eight scaled scores assessing vitality, physical functioning, bodily pain, general health perceptions, physical role functioning, emotional role functioning, social role functioning and mental health. Scores range from 0 to 100 with higher scores corresponding to

better quality of life (Ware 1992).
6. Adverse events e.g. fractures, pain.
7. Compliance e.g. participant adherence, treatment fidelity.
8. Economic analysis.

Search methods for identification of studies

We undertook a systematic search of the literature up to the end of January 2012 for publications or abstracts describing relevant trials. This included searching the following.
1. General biomedical and science electronic databases (without date limiters) including the Cochrane Movement Disorders Specialised Register, *The Cochrane Library*, MEDLINE (1966 to 2012), EMBASE (1974 to 2012), CINAHL (1982 to 2012), ISI-SCI (1981 to 2012); the rehabilitation databases AMED (1985 to 2012), REHABDATA (1995 to 2012), REHADAT (1990 to 2012), PEDro (1929 to 2012), GEROLIT (1979 to 2012); the English language databases of foreign language research and third world publications LILACS (1982 to 2012), MedCarib (17th Century to 2012) and IMEMR (1984 to 2012).
2. The Cochrane Central Register of Controlled Trials (CENTRAL), the CentreWatch Clinical Trials listing service, the metaRegister of Controlled Trials, ClinicalTrials.gov, RePORT, National Institute on Disability and Rehabilitation Research (NIDRR) and National Research Register (NRR).
3. Handsearching of general (Lancet, BMJ, JAMA) and specific journals *(Movement Disorders*,*Neurology*,*Archives of Physical Medicine and Rehabilitation*,*Clinical Rehabilitation*,*Physiotherapy*, *Physical Therapy*) from 2001 to the end of January 2012.
4. The reference lists of retrieved papers and review articles.
5. Abstract books and conference proceedings. This included The XIII International Congress on Parkinson's disease (1999), The International Congress of Parkinson's Disease and Movement Disorders (1990, 1992, 1994, 1996, 1998, 2000, 2002, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012), World Congress on Parkinson's Disease and Related Disorders (2009) and The American Academy of Neurology 51st annual meeting (1999).
6. Grey literature databases (including theses): Conference Proceedings Citation Index (1982 to 2012), DISSABS (1999 to 2012), Conference Papers Index (1982 to 2012), Index to Theses (1970 to 2012), Electronic Theses Online Service (EThOS) (16^{th} Century to 2012) and ProQuest dissertations and theses databases (1861 to 2012).
The search strategies are listed in full in Appendix 1.

Data collection and analysis

Selection of studies

From the search results, two review authors (CLT, CPH, SP or LS) independently screened the abstracts of potentially relevant studies, with the full paper being obtained if the abstract did not provide sufficient information to determine eligibility for inclusion in the review. Disagreement was resolved by referral to a third review author (RS, CM or NI). Authors of potentially eligible studies were contacted for further information if details of their trial were unclear.

Data extraction and management

Two review authors (CLT, CPH, SP or CM) independently assessed the eligible papers or abstracts for trial details and outcome data. These were validated by discussion with any discrepancies resolved by consensus. Trial details were recorded on a standard trial description form and included: trial name, trial group, authors, randomised comparison, treatment schedule (including duration, number of sessions, type of intervention), other therapy, eligibility criteria, method of randomisation, allocation concealment, blinding, accrual period, number of participants randomised, number of dropouts, duration of follow-up, outcomes reported, use of intention-to-treat analysis and publication date(s). The outcome data extracted included data on gait, functional mobility and balance, falls, clinician-rated disability scale and patient-rated quality of life, adverse events, compliance or withdrawals and health economics where available.
Authors of any eligible unpublished studies were contacted to ask if further details and the data for their trial could be provided.

Assessment of risk of bias in included studies

Two review authors (CLT, CPH, SP or CM) assessed the methodological quality of the full papers by recording the eligibility criteria (for example specified inclusion (and exclusion) criteria - low risk), method of randomisation (for example used computer random number generator - low risk) and blinding (for example blinding of assessors - low risk), concealment of allocation (for example use of central randomisation service - low risk), similarity of participants in treatment groups at baseline (no difference in baseline characteristics between treatment groups as stated in trial publication - low risk), co-intervention(s) constant (for example drug therapy stable - low risk), comparable treatment arms (for example similar treatment duration and frequency - low risk), whether an intention-to-treat analysis was performed (intention-to-treat analysis and withdrawals < 10% - low risk, withdrawals > 10% - unclear risk, per protocol analysis - all unclear risk) and the number of participants lost to follow-up and missing values (withdrawals below 10% - low risk) (see the risk of bias tables under 'Characteristics of included studies').

Data synthesis

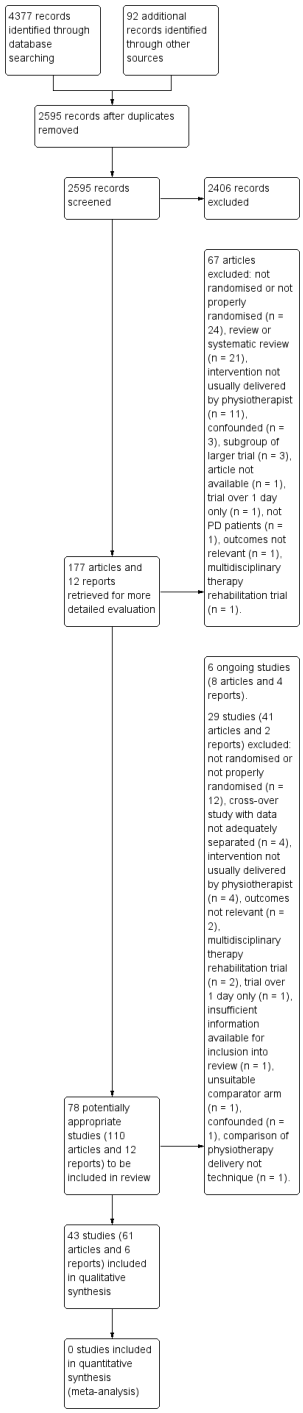
Treatment arms of the included studies were classified and divided according to the types of interventions administered:
1. general physiotherapy;
2. exercise;
3. treadmill training;
4. cueing;
5. dance;
6. martial arts.
Disparate study designs in the included trials resulted in a lack of overlap in the collated physiotherapy methods and outcome measures such that data could not be combined in a meaningful way.

RESULTS

Description of studies

A total of 78 randomised trials of physiotherapy intervention in PD patients were identified; 29 studies were excluded (see Characteristics of excluded studies). The reasons for excluding these trials were: not randomised or not properly randomised (n = 12), cross-over study with data for the different phases not adequately separated (n = 4), treatment given in trial not usually used by physiotherapists (such as whole body vibration technique) (n = 4), no outcome measures relevant to our review (n = 2), multidisciplinary therapy rehabilitation trial (n = 2), trial duration under one day (n = 1), insufficient information available for inclusion in review (n = 1), unsuitable comparator arm (n = 1), study was confounded (n = 1) and comparison of physiotherapy delivery rather than technique (n = 1). There were also six ongoing trials for which data were not yet available (see Characteristics of ongoing studies). Therefore, there were 43 trials available for inclusion in the review, compared to seven in the 2001 review (Figure 1).

Figure 1. PRISMA flow diagram.



The number of participants randomised into each of the 43 trials ranged from eight to 210 participants, with 1673 participants randomised in total (giving an average trial size of 39 participants) (see Characteristics of included studies). The assessment period ranged from two weeks to 24 months. The mean age of the participants in the trials was 67 years, 62% were male, the mean Hoehn and Yahr stage was 2.4, and they had had PD for approximately seven years.

There were 14 three-arm trials. Eight trials compared two different experimental physiotherapy interventions with placebo or no intervention (Almeida 2012; Fisher 2008; Li 2012; Mak 2008; McGinley 2012; Shankar 2009; Talakkad 2011; Thaut 1996). The placebo or no intervention arms of these trials were not included in any analysis for this review (see Tomlinson 2012). Six trials compared three different physiotherapy techniques (Chaiwanichsiri 2011; Ebersbach 2010; Juncos 2006; Reuter 2011; Schenkman 2012a; Toole 2005). There was also one four-arm trial comparing two types of dance (waltz or foxtrot and tango) and martial arts with no intervention (Hackney 2009).

Risk of bias in included studies

See the Characteristics of included studies risk of bias in included studies tables, risk of bias graph (Figure 2) and risk of bias summary (Figure 3).

Figure 2. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.

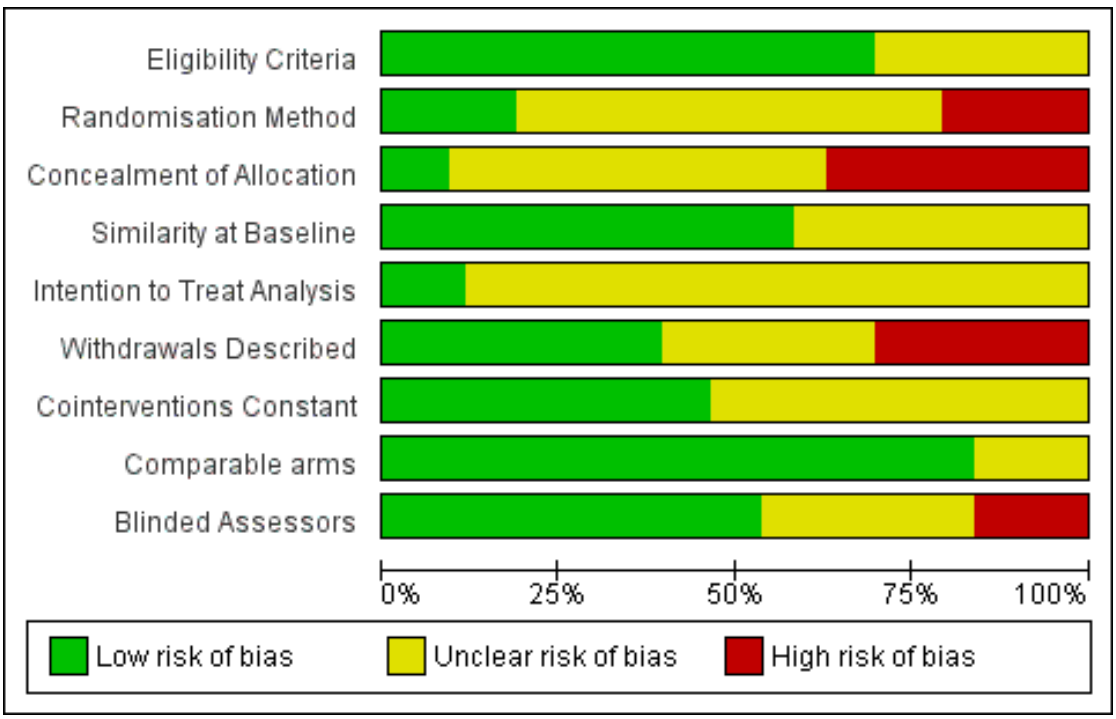
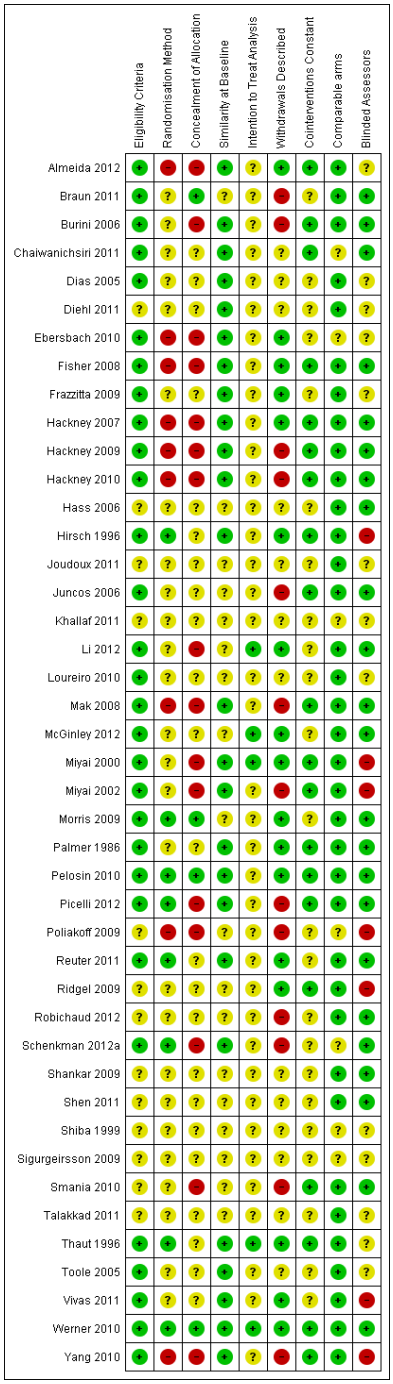


Figure 3. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.



Trial design

A total of 40 trials had a parallel design and three had a cross-over design (Burini 2006; Miyai 2000; Shiba 1999). Most trials looked at the short-term effect of therapy by assessing the participants at baseline and immediately or shortly after the physiotherapy intervention period (which ranged from two weeks to 24 months). Of the parallel design trials 21 reported additional data at assessment points after the treatment period had finished; this may have been at only two weeks or up to 12 months after the end of the treatment period.

Sample size

Only 13 studies (30%) (Braun 2011; Hackney 2007; Hackney 2009; Hackney 2010; Hirsch 1996; Li 2012; McGinley 2012; Morris 2009; Picelli 2012; Reuter 2011; Schenkman 2012a; Smania 2010; Yang 2010) reported a sample size calculation in the trial report, which was achieved by seven studies.

Eligibility criteria

The eligibility criteria for the trials were broad and varied considerably across the trials. The level of detail provided on the eligibility criteria was also variable, with some studies providing a detailed description of the entry criteria and others just stating 'patients with Parkinson's disease'. Only four trials (Pelosin 2010; Reuter 2011; Schenkman 2012a; Yang 2010) stated that a diagnosis of PD by the United Kingdom Brain Bank Criteria (Gibb 1988) was required. It is vital that eligibility criteria are well-defined so that the trial participant population can be determined.

Randomisation method and concealment of allocation

A total of 24 trials (56%) described the randomisation method used, of which only eight trials used low risk methods (for example computer random number generators). No details of the randomisation method used were provided for the remaining 19 trials. Further, only 20 trials (47%) either stated or gave adequate information that allowed the assessment of whether an adequate concealment of treatment allocation procedure had been used. Four trials were considered to be low risk by virtue of having used a central independent randomisation service, with the other 16 considered high risk (that is concealment of treatment allocation was potentially compromised as sealed envelopes, picking a card or picking from a hat were used).

Blinding of assessors

It would be impossible to blind participants and therapists to randomised treatment allocation in trials of physiotherapy. Therefore, such trials are open label by nature, and they are consequently liable to the possibility of both performance and attrition bias. However, blinding of assessors could be employed to try and reduce the possibility of bias; 23 (53%) of the 43 studies used blinded assessors, seven used unblinded assessors so were classed as high risk, and in the other 13 studies this information was not provided (classed as unclear risk).

Co-interventions

Information on co-interventions was provided in 24 trials (56%), with participants continuing with their standard PD medication. In 20 trials the drug therapy was kept stable (low risk) throughout the duration of the trial, whereas five trials allowed variation (unclear risk). The remaining trials did not describe drug therapy (unclear risk).

Similarity of treatment groups at baseline

A description of the baseline characteristics of the trial participants is important to determine whether the trial results are generalisable and to compare characteristics of the two arms to ensure that the randomisation methods were successful. Six trials (Diehl 2011; Joudoux 2011; Khallaf 2011; Shankar 2009; Shen 2011; Talakkad 2011) did not provide any information on the baseline characteristics of the participants entered into the trial; 31 (of the 37) trials that reported baseline data gave this information split by treatment group; 25 trials reported sufficient data that showed participants to be similar at baseline. In six trials the baseline characteristics of the withdrawn participants were not given (Hackney 2009; Mak 2008; Miyai 2002; Picelli 2012; Smania 2010; Yang 2010). Along with the six trials that did not supply baseline data, this meant that 274 (16%) of the 1693 randomised participants were not characterised.

Data analysis

Ten trials stated intention to treat as the primary method of analysis, although it was not always clear if participants who withdrew from the trial were included in the analysis. The number of participant withdrawals was classed as low risk ($\leq$ 10% of trial participants withdrew) in five of the 10 trials. Four trials used per protocol as the method of analysis (unclear risk). In the other 29 trials the method of analysis was not described (unclear risk), of

these trials seven were considered high risk in terms of the proportion of participants that withdrew (that is > 10%), and in 13 trials the number of participant withdrawals (if any) was not described (unclear risk).

Available trial information and data

A total of 13 trials were reported in abstract form; further information was requested from the authors (two were not contactable: Khallaf 2011; Shiba 1999) with four (Juncos 2006; Poliakoff 2009; Robichaud 2012; Shankar 2009) providing additional information and seven (Diehl 2011; Hass 2006; Joudoux 2011; Loureiro 2010; Shen 2011; Sigurgeirsson 2009; Talakkad 2011) being unsuccessful. A total of 30 trials were reported as full publications; further information was requested from authors for 26 trials with 13 providing additional information.

Effects of interventions

See 'Summary of results' table for included trials (Table 1).

The physiotherapy interventions were placed into one of the six categories (general physiotherapy, exercise, treadmill training, cueing, dance and martial arts) according to the type of treatment administered. However, the content and delivery of the interventions within each category were diverse and varied substantially. Further, a wide variety of validated and customised outcome measures were used to assess the effectiveness of the physiotherapy interventions. Consequently, it was inappropriate to combine the results of studies or perform any statistical analysis.

Nevertheless, results of the most regularly used outcome measures could be examined on a trial by trial basis. The most frequently reported physiotherapy outcome measures were gait speed and timed up and go. The motor subscales of the UPDRS and PDQ-39 were the most commonly reported clinician-rated disability and patient-rated quality of life outcome measures respectively. Falls data were also considered to be an important outcome in PD. Even in the case of these more widely reported outcome measures, quantitative meta-analysis could not be performed due to the wide variety of interventions employed by the included studies such that no two studies with comparable interventions assessed the same outcome measure.

Gait speed (m/s)

Gait speed was measured in 19 studies with data available from 15 studies; data were inadequately or not reported for four trials (Juncos 2006; Khallaf 2011; McGinley 2012; Shen 2011). Nine (Almeida 2012; Chaiwanichsiri 2011; Fisher 2008; Hackney 2007; Hass 2006; Li 2012; Miyai 2000; Vivas 2011; Werner 2010) of the 15 studies reported no difference between the two intervention arms. In five studies (Dias 2005 (mean difference between arms 0.34 m/s); Frazzitta 2009 (mean difference between arms 0.1 m/s); Miyai 2002 (mean difference between arms 0.16 m/s); Thaut 1996 (mean difference between arms 0.093 m/s); Yang 2010 (mean difference between arms 0.15 m/s)) the gait speed was significantly increased in the novel experimental arm compared to the comparator arm. The remaining study (Hackney 2009) was a three-arm trial. Hackney (Hackney 2009) recorded significantly greater gait speed in the tango arm compared to the waltz/foxtrot arm (mean difference between arms 0.06m/s), but not the Tai Chi arm.

Timed up and go (s)

The timed up and go test was reported in 15 studies with data available from 14 studies; data were inadequately or not reported for one study (McGinley 2012). There was no difference between the two intervention arms for 12 studies (Almeida 2012; Braun 2011; Chaiwanichsiri 2011; Hackney 2007; Hackney 2010; Li 2012; Loureiro 2010; Morris 2009; Pelosin 2010; Robichaud 2012; Sigurgeirsson 2009; Vivas 2011). In the Ebersbach (Ebersbach 2010) study, the time taken to complete the timed up and go test was significantly improved (that is reduced) with the Lee Silverman voice treatment (LSVT) BIG arm compared to the Nordic walking and home exercise arms. In the Hackney (Hackney 2009) study, the timed up and go test was significantly improved in the tango arm compared to the waltz or foxtrot and Tai Chi arms.

Falls

Outcome measures that report data on falls are important and pertinent in PD studies. However, only five trials reported data on falls (11%) (Hirsch 1996; Juncos 2006; Li 2012; McGinley 2012; Smania 2010).

Hirsch 1996 reported the effect of training on mean latency to fall (average number of seconds participants swayed before stepping or falling, touching the surrounding panels with hands, or needing assistance from the technician to keep from sitting in the harness) and the proportion of falls (number of trials resulting in falls). There were no significant differences between the combined balance and resistance arm and balance only arm for either outcome.

Juncos 2006 was published in abstract form. There was insufficient information on the falls data collected to allow a description of the manner in which falls were analysed or to give any indication of the result.

Li 2012 monitored falls using daily 'falls calendars' that were maintained by study participants. There were no differences between the Tai Chi and resistance training arms.

McGinley 2012 measured the number of fallers, the number of multiple fallers and falls rate. The number of falls during the intervention phase (eight weeks) was significantly lower in the progressive strength training arm compared to the movement strategy training arm (n = 10 versus n = 24; P = 0.006), with the frequency

of falls varying markedly. However, the time to first fall did not differ significantly between groups (P = 0.4).
Smania 2010 reported the number of falls by means of a falls diary. A diary of the number of falls, their circumstances, and the consequences for the patient's health were kept for one month prior to each evaluation session. There was no significant difference between the balance training experimental arm and the general physical exercises arm.

Clinician-rated disability

UPDRS motor subscale

The motor subscale of the UPDRS was reported in 23 studies with data and information available from 17; data were inadequately or not reported for six studies (Joudoux 2011; Khallaf 2011; Reuter 2011; Shankar 2009; Shen 2011; Toole 2005). There was no difference between the two intervention arms for 14 studies (Almeida 2012; Burini 2006; Fisher 2008; Frazzitta 2009; Hackney 2007; Hackney 2009; Juncos 2006; Li 2012; McGinley 2012; Miyai 2000; Miyai 2002; Poliakoff 2009; Robichaud 2012; Schenkman 2012a). In the Ebersbach 2010 study, the UPDRS motor score was significantly improved in the LSVT BIG arm compared to the Nordic walking and home exercise arms. In the Ridgel 2009 study, UPDRS motor scores showed a significantly greater improvement in the forced exercise arm compared to the voluntary exercise arm. In the Talakkad 2011 study, partial weight supported (-20%) treadmill training had a significantly greater improvement in UPDRS motor score compared to conventional gait training (no data in publication).

Patient-rated quality of life

PDQ-39 (Summary Index)

A total of 13 studies described using data from the PDQ-39 but the data were only available from eight studies; data were inadequately or not reported in five studies (Joudoux 2011; McGinley 2012; Reuter 2011; Shankar 2009; Sigurgeirsson 2009). Seven studies (Burini 2006; Ebersbach 2010; Juncos 2006; Morris 2009; Pelosin 2010; Poliakoff 2009; Schenkman 2012a) reported no difference between the intervention arms. Only the Hackney 2009 trial reported a significant difference, with quality of life scores significantly improved in the tango arm compared to the waltz or foxtrot and Tai Chi arms.

Adverse events

Nine trials recorded adverse event data (Chaiwanichsiri 2011; Fisher 2008; Li 2012; McGinley 2012; Picelli 2012; Poliakoff 2009; Reuter 2011; Schenkman 2012a; Yang 2010). Minor adverse events such as muscle soreness, falls and dizziness were reported, with none of these trials reporting events significant enough to cause concern over the safety of the intervention.

Compliance

Only 18 of the 43 trials discussed participant compliance, with 13 (Burini 2006; Ebersbach 2010; Hackney 2007; Hackney 2009; Hirsch 1996; Li 2012; McGinley 2012; Miyai 2000; Miyai 2002; Poliakoff 2009; Reuter 2011; Thaut 1996; Toole 2005) quantifying it in some form; however this was difficult to analyse.

Health economics

Only one trial (McGinley 2012) intended to look at health economics. Watts 2008 (See McGinley 2012) published a protocol for economic analysis alongside the McGinley trial. They proposed to evaluate cost-effectiveness using a three-way comparison of the cost per fall averted and the cost per quality adjusted life year saved across two physical therapy interventions and a control group.

DISCUSSION

Summary of main results

This review updates the previous Cochrane review published in 2001 (Deane 2001b) comparing the effectiveness of one approach of physiotherapy intervention versus a second approach of physiotherapy intervention for the treatment of PD. The review now includes 43 randomised trials and 1693 participants (compared with seven trials and 142 participants in the 2001 review). Many recent systematic reviews have focused on specific areas of physiotherapy such as exercise, cueing and treadmill training (Allen 2011; Crizzle 2006; Goodwin 2008; Lim 2005; Mehrholz 2010; Nieuwboer 2008). Physiotherapy for PD encompasses a wide range of methods and techniques ranging from standard UK National Health Service (NHS) physiotherapy to exercise regimens and martial arts (Tomlinson 2012). Therefore, it is important that all approaches of physiotherapy intervention are included. Physiotherapy interventions were placed into six categories according to the type of treatment administered. However, the content and delivery of the interventions within each category varied substantially. In view of the disparate study designs, variety of interventions, and the array of outcome measures used the results of individual studies could not be combined using quantitative meta-analysis methods.

Comparison of different physiotherapy interventions

A recent Cochrane review provided evidence on the short-term benefit of physiotherapy in the treatment of PD (Tomlinson 2012). However, it did not identify whether any specific type of physiotherapy intervention provides greater benefit. This review aimed to assess this by comparing the effectiveness of one approach of physiotherapy intervention with a second approach of physiotherapy intervention. The various physiotherapy interventions used in the trials included in this review were categorised according to the type of treatment administered to aid comparisons (general physiotherapy, exercise, treadmill training, cueing, dance, martial arts). However, despite categorisation, the techniques employed within each category were diverse. Therefore, it was not possible or appropriate to combine the results by meta-analysis as any such analysis would be difficult to interpret. It is also difficult to summarise such large amounts of heterogeneous data using a qualitative approach. Consequently, we conclude that there is no robust trial evidence to support any one approach of physiotherapy over another in the treatment of PD.

The content and delivery of the interventions used in the trials included within this review were diverse in nature. Although attempts were made to compare trials that were 'like for like' through the creation of different categories, the interventions delivered varied substantially within these categories. In the future it may be useful to further subcategorise by the primary aim of the trial. For example, categories for the primary aim might be to improve gait or improve a specific problem such as gait freezing or balance, or improve overall PD performance or function. The variation in the therapy delivered is unsurprising. Physiotherapy is an autonomous profession. Physiotherapists use different sets of skills and work within their own scope of practice (Chartered Society of Physiotherapy), and so this variation in the interventions delivered within clinical trials may reflect the diversity of clinical practice. Over the past decade, steps have been taken to try and provide best practice consensus in the form of the Dutch *KNGF guidelines for physical therapy in patients with Parkinson's disease* (Keus 2004). However, this publication provides a guidance framework rather than a 'recipe' for treatment. It is therefore important that physiotherapy interventions are compared against each other within rigorous trial designs to determine which are the most effective. This will provide therapists with a menu of treatment strategies that are known to be effective, from which they can devise individualised interventions. However, given the complexity of physiotherapy interventions, it is important that such trials follow the Medical Research Council guidelines for developing and evaluating complex interventions (MRC 2008), which will help standardise interventions. In addition, many of the trials included in this review had interventions that were intensive and for long durations, which may not be feasible in main stream care. Therefore, future trials should be designed such that the interventions are transferable and cost-effective in main stream care.

Outcome measures

There was a large variety of outcome measures utilised in the different studies included in this review. The majority of the outcomes were standard physiotherapy and PD outcomes. Gait speed, timed up and go, UPDRS motor score and quality of life measured using the PDQ-39 were the most frequently reported outcome measures within their respective categories. PD is a multidimensional disease and several important outcomes were either poorly or not reported; this includes data on the number of the falls, depression and anxiety and adverse events. Further, many of the outcomes measured were not relevant to the PD patient or carer. There is a need for the use of functional gait outcomes in future trials which look at the impact on the patient during everyday living rather than in a laboratory environment. Further, only one trial intended to look at a health economics analysis of physiotherapy intervention, therefore little is known about the cost-effectiveness and economic value of this therapy. Future trials should include these outcomes.

Gait speed

Six trials (Dias 2005; Frazzitta 2009; Hackney 2009; Miyai 2002; Thaut 1996; Yang 2010) reported significant differences between the treatment arms for gait speed. The observed differences between treatment arms ranged from 0.06 to 0.34 m/s. In all these trials, with the exception of Hackney 2009, the intervention arm that used cueing or treadmill training methods, or both, was the better treatment arm. The Hackney trial (Hackney 2009) examined dance with the tango arm outperforming the waltz or foxtrot arm. The possible relevance and benefit of these significant differences to patients with PD must be put into context in terms of what is considered a minimally clinically important change (MCIC). Data on what is considered an MCIC are lacking for PD patients, but some data have been reported in stroke patients. In one study, it was reported that an increase in speed of just 0.03 and 0.13 m/s could translate into a change from a limited household to an unlimited household walker, and from an unlimited household walker to a most-limited community walker, respectively (Perry 1995). Therefore, these differences in gait speed between arms are consistent with the findings reported by Perry (Perry 1995).

Timed up and go

The MCIC in PD patients is thought to be 11 seconds (Steffen 2008). The differences seen between treatment arms in the Ebersbach (Ebersbach 2010) and Hackney trials (Hackney 2009) were much smaller than this (the mean difference between arms ranged from 1.1 to 2 seconds).

UPDRS motor subscale

Three trials reported a significant benefit of one treatment arm in improving UPDRS motor over the other arms. The UPDRS motor score in the LSVT BIG arm in the Ebersbach (Ebersbach 2010) trial improved by 5.05 points, which was significantly different from the two other arms in which the score increased (that is got worse) by 0.53 and 1.68 points in the Nordic walking and home exercise arms, respectively. Ridgel (Ridgel 2009) reported a significant difference in UPDRS motor score between the forced exercise arm (-16.6 points) and the voluntary exercise arm (3.6 points). Additionally, Talakkad (Talakkad 2011) reported a significantly greater improvement of the UPDRS motor score in the partial weight supported (-20%) treadmill training compared to conventional gait training, although there were no data in the abstract publication. The MCIC for the UPDRS motor score has been reported in two studies. One analysed data from two independent randomised controlled trials and concluded that the MCIC was five points for the motor score (Schrag 2006). The second study performed a cross-sectional analysis on 653 PD participants and reported a MCIC of 2.3 to 2.7 points for the motor score (Shulman 2010). Considering the recommendations of both Schrag (Schrag 2006) and Shulman et al (Shulman 2010) the improvements seen in the Ebersbach (Ebersbach 2010) and Ridgel (Ridgel 2009) trials may reflect a MCIC.

Patient-rated quality of life

A study performed by Peto et al (Peto 2001) to determine the MCIC for the PDQ-39 Parkinson's questionnaire reported that a difference of 1.6 on the summary index was a meaningful change. Only the Hackney 2009 trial reported a significant difference, with quality of life scores significantly improved by 7.10 points in the tango arm, which was significantly different from the waltz or foxtrot arm that improved by 0.68 points and the Tai Chi arm which had an increased score of 1.55 points (that is got worse). This improvement in quality of life that was seen in the tango arm is therefore meaningful to patients.

Quality of the evidence

There has been an improvement in the trial methodological quality and reporting since the last Cochrane review (Deane 2001b). The use of more robust randomisation methods, blinding and intention-to-treat analyses has increased since the previous review, although it was still inadequate. Of the 43 trials, only 24 trials provided information on the randomisation method (of which eight were considered low risk) and only four used a central independent randomisation procedure to ensure concealment of treatment allocation; 23 trials used blinded assessors and only 10 stated that they used intention-to-treat analysis methods. The lack of information in many trial reports may not necessarily indicate lack of implementation within the trial, but without this information provided in the trial publications the level of bias within the individual trials is difficult to assess. The need for further improvement in the methodological quality of trials in physiotherapy for PD was noted recently (Kwakkel 2007; Tomlinson 2012). Future trials must be methodologically sound, large, randomised, and controlled with reporting following CONSORT guidelines (Boutron 2008a; Boutron 2008b).

The trials included in the review were relatively small, with the majority assessing the effect of one approach of physiotherapy intervention versus a second approach of physiotherapy intervention over a short period of time, with limited follow-up. The overall size of trials has increased (with an average of 39 participants per trial in this review compared to 20 in the previous review), but the number of small and underpowered trials remains a problem. Small trials may be subject to 'random error' (Doll 1980) and consequently may give rise to false negative or positive results. Further, it must be noted that the mean age of onset of PD in the participants in the trials was 60 years. This is relatively young as the average age of onset in the PD MED trial is 67 to 69 years (Patel 2010), therefore the results of the trials may not be relevant to the general PD population, in particular older PD patients.

It should also be noted that only 18 of the 43 trials discussed participant compliance. This is surprising as compliance can be an important determinant of the outcomes measured and the acceptability of the interventions being assessed in the trials. Therefore, it would be beneficial if the level of compliance is measured in future trials.

Another limitation is that the follow-up period in the trials included in this review was relatively short. Outcome measures were assessed in all trials at baseline and immediately or shortly after the intervention had ceased (one or two weeks, with one trial (Ebersbach 2010) assessing at 12 weeks post-intervention). PD is a long-term neurodegenerative disease, so it is important that the long-term effect of treatment is assessed. Only half of the 43 trials followed-up participants and reported further data during the post-treatment period (but this could have been only two weeks or up to 12 months post-treatment). The previous review's recommendations were for participants to be followed-up for at least six months. Only two trials did this, reporting follow-up data at 12 months (McGinley 2012) and at both 6 and 12 months (Werner 2010) post-treatment. Long-term data will provide valuable information about the duration of any improvement following therapy.

Reporting biases

Many trials used multiple outcome measures, and in the majority of trials the primary outcome measure was not explicitly stated. Therefore, it was difficult to assess and identify if studies were free of selective outcome reporting.

In order to minimise the risk of publication bias, a comprehensive search was performed of multiple databases, including searching

of unpublished and ongoing studies, without any language restrictions. Also, where necessary, authors were contacted to request additional information. However, as with any systematic review, publication bias should still be taken into consideration.
In summary, large, well-designed randomised trials with improved specific treatment strategies and a follow-up of at least 12 months that assess the impact of treatment on all aspects of a patient's PD, alongside a health economics assessment, are needed.

AUTHORS' CONCLUSIONS

Implications for practice

Considering the small number of participants, the methodological flaws in many of the studies, the wide variety of physiotherapy interventions and outcome measures used, there is insufficient evidence to support the use of one approach of physiotherapy intervention over another for the treatment of PD.

Implications for research

- The majority of the studies included in this review were small and had a short follow-up period. It is clear that larger randomised controlled trials with longer-term follow-up are required, particularly focusing on improving trial methodology and reporting. Rigorous methods of randomisation should be used and the allocation should be adequately concealed. Data should be analysed according to intention-to-treat principles and trials should be reported according to the guidelines set out in the CONSORT statement (Boutron 2008a; Boutron 2008b).

- This review highlights the variety of physiotherapy interventions being tested for the treatment of PD. There is a need for more specific trials with improved treatment strategies to underpin the most appropriate choice of physiotherapy intervention and the outcomes measured. This review also reinforces the need for the universal employment of clinically relevant, reliable and sensitive outcome measures with a predefined outcome in each trial.

- Future trials should, where appropriate, try to follow the Medical Research Council guidelines for developing and evaluating complex interventions (MRC 2008).

- Future trials should be designed such that the interventions are transferable and cost-effective in main stream care.

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* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Almeida 2012

Methods	Parallel group design Randomised by pulling allocation out of a hat Analysed on a per protocol basis Treated as outpatients for 9 hours over 6 weeks Assessed at baseline, 6 weeks and 12 weeks Assessors were blinded for UPDRS III evaluation
Participants	14 participants in the Overground walking group (OG), 14 in the Treadmill walking group (TM) and 14 in the control group (CL). 2 dropouts in TM group, 1 dropout in CL group Participants' mean age 73.9 years (OG), 63.9 years (TM), 67.4 years (CL); male/female 12/2 (OG), 8/6 (TM), 11/3 (CL); Hoehn and Yahr stage not stated; duration of PD not stated Inclusion criteria: Confirmed as having clinically typical Parkinson's disease by at least one movement disorders neurologist. Exclusion criteria: Past history of neurological conditions other than Parkinson's disease, orthopaedic or visual disturbances that severely impaired walking ability, unable to independently walk down an 8 metre GAITRite carpet for a total of 10 trials
Interventions	OG: Walk down equally spaced transverse lines presented on a 16m carpet. The cues were white lines of tape. Participants asked to walk across the lines, turn and continue back. Spacings were set at 8% greater than the initial step length of any of the groups (70 cm). 30 minute session with mandatory 2 min break every 8 mins, additional rest allowed if necessary but a total of 24 mins walking was required to consider gait session complete TM: Walk on a treadmill presented with equally distributed standardised transverse white lines. Spacings were set at 8% greater than the initial step length of any of the groups (70 cm). 30 minute session with mandatory 2 min break every 8 mins, additional rest allowed if necessary but a total of 24 mins walking was required to consider gait session complete CL: Instructed to continue their usual activities. Participants were optimally medicated at time of all training and testing sessions and remained on stable regimen throughout trial period
Outcomes	Step length UPDRS III Timed up and go Gait speed Cadence Double support time Step time Step-to-step variability, step time variability 30 second chair stand
Notes	CL arm not included in review

Risk of bias

Bias	Authors' judgement	Support for judgement

Almeida 2012 (*Continued*)

Eligibility Criteria	Low risk	Inclusion and exclusion criteria stated
Randomisation Method	High risk	Allocation pulled out of hat
Concealment of Allocation	High risk	Allocation pulled out of hat
Similarity at Baseline	Low risk	Group characteristics similar at baseline
Intention to Treat Analysis	Unclear risk	Analysed on a per protocol basis
Withdrawals Described	Low risk	Withdrawals at less than 10%
Cointerventions Constant	Low risk	Participants maintained stable drug regiment throughout trial period
Comparable arms	Low risk	Same time and attention given to both arms
Blinded Assessors	Unclear risk	Assessors blind for UPDRS III evaluation only

Braun 2011

Methods	Parallel group design Random allocation list used for each site with block sizes of 4 Both intention-to-treat and per protocol analysis were carried out Treated as outpatients for either 1 hour per week (groups) or 30 mins per week (individuals) over 6 weeks Assessed at baseline (week 0-1), at 7-8 weeks and at 3 months (12-13 weeks) Assessors were blinded
Participants	25 participants in the physiotherapy with mental practice group (PT+MP) and 22 in the physiotherapy and relaxation group (PT+R). There were 3 dropouts PT+MP group and 4 in the PT+R group prior to the post-intervention assessment, and a further 4 dropouts in the PT-MP group and 3 in the PT-R group prior to the 3 month follow-up assessment Participants' mean age 70 years (PT-MP), 69 years (PT-R); Male/female ratio, 17/8 (PT-MP), 15/7 (PT-R); Mean Hoehn and Yahr not given; Mean duration of PD 5.2 years (PT-MP), 6.6 years (PT-R) Inclusion criteria: Clinically diagnosed adults with PD, sufficient cognitive level and communication skills to engage mental practice. Exclusion criteria: Other conditions such as stroke, rheumatic disease or dementia prior to onset of PD and sufficient to cause persistent premorbid disability
Interventions	Participants entering the trial were already receiving physiotherapy. This pre-existing treatment was continued. The randomly allocated new treatment was incorporated into the participants existing program PT-MP: In half hour sessions 10 mins were spent on mental practice, in group sessions of 1 hour, 20 mins were spent on mental practice. Therapy was recorded in pre-structured files which detailed content and duration. As soon as possible therapists encouraged unguided mental practice. Logs were given to participants to record unguided mental practice behaviour. The main goal of mental practice was to improve locomotor tasks like walking, standing up from a chair or the floor. This was achieved through four steps, explaining the concept, developing imagery techniques, applying mental practice

	and consolidating. During therapy imagery attempts and overt movements were combined. This information was embedded in the imagery attempts to make them as vivid as possible. The proportions of actual movements and imagery attempts were based on individual preferences PT-R: In half hour sessions 10 mins were spent on relaxation, in group sessions of 1 hour, 20 mins were spent on relaxation. Therapy was recorded in pre-structured files. As soon as possible therapists encouraged unguided relaxation. Logs were given to participants to record unguided practice. Used to control for attention and consisted of treatment according to the national Dutch guidelines with relaxation therapy being incorporated into each session. The amount of relaxation incorporated matched the amount of mental practice in the experimental group. Relaxation followed the principles of progressive muscle relaxation It was not stated whether drug therapy was kept constant during the trial
Outcomes	Patient and therapist perceived effect on walking performance using visual analogue scale Timed up and go 10 m walk test
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Eligibility Criteria	Low risk	Inclusion and exclusion criteria
Randomisation Method	Unclear risk	Random allocation list not clear how generated
Concealment of Allocation	Low risk	Lists kept by independent 3rd party
Similarity at Baseline	Unclear risk	Hoehn and Yahr not stated
Intention to Treat Analysis	Unclear risk	Primary analysis was ITT then per protocol was carried out
Withdrawals Described	High risk	Withdrawals > 15% prior to post-intervention assessment
Cointerventions Constant	Unclear risk	Not stated whether drug therapy was kept constant during the trial
Comparable arms	Low risk	Same time and attention given in both arms
Blinded Assessors	Low risk	Assessors were blinded

Burini 2006

Methods	Cross-over design Participants coupled consecutively with list of random numbers. Numbers correspond to a sealed envelope containing group allocation Method of analysis not stated Treatment delivered to groups in 45-50 minute sessions, 3 times per week up to a total of 20 sessions Assessed at Baseline, after 7 weeks of first treatment, after 8 weeks wash-out period, after 7 weeks of second treatment Assessors were blinded
Participants	13 participants in the aerobic training group and 13 in the Qi-gong group. There were 2 dropouts in each group Participants' mean age 65.7 years (aerobic training), 62.7 years (Qi-gong); Male/female ratio, 5/8 (aerobic training), 4/9 (Qi-gong); Mean Hoehn and Yahr 2.8 (aerobic training), 2.7 (Qi-gong); Mean duration of PD 11.2 years (aerobic training), 10.6 years (Qi-gong) Inclusion criteria: PD subjects, stable medication, Hoehn and Yahr stage II to III. Exclusion criteria: Severe cognitive impairment (MMSE < 24), concomitant severe neurologic cardiopulmonary or orthopaedic disorders, specific contraindication to the execution of a cardiopulmonary test or aerobic training, recent participation in any physiotherapy/rehabilitation program during 2 months prior to start of trial
Interventions	Aerobic training: Cycle ergometer used with warm-up, endurance and cool-down phases in each 45 min session occurring 3 times per week Qi-gong: Breathing exercises, stretches, neck and trunk rotation exercises and balance training in the upright position, 50 minute sessions 3 times per week Drug regimen remained constant throughout trial period.
Outcomes	UPDRS III UPDRS II Brown's disability scale (BDS) 6-minute walk test Borg scale for breathlessness Beck depression inventory (BDI) PDQ-39 Spirometry test Maximum cardiopulmonary exercise test
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Eligibility Criteria	Low risk	Inclusion and exclusion criteria stated
Randomisation Method	Unclear risk	Not stated how random number list was generated
Concealment of Allocation	High risk	Sealed envelopes
Similarity at Baseline	Low risk	Group characteristics similar at baseline

Burini 2006 (*Continued*)

Intention to Treat Analysis	Unclear risk	Method of analysis not stated
Withdrawals Described	High risk	Dropouts at 15%
Cointerventions Constant	Low risk	Drug regimen remained constant throughout trial period
Comparable arms	Low risk	Same time and attention given to both groups
Blinded Assessors	Low risk	Assessors blinded, patients instructed not to discuss treatment schedule

Chaiwanichsiri 2011

Methods	Parallel group design Randomisation method not stated Method of analysis not stated Treated as outpatients for 3 sessions per week and using home practice for 3 sessions per week each lasting 30 minutes over 4 weeks plus 4 week home program Assessed at baseline, immediately after treatment (4 weeks), and after home program at 8 weeks Assessors were blinded
Participants	10 participants in the treadmill + music + home-walking (TMH) group, 10 participants in the treadmill and home-walking (TH) group, 10 participants in the home-walking group (H). No dropouts described Participants' mean age 67.1 years (TMH group), 67.9 years (TH group), 68.6 years (H group); Male/female ratio 10/0 (TMH group), 10/0 (TH group), 10/0 (H group); Mean Hoehn and Yahr score 2.3 (TMH group), 2.5 (TH group), 2.1 (H group); Mean duration of PD 3.7 years (TMH group), 7.4 years (TH group), 4.4 years (H group) Inclusion criteria: Male, 60-80 years old, PD as diagnosed by attending neurologists, Thai Mental State Examination > 23, stable medications without freezing, no exercise program in last 2 months, no contraindication for exercise, H&Y II-III, independent walking without use of gait aids. Exclusion criteria: Medication change during study, inability to walk on treadmill, cannot complete 80% of prescribed program
Interventions	TMH: 10 minutes of stretching followed by 20 minutes of treadmill training with cueing (music) delivered 3 days per week and home-walking practised 3 days per week. After treadmill speed was set, the step frequency would be identified by adjustable electrical metronome. The prepared music with the same rhythmic frequency was chosen. Then the participants were training to walk synchronised with the matched music rhythm on the treadmill. This music would be recorded in MP3 for the participants to take home and listen during home practice. Home program consisted of 10 minutes of stretching and 20 minutes walking. After 4 weeks treadmill training ceased but home program was continued for a further 4 weeks TH: 10 minutes of stretching followed by 20 minutes of treadmill training without cueing delivered 3 days per week and home-walking, as described above, practised 3 days per week. After 4 weeks treadmill training ceased but home program was continued for a further 4 weeks H: Home-walking practised 6 days per week. Patients were excluded if medication was changed during trial period. Patients did not participate in training in 2 months prior to study start

Chaiwanichsiri 2011 (*Continued*)

Outcomes	Timed up and go Walking speed Step length Cadence Stride length 6-minute walk test 6 metre walk time Single leg stance UPDRS I, II, III
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Eligibility Criteria	Low risk	Inclusion and exclusion criteria stated
Randomisation Method	Unclear risk	Method not stated
Concealment of Allocation	Unclear risk	Method of randomisation not stated
Similarity at Baseline	Low risk	Group characteristics similar at baseline
Intention to Treat Analysis	Unclear risk	Analysis method not stated
Withdrawals Described	Unclear risk	Withdrawals not described
Cointerventions Constant	Low risk	Patients were excluded if medication changed during trial period
Comparable arms	Unclear risk	Home group no therapist time
Blinded Assessors	Low risk	Assessors were blinded

Dias 2005

Methods	Parallel group design Randomisation method not stated Method of analysis not stated Treatment delivered in a total of 20 hour long sessions Assessed at baseline, immediately after treatment and 30 days after end of treatment Not stated whether assessors were blinded
Participants	8 participants in the physiotherapy and cardiovascular exercise with visual cues (PTCV) group and 8 in the physiotherapy only (PT) group. No dropouts described Participants mean age 61.5 years (PTCV group), 64.3 years (PT group); Male/female ratio 4/4 (PTCV group), 7/1 (PT group); Mean Hoehn and Yahr 1.6 (PTCV group), 1.7 (PT group); Mean duration

Dias 2005 (*Continued*)

	of PD 7.4 years (PTCV group), 8.4 years (PT group) Inclusion criteria: Hoehn and Yahr stage ≤3. Exclusion criteria: Any degree of dementia, joint deformations, arthritis, severe pain, other neurological disturbance, submitted to neurological surgery, severe associated pathologies that would impair physiotherapy
Interventions	PTCV: 20 sessions of physiotherapy following a protocol that included 15 mins muscular stretching, 30 mins gait training on stable ground with visual cues, 15 mins cardiovascular exercise using ergometric bicycle PT: Conventional physiotherapy. It was not stated whether drug therapy was kept constant during the trial
Outcomes	UPDRS Functional independence measurement scale Berg balance scale Hoehn and Yahr scale
Notes	Article in Portuguese

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Eligibility Criteria	Low risk	Inclusion and exclusion criteria stated
Randomisation Method	Unclear risk	Method of randomisation not stated
Concealment of Allocation	Unclear risk	Method of randomisation not stated
Similarity at Baseline	Low risk	Group characteristics similar at baseline
Intention to Treat Analysis	Unclear risk	Method of analysis not stated
Withdrawals Described	Unclear risk	Number of dropouts not stated
Cointerventions Constant	Unclear risk	Not stated whether drug regimen remained constant throughout trial period
Comparable arms	Low risk	Same number of sessions of active therapy in both arms
Blinded Assessors	Unclear risk	Not stated whether assessors were blinded

Diehl 2011

Methods	Parallel group design Randomisation method not stated Analysis method not stated Treated for 24-36 sessions, lasting 90 mins each over 12 weeks Assessed at baseline and immediately after treatment Not stated whether assessors were blinded
Participants	20 participants were recruited, group split not stated. Dropouts not stated Baseline characteristics not stated but it was reported that no significant differences were found between groups in pre-test demographic variables Inclusion and exclusion criteria not stated.
Interventions	Group box training: Stretching, lateral foot work, punching various targets, resistance exercises and aerobic training Traditional group exercises:Stretching, resistance exercises, aerobic and balance activities It was not stated whether drug therapy was kept constant during the trial
Outcomes	Berg balance scale Activities-specific balance confidence scale Functional reach test Parkinson's disease quality of life scale
Notes	Abstract only

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Eligibility Criteria	Unclear risk	Eligibility criteria not stated
Randomisation Method	Unclear risk	Method not stated
Concealment of Allocation	Unclear risk	Randomisation method not stated
Similarity at Baseline	Low risk	No significant differences were found between groups in pretest demographic variables
Intention to Treat Analysis	Unclear risk	Method of analysis not stated
Withdrawals Described	Unclear risk	Withdrawals not described
Cointerventions Constant	Unclear risk	Not stated whether drug therapy was kept constant during the trial
Comparable arms	Low risk	Same time and attention given to both groups
Blinded Assessors	Unclear risk	Not stated whether assessors were blinded

Ebersbach 2010

Methods	Parallel group design Randomly allocated by drawing lots Analysed on a per protocol basis Treatment took place for 1 hour sessions 4 times per week for 4 weeks Assessed at baseline and at 16 weeks Assessors blinded for UPDRS III, not stated for other outcomes
Participants	20 participants in LSVT BIG (BIG) group, 19 participants in Nordic walking (WALK) group and 19 participants in the Home exercise (HOME) group. 1 dropout in WALK group and 1 in HOME group Participants mean age 67.1 years (LSVT BIG group), 65.5 years (WALK group), 69.3 years (HOME group); Male/female ratio 7/13 (LSVT-BIG group), 7/12 (WALK group), 8/11 (HOME group); Mean Hoehn and Yahr 2.8 (LSVT BIG group), 2.6 (WALK group), 2.5 (HOME group); Mean duration of PD 6.1 years (LSVT-BIG group), 7.8 years (WALK group), 7.4 years (HOME group) Inclusion criteria: Fulfil diagnostic criteria for IPD, Hoehn & Yahr stage I-III outpatient treatment, stable medication 4 weeks prior to inclusion. Exclusion criteria: Dementia (MMSE<25), severe depression, disabling dyskinesias, comorbidity affecting mobility or ability to exercise
Interventions	LSVT BIG: 50% of exercises consisted of standardized whole-body movements with maximal amplitude, repetitive multidirectional movements and stretching. 50% of exercise included goal-directed ADL according to individual needs and preferences. ADL were performed using high amplitude LSVT BIG movements. LSVT BIG was delivered one-to-one with intensive motivation and feedback. Participants were constantly encouraged to work with at least '80% of their maximal energy' on every repetition and taught to use bigger movements in routine activities to provide continuous exercise in everyday movements. Participants in all groups were encouraged to exercise regularly at home. Diaries were used to document type and duration of exercise performed in addition to supervised LSVT BIG WALK: Each session consisted of a standardized protocol for beginners including warming up, practicing Nordic walking and finally a cooling down. Sessions were performed in a local park in groups of 4 or 6 and constantly supervised by the therapist. Participants in all groups were encouraged to exercise regularly at home. Diaries were used to document type and duration of exercise performed in addition to supervised WALK sessions HOME: 1 hours instruction of domestic training with practical demonstration and training. Exercises included stretching, high-amplitude movements, as well as active workouts for muscular power and posture. Participants in all groups were encouraged to exercise regularly at home. They received a diary to document type and duration of exercise performed Changes in medication occurred in 6 patients from each group
Outcomes	UPDRS III PDQ-39 Timed up and go Time to walk 10 m
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Eligibility Criteria	Low risk	Inclusion and exclusion criteria stated

Ebersbach 2010 (*Continued*)

Randomisation Method	High risk	Randomised by drawing lots
Concealment of Allocation	High risk	Randomised by drawing lots
Similarity at Baseline	Low risk	Group characteristics similar at baseline
Intention to Treat Analysis	Unclear risk	Analysed on a per protocol basis
Withdrawals Described	Low risk	Withdrawals <10%
Cointerventions Constant	Unclear risk	Minor changes to medication
Comparable arms	Unclear risk	Time and attention greater in LSVT BIG and WALK groups than in HOME group
Blinded Assessors	Unclear risk	Assessors blinded for primary outcome, not stated for secondary outcomes

Fisher 2008

Methods	Parallel group design Subjects closed their eyes and selected a card corresponding to 1 of the 3 groups Analysis method not stated Treated as outpatients for 24 sessions over 8 weeks for both treatment arms, 6 sessions over 8 weeks for control group Assessed at baseline and immediately post-treatment Assessors were blinded
Participants	10 participants in treadmill group, 10 participants in physiotherapy group and 10 in the control arm. No dropouts Participants' mean age, 64.0 years (treadmill), 61.5 years (physiotherapy), 63.1 years (control). Male/female ratio, 6/4 (treadmill), 5/5 (physiotherapy), 8/2 (control). Mean Hoehn and Yahr 1.9 in all 3 groups. Mean duration of PD 1.2 years (treadmill), 0.7 years (physiotherapy), 1.5 years (control) Inclusion criteria: Early stage PD, diagnosis of PD within 3 years of study participation, Hoehn and Yahr stage 1 or 2, 18 years or older, medical clearance from primary care physician to participate in exercise programme, ability to walk. Exclusion criteria: Medical or physical screening examination showed a score of less than 24 on the MMSE, there were physician determined major medical problems such as cardiac dysfunction that would interfere with participation, they had musculoskeletal impairments or excessive pain in any joint that could limit participation in an exercise programme, had insufficient endurance and stamina to participate in exercise 3 times per week for a 1 hour session
Interventions	Treadmill: Level of intensity was defined by metabolic equivalents (MET). High intensity exercise greater than 3 METs. Body weight supported (BWS) treadmill training. Goal of each session was to reach and maintain a MET > 3. Exercise progressed by decreasing BWS (initially 10% of participants' bodyweight) and physical assistance, increasing the treadmill speed and time on the treadmill, with the end goal for each participant to walk on the treadmill continuously for 45 min within the MET range Physiotherapy: Less than 3 METs. This group was representative of general or traditional physical therapy. Each 45 min session was individualised and consisted of activities from 6 categories 1) passive

Fisher 2008 (*Continued*)

	range of motion and stretching 2) active range of motion 3) balance activities 4) gait 5) resistance training 6) practice of functional activities and transitional movements Control: Zero intensity group. Six 1 hour education classes taken over an 8 week period All participants were allowed to continue their customary exercise routines and filled out a daily exercise diary Drug therapy was constant during the trial.
Outcomes	UPDRS (Total, I, II and III subscores) Hoehn and Yahr Functional assessments Walking tests: average gait velocity, step length, stride length, cadence, double limb support time, ankle, knee, hip rotation Sit-to-stand test Transcranial magnetic stimulation (subset) All participants took their customary medications at the same time relative to each assessment
Notes	Control arm not included in this review

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Eligibility Criteria	Low risk	Inclusion and exclusion criteria stated
Randomisation Method	High risk	Subjects self-selected a card with eyes closed
Concealment of Allocation	High risk	Subjects self-selected a card with eyes closed
Similarity at Baseline	Low risk	Group characteristics similar at baseline
Intention to Treat Analysis	Unclear risk	Method of analysis not described
Withdrawals Described	Low risk	No dropouts
Cointerventions Constant	Low risk	All medication kept stable during course of study
Comparable arms	Low risk	Same time and attention given to participants in both arms
Blinded Assessors	Low risk	Assessors were blinded to group allocation

Frazzitta 2009

Methods	Parallel group design Randomisation method not stated Analysis method not stated Treatment was delivered over 4 weeks in 28 sessions lasting 20 mins each Assessed at baseline and immediately after treatment Not stated whether assessors were blinded
Participants	20 participants in treadmill with cues group, 20 in Auditory and visual cues group. No dropouts Participants mean age 71 years for both groups; Male/female ratio not stated; Mean Hoehn and Yahr 3 for both groups; Mean duration of condition 13.2 years (treadmill group), 12.9 years (cued group) Inclusion criteria: Clinically probable IPD, ability to walk without assistance, visual and hearing capacity sufficient to perceive the cues, freezing of gait at the time of peak medication, stable pharmacological treatment, Hoehn & Yahr stage III, no cognitive impairment, MMSE > 26. Exclusion criteria: Neurological condition other than IPD, postural hypertension, cardiovascular disorders, musculoskeletal disorders, vestibular dysfunction limiting locomotion or balance
Interventions	Treadmill: Rehabilitation protocol for gait disturbance & freezing that used treadmill training associated with auditory & visual cues. Maximum tolerated walking speed -40% used for 2 day warm-up, then increased by 0.05 stride cycles/second. Visual cue of target on screen that participant had to reach with stride, auditory cue of music at matched frequency Cued: Visual cue of lines spaced according to individual stride length for gait training coupled with auditory cue of music at frequency matching that used in Treadmill group It was not stated whether drug therapy was kept constant during the trial
Outcomes	UPDRS III Gait speed Freezing of gait questionnaire Stride length 6 minute walking test
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Eligibility Criteria	Low risk	Inclusion and exclusion criteria stated
Randomisation Method	Unclear risk	Method not stated
Concealment of Allocation	Unclear risk	Randomisation method not stated
Similarity at Baseline	Low risk	Group characteristics similar at baseline
Intention to Treat Analysis	Unclear risk	Method of analysis not stated
Withdrawals Described	Low risk	No dropouts

Frazzitta 2009 (*Continued*)

Cointerventions Constant	Unclear risk	Not stated whether drug regimen remained constant throughout trial period
Comparable arms	Low risk	Same time and attention given to participants in both arms
Blinded Assessors	Unclear risk	Not stated whether assessors were blinded

Hackney 2007

Methods	Parallel group design Randomisation method not stated Method of analysis not given Treated as outpatients for 20 sessions each lasting 1 hour delivered over 13 weeks Assessed 1 week prior to treatment and 1 week after treatment Assessors were blinded
Participants	9 participants in Tango group, 10 in Exercise group. No dropouts were reported Participants mean age 72.6 years (Tango), 69.6 years (exercise); Male/female ratio 6/3 (Tango), 6/4 (exercise); Hoehn and Yahr 2.3 (Tango), 2.2 (exercise); Mean duration of condition 6.2 years (Tango), 3.3 years (exercise) Inclusion criteria: Diagnosed with clinically defined IPD, clear benefit from PD medications
Interventions	Tango: Progressive Tango dance lessons with postural stretches, balance exercises, Tango-style, footwork patterns and experimentation with timing of steps to music with and without partner Exercise: Structured flexibility exercise classes designed for people with PD and/or elderly individuals. Breathing and stretching exercises progressed to resistance and dexterity exercises sometimes using water bottles or yard sticks to provide resistance or leverage. Some exercises done standing or using chair for support and last 10 minutes consisted of core strengthening exercises using floor matts or modified exercises in chair Drug therapy was kept constant during the trial.
Outcomes	UPDRS III Berg balance scale Freezing of gait Timed up and go Velocity of walking and dual-task walking
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Eligibility Criteria	Low risk	Inclusion criteria stated, clear definition of disease
Randomisation Method	High risk	Numbers drawn from a hat

Hackney 2007 (*Continued*)

Concealment of Allocation	High risk	Numbers drawn from a hat
Similarity at Baseline	Low risk	Group characteristics similar at baseline
Intention to Treat Analysis	Unclear risk	Method of analysis not given
Withdrawals Described	Low risk	No dropouts reported
Cointerventions Constant	Low risk	Drug regimen remained constant throughout trial period
Comparable arms	Low risk	Same time and attention given to participants in both arms
Blinded Assessors	Low risk	Assessors were blinded

Hackney 2009

Methods	Parallel group design Randomised by selecting allocation from a hat, carried out by trial investigator Method of analysis not given Treatment delivered in 1 hour sessions twice weekly for a total of 20 sessions Assessed at baseline and within 1 week of completing 20 classes Assessors were blinded
Participants	19 participants in tango group, 19 in Waltz/Foxtrot group , 17 in Tai Chi and 20 in control. 5 dropouts in Tango group, 2 dropouts in Waltz/Foxtrot, 4 dropouts in Tai Chi and 3 in control group Participants mean age 68.2 years (Tango group), 66.8 years (Waltz/Foxtrot group), 64.9 (Tai Chi), 66.5 (control); Male/female ratio 11/3 (Tango group), 11/6 (Waltz/Foxtrot), 11/2 (Tai Chi),12/5 (control) ; Hoehn & Yahr 2.1 (Tango), 2.0 (Waltz/Foxtrot), 2.0 (Tai Chi), 2.2 (control); Mean duration of condition 6.9 years (Tango), 9.2 years (Waltz/Foxtrot), 8.7 (Tai Chi), 5.9 (control) Inclusion criteria: At least 40 years of age, could stand for at least 30 min, could walk independently 3 or more metres with or without assistive device, diagnosis of IPD using diagnostic criteria for critically defined "definite PD" based upon published standards, patients demonstrated clear benefit from L-dopa, Hoehn & Yahr I-III. Exclusion criteria: History of neurological deficit other than PD, patients had been previously screened for dementia by their neurologists and none were diagnosed with dementia
Interventions	Waltz/Foxtrot and Progressive Tango: Experience professional ballroom dancer taught progressive Tango, Waltz/Foxtrot lessons. Instructor, equally versed in both dances, attempted to give all students equal time in leading and following dance roles. All steps done in closed practice position, participants maintain contact through upper extremities and face one another Tai Chi: Progressive lessons on Tai Chi's 1st and 2nd circles of the Yang short style of Cheng Manching taught by experienced instructor Control: No intervention. Drug therapy was constant during the trial or patients were excluded

Hackney 2009 (*Continued*)

Outcomes	PDQ-39 UPDRS III Berg balance scale Tandem stance test Timed up and go test One leg stance test 6 minute walk test Gait
Notes	Control arm not included in this review

Risk of bias

Bias	Authors' judgement	Support for judgement
Eligibility Criteria	Low risk	Inclusion and exclusion criteria stated
Randomisation Method	High risk	Allocation pulled out of hat
Concealment of Allocation	High risk	Allocation pulled out of hat
Similarity at Baseline	Low risk	Group characteristics similar at baseline
Intention to Treat Analysis	Unclear risk	Method of analysis not given
Withdrawals Described	High risk	Withdrawals at 19%
Cointerventions Constant	Low risk	Patients excluded if change in medication was required
Comparable arms	Low risk	Same time and attention given to both groups
Blinded Assessors	Low risk	Assessors blinded

Hackney 2010

Methods	Parallel group design Randomised by selecting allocation from a hat Analysed on an intention-to-treat basis Treatment was delivered in 1 hour classes twice a week for 10 weeks Assessed in the week prior to start of treatment, the week following completion of 10 week treatment and 4 weeks after completion of treatment Assessors were blinded
Participants	19 participants in the partnered tango group, 20 in the non-partnered tango group. 7 dropouts in partnered group, 5 in non-partnered group Participants mean age 69.6 years in both groups; Male/female ratio 13/6 (partnered), 15/5 (non-

	partnered); Mean Hoehn and Yahr 2.5 (partnered) 2.0 (non-partnered); Duration of condition 9.5 years (partnered), 7.9 years (non-partnered) Inclusion criteria: PD without a history of other neurological deficits, at least 40 years of age, able to stand for at least 30 minutes and walk independently for 3 or more metres with or without an assistive device, diagnosis of IPD Hoehn and Yahr stages I-III using diagnostic criteria for clinically defined 'definite PD' and demonstrated clear benefit from L-dopa. Exclusion criteria not stated
Interventions	Both partnered and non-partnered groups began with identical warm-ups to upbeat latin music. After warm-up both classes listened to and danced to identical commercial tango music selections in the same order of presentation Partnered: both sexes spent equal time leading and following dance steps, performed in a 'closed practice' position, an adaptation of the traditional ballroom frame. Participants with PD always danced with individuals without PD. These individuals included caregivers and loved ones who elected to participate in classes as well as young adult volunteers Non-partnered: learned the same Argentine 'leading' and 'following' tango-based steps as the partner group but performed them without a partner. Caregivers, loved ones and volunteers participated in the nonpartner class also Participants remained on a steady drug regimen throughout the study
Outcomes	Tandem stance One leg stance Timed up and go 6 minute walk test Gait velocity Cadence Stride length Swing percentage Double support percentage
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Eligibility Criteria	Low risk	Inclusion criteria stated
Randomisation Method	High risk	Randomised by selecting allocation from a hat
Concealment of Allocation	High risk	Randomised by selecting allocation from a hat
Similarity at Baseline	Low risk	Group characteristics similar at baseline
Intention to Treat Analysis	Unclear risk	Analysed on an intention-to-treat basis
Withdrawals Described	High risk	Withdrawals at 31%

Hackney 2010 (*Continued*)

Cointerventions Constant	Low risk	Participants remained on a steady drug regimen throughout the study
Comparable arms	Low risk	Same time and attention given to participants in both arms
Blinded Assessors	Low risk	Assessors were blinded

Hass 2006

Methods	Parallel group design Randomisation method not stated Analysis method not stated Treatment delivered in 1 hour sessions twice a week for a total of 32 sessions Assessment intervals not stated Investigators were blinded
Participants	23 participants were recruited into the study. Number of dropouts was not stated Baseline characteristics for groups not stated. Total mean age 67 years; Hoehn Yahr 2.2 Inclusion criteria: IPD. Exclusion criteria not stated.
Interventions	Tai Chi: Emphasised physical movements, mind/body coordination & meditation. 8 forms of Tai Chi performed in sessions Qi-gong: Emphasised prolonged intense contemplative or deep meditation in 2 postures, seated or lying supine on floor mats It was not stated whether drug therapy was kept constant during the trial
Outcomes	Gait initiation Gait velocity Stride length Stance Double limb support Step duration
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Eligibility Criteria	Unclear risk	Inclusion criteria IPD only
Randomisation Method	Unclear risk	Method not stated
Concealment of Allocation	Unclear risk	Method of randomisation not stated
Similarity at Baseline	Unclear risk	Baseline characteristics not split by group

Hass 2006 (*Continued*)

Intention to Treat Analysis	Unclear risk	Method of analysis not stated
Withdrawals Described	Unclear risk	Withdrawals not described
Cointerventions Constant	Unclear risk	Not stated whether drug therapies were kept constant throughout trial period
Comparable arms	Low risk	Same time and attention given to participants in both arms
Blinded Assessors	Low risk	Single blind study

Hirsch 1996

Methods	Parallel group design Randomised according to a computer generated random number list but concealment of allocation not stated Analysed on a per protocol basis Treated as outpatients for an unspecified period of time (3 days/week) for 10 weeks Assessed at baseline, immediately after treatment and 4 weeks later Assessors were not blinded
Participants	6 patients in novel combined balance and resistance training group and 9 patients in balance training group. No dropouts stated. Patients mean age 70.8 years (combined), 75.7 years (balance); Male/female ratio not stated; Hoehn and Yahr 1.8 (combined), 1.9 (balance); Duration of condition 5.5 years (combined), 8.3 years (balance). Inclusion criteria: Diagnosed with IPD by neurologist, not participated in any organised balance or muscle strengthening activities before being pre-tested, ambulatory, not acutely ill, able to follow simple commands, not suffering from unstable cardiovascular disease. Exclusion criteria: Uncontrolled chronic conditions that would interfere with safety and conduct of the training and testing
Interventions	Combined: Group training in strengthening and balance exercises. Resistance exercises used Nautilus leg extension and side-lying leg-flexion machines and therabands. Balance training consisting of gentle sternal or dorsal perturbation and leaning movements designed to enhance limit of stability whilst standing on a firm or a compliant surface. Balance: 'standard' group balance therapy as described above. Medications kept stable throughout trial period.
Outcomes	Balance Muscle strength (subset) : knee extensors, knee flexors, ankle plantar flexors Latency to fall % of trials resulting on falls
Notes	Randomisation violation; 1 patient who was allocated to the combined therapy group was reassigned to the balance group after 2 weeks of training due to an inguinal hernia making it impossible for him to carry out the strength training

Hirsch 1996 (*Continued*)

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Eligibility Criteria	Low risk	Inclusion and exclusion criteria stated
Randomisation Method	Low risk	Computer generated random number list
Concealment of Allocation	Unclear risk	Method not stated
Similarity at Baseline	Low risk	Group characteristics similar at baseline
Intention to Treat Analysis	Unclear risk	Per protocol analysis
Withdrawals Described	Low risk	13% withdrawal rate for muscle strength outcomes only
Cointerventions Constant	Low risk	Medications kept stable throughout trial period
Comparable arms	Low risk	Same time and attention given to participants in both arms
Blinded Assessors	High risk	Assessors not blinded

Joudoux 2011

Methods	Parallel group design Randomisation method not stated Analysis method not stated Treated for 3 weekly 1 hour sessions for 8 weeks Assessed at baseline, after treatment and after 3 months follow-up Not stated whether assessors were blinded
Participants	50 participants recruited, group split not stated. Dropouts not stated Patients baseline characteristics not stated. Inclusion criteria: Mild to moderate PD (Hoehn and Yahr II-III). Exclusion criteria not stated
Interventions	Assymmetric motor training Program: Designed to enhance only the agonist activity of the 'body openers' i.e. extension/supination/abduction/external rotation - which is more reduced than their antagonist activity of flexion/protonation/adduction/internal rotation in PD - aiming at re-balancing forces around joints Broad program: Standard techniques of passive and active joint mobilisations, balance and gait training, relaxation techniques and respiratory techniques and respiratory work Not stated whether drug regimen remained constant throughout trial period
Outcomes	UPDRS III GMT score

Joudoux 2011 (*Continued*)

	Rapid alternating movements Hand writing and spiralography PDQ-39 Dpression (GDS-15) Video recording of 8 activities of daily living and biomechanical evaluations
Notes	Abstract only

Risk of bias

Bias	Authors' judgement	Support for judgement
Eligibility Criteria	Unclear risk	Inclusion and exclusion criteria stated
Randomisation Method	Unclear risk	Method not stated
Concealment of Allocation	Unclear risk	Randomisation method not stated
Similarity at Baseline	Unclear risk	Group characteristics not stated
Intention to Treat Analysis	Unclear risk	Method of analysis not stated
Withdrawals Described	Unclear risk	No dropouts described
Cointerventions Constant	Unclear risk	Not stated whether drug regimen remained constant throughout trial period
Comparable arms	Low risk	Same time and attention given to participants in both arms
Blinded Assessors	Unclear risk	Not stated whether assessors were blinded

Juncos 2006

Methods	Parallel group design Method of randomisation not stated Analysed on an intention-to-treat basis Treated for 6 months Assessed at baseline then monthly and after last training session Assessors were blinded
Participants	56 participants were randomised into Aerobic exercise (AE), Tai Chi Chung (TCC) or Qi Gong (QG) groups. 16 dropouts in total. Group splits not stated Baseline characteristics for groups not stated. Total mean age 65 years Inclusion criteria: Ambulatory subjects with IPD, stable medication regimen, MMSE > 24/30. Exclusion criteria not stated

Juncos 2006 (*Continued*)

Interventions	AE: Moderate intensity walk-run program with moderate caloric expenditure TCC: Intermediate intensity to that of AE, low caloric expenditure QG: Meditation in stillness, minimal caloric expenditure. Drugs stable during therapy.
Outcomes	UPDRS total UPDRS motor UPDRS ADL PDQ-39 Clinical global impression Walking speed Falls
Notes	Abstract and trial registration only

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Eligibility Criteria	Low risk	Inclusion criteria stated
Randomisation Method	Unclear risk	Method not stated
Concealment of Allocation	Unclear risk	Method of randomisation not stated
Similarity at Baseline	Unclear risk	Hoehn and Yahr not stated
Intention to Treat Analysis	Unclear risk	Intention-to-treat analysis used
Withdrawals Described	High risk	Withdrawals to 29%
Cointerventions Constant	Low risk	Drugs stable during therapy
Comparable arms	Low risk	Same time and attention given to both groups
Blinded Assessors	Low risk	Assessors were blinded

Khallaf 2011

Methods	Parallel group design Randomisation method not stated Analysis method not stated Treatment dose not stated Assessment intervals not stated Not stated whether assessors were blinded

Khallaf 2011 (*Continued*)

Participants	15 participants in Physiotherapy and treadmill group (PT + T) and 15 in Physiotherapy only group (PT). Dropouts not described Participant baseline characteristics not stated. Inclusion/exclusion criteria not stated.
Interventions	PT + T: Designed physiotherapy program in addition to 20 min of treadmill training PT: Designed physiotherapy program only. Not stated whether drug therapies were kept constant throughout trial period
Outcomes	UPDRS II and III Hamilton rating scale of depression Walking speed Walking distance
Notes	Abstract only, no contact details found for author

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Eligibility Criteria	Unclear risk	Inclusion criteria not stated
Randomisation Method	Unclear risk	Method not stated
Concealment of Allocation	Unclear risk	Method of Randomisation not stated
Similarity at Baseline	Unclear risk	Participant baseline characteristics not stated
Intention to Treat Analysis	Unclear risk	Method of analysis not stated
Withdrawals Described	Unclear risk	Dropouts not described
Cointerventions Constant	Unclear risk	Not stated whether drug therapies were kept constant throughout trial period
Comparable arms	Unclear risk	No details of intervention schedules
Blinded Assessors	Unclear risk	Not stated whether assessors were blinded

Li 2012

Methods	Parallel group design Randomised by permuted blocks, allocation delivered in sealed envelopes Analysed on an intention-to-treat basis Treatment delivered in 2 sessions per week each lasting an hour over 24 weeks Assessed at baseline and post intervention (at 6 months) and at 3 months follow-up Assessors were blinded
Participants	65 participants in Tai Chi group, 65 in resistance group, 65 in the stretching group. 9 dropouts in Tai Chi group, 6 in resistance group, 4 in stretching group Participants mean age 68 years (Tai Chi), 69 years (resistance), 69 years (stretching); Male/female ratio 45/20 (Tai Chi), 38/27 (resistance), 39/26 (stretching); Mean Hoehn and Yahr not given; Duration of condition 8 years (Tai Chi), 8 years (resistance), 6 years (stretching) Inclusion criteria: Clinical diagnosis of PD, aged 40 - 85 years, Hoehn and Yahr stage I - IV, at least one score of at least 2 or more for at least one limb for the tremor, rigidity, postural stability or bradykinesia items in the motor section of the UPDRS, stable medication use, ability to stand unaided and walk with or without an assistive device, medical clearance for participation and willingness to be assigned to any of the three interventions. Exclusion criteria: Current participation in any other behavioural or pharmacologic study or instructor led exercise program, a MMSE score lower than 24, debilitating conditions or vision impairment that would impede full participation in the study, unavailability during the study period
Interventions	Tai Chi: Six Tai Chi movements integrated into an eight-form routine. The protocol was specifically designed to tax balance and gait by having participants perform symmetric and diagonal movements, such as weight shifting, controlled displacement of the centre of mass over the base of support, ankle sways an anterior -posterior and lateral stepping. The first 10 weeks emphasized the mastery of single forms through multiple repetitions; later weeks focused on repetitions to enhance balance and increase locomotion. Natural breathing was integrated into the training routine Resistance: Focused on strengthening the muscles that are important for posture, balance and gait. Resistance (with weighted vests and ankle weights) was introduced at week 10. Weight vest resistance was initially set at 1% of body weight and was increased by approx. 1 to 2% of body weight, depending on each participants tolerance, every fifth week until 5% of body weight was achieved. Ankle weights started at 0.45 Kg per limb and were gradually increased to 1.36 Kg. the routine involved 8 to 10 exercises, including forward and side steps, squats, forward and side lunges, and heel and toe raises, performed in 1 to 3 sets of 10 to 15 repetitions. Progression was modified for participants with physical limitations. Natural breathing was emphasized during the training routine Stretching: This control condition was designed to provide a low intensity exercise program with the social interaction and enjoyment inherent in the two other interventions but without similar training benefits in lower-extremity weight bearing, strength or balance. The core activities encompassed a variety of seated and standing stretches involving the upper body (neck, upper back, shoulders, chest and arms) and lower extremities (quadriceps, hamstrings, calves and hips) with the use of gentle joint extension and flexion and trunk rotation. Abdominal breathing with an emphasis on inhaling and exhaling to maximum capacity and relaxation of major muscle were also included There were no significant changes reported in outside physical activity or use of anti-parkinsonian medication
Outcomes	Two indicators of postural stability: maximum excursion and directional control Stride length Walking velocity Strength of bilateral knee extensors and flexors Functional reach test

Li 2012 (*Continued*)

	Timed up and go UPDRS III Number of falls
Notes	122/195 participants continued with their exercise out to 3 month follow-up so this is not a clean follow up comparison Stretching arm classed as attention control and not included in this review

Risk of bias

Bias	Authors' judgement	Support for judgement
Eligibility Criteria	Low risk	Inclusion and exclusion criteria stated
Randomisation Method	Unclear risk	Permuted blocks
Concealment of Allocation	High risk	Sealed envelopes used
Similarity at Baseline	Unclear risk	Mean Hoehn and Yahr not given
Intention to Treat Analysis	Low risk	Intention-to-treat analysis used
Withdrawals Described	Low risk	Withdrawals <10%
Cointerventions Constant	Unclear risk	No significant change in medications
Comparable arms	Low risk	Same time and attention given to each group
Blinded Assessors	Low risk	Assessors blinded

Loureiro 2010

Methods	Parallel group design Randomisation method not stated Analysis method not stated Treatment delivered in 2 sessions per week over 6 weeks Assessment intervals not stated Not stated whether assessors were blinded
Participants	6 participants in conventional physiotherapy (Physio) group, 6 in complimentary activities (CA) group Mean age 57 (Physio group), 65 (CA group). Inclusion criteria: Hoehn and Yahr II-III. Exclusion criteria not stated
Interventions	Physio: Conventional physiotherapy. CA: Wii fit in addition to conventional physiotherapy. Not stated whether the drug therapy was constant during trial

Loureiro 2010 (*Continued*)

Outcomes	Timed up and go Anterior functional reach
Notes	Abstract only

Risk of bias

Bias	Authors' judgement	Support for judgement
Eligibility Criteria	Low risk	Inclusion criteria stated
Randomisation Method	Unclear risk	Method not stated
Concealment of Allocation	Unclear risk	Method of randomisation not stated
Similarity at Baseline	Unclear risk	Hoehn and Yahr not stated
Intention to Treat Analysis	Unclear risk	Method of analysis not stated
Withdrawals Described	Unclear risk	Dropouts not described
Cointerventions Constant	Unclear risk	Not stated whether drug therapies were kept constant throughout trial period
Comparable arms	Low risk	Same time and attention given to participants in both arms
Blinded Assessors	Unclear risk	Not stated whether assessors were blinded

Mak 2008

Methods	Parallel-group design Participants randomly allocated to groups by drawing lots Method of analysis not described Treated as outpatients for 4 hours (audio-visual), 6 hours (exercise) over 4 weeks Assessed at baseline, at 2 weeks, immediately after and 2 weeks after treatment had ended Assessor was blinded
Participants	21 participants in the cueing group, 21 participants in the exercise group and 18 in the control group. 2 dropouts from the cueing group, 2 from the exercise group and 4 from the control group No baseline characteristics given for drop-outs. Participants' mean age 63 (cueing), 66 (exercise), 63 (control). No data given for the sex of participants. Hoehn and Yahr stage 2.8 (cueing), 2.7 (exercise) and 2.7 (control). Duration of PD 5.9 years (cueing), 6.1 years (exercise), 5.9 years (control) Inclusion criteria: diagnosed with PD according to Quinn, stable on anti-PD medications without dyskinesia, orthopaedic, arthritic or heart problems, aged between 50-75 years old, perform sit to stand independently, can follow instructions. No exclusion criteria stated

Interventions	Cueing: Audio-visual cued task-specific training for 20 min three times per week. Received cued sit-to-stand training using Equitest-Balance Master. Visual cue was given on a computer screen with verbal command as auditory cue. Each task lasted 2 min, repeated once with a 30 second rests in between Exercise: 45 min of conventional exercise twice a week. Conventional mobility and strengthening exercises for flexors and extensors of trunk, hips, knees and ankles followed by sit-to-stand practice Control: No treatment. Drugs stable during therapy.
Outcomes	Peak horizontal velocity Peak vertical velocity Movement time 3D Kinematics data of sit-to-stand Not stated when during the day tests took place
Notes	Control group not included in this review

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Eligibility Criteria	Low risk	Inclusion criteria stated
Randomisation Method	High risk	Participants randomised by drawing lots
Concealment of Allocation	High risk	Participants randomised by drawing lots
Similarity at Baseline	Low risk	Group characteristics similar at baseline
Intention to Treat Analysis	Unclear risk	Method of analysis not stated
Withdrawals Described	High risk	Withdrawals at 13%
Cointerventions Constant	Low risk	Medications kept stable throughout trial period
Comparable arms	Low risk	Same time and attention given to participants in both arms
Blinded Assessors	Low risk	Assessors blinded

McGinley 2012

Methods	Parallel group design Method of randomisation not stated Analysed on an intention-to-treat basis Treated as outpatients for a 2 hour session once per week for 8 weeks plus home practice Assessed at baseline, one week after intervention, at 3 months and 12 months after intervention Assessors blinded.
Participants	69 participants in Movement strategy training group (MST), 70 in Progressive strength training group (PST), 71 in Life-skills control group (LS). 14 dropouts prior to post-intervention time point Baseline characteristics not split by group. Participants mean age 67.9 years; Male/female ratio 140/70; Hoehn and Yahr mean score not stated; Duration of condition 6.7 years Inclusion criteria: Confirmed Idiopathic Parkinson's disease, Hoehn & Yahr stages 0-4, able to participate in an outpatient exercise program including strength training, willing to complete a falls calendar for 12 months after therapy, able to walk, willing and able to attend the therapy and assessment program. Exclusion criteria: Score less than 24 on mini-mental state examination, rating greater than 4 on the modified Hoehn & Yahr scale, on major tranquillisers, other medical conditions that could limit or prevent exercising safely at the required intensity, other prior neurological conditions affecting and dementia
Interventions	MST: Movement strategies emphasise task specific practice of everyday functional actions such as rolling over, standing up, walking, crossing obstacles and turning. These tasks are practised with strategies such as visual or auditory cues, mental rehearsal and movement planning, conscious attention during the task and breaking the task into a sequence of smaller components. The program is tailored to movement impairments, activity limitations, and cognitive status and learning ability An individualised home practice session of strategies to practice within the home or community will be completed once a week. Structured falls risk education will also be provided each week. A single home visit will be conducted by a trained therapist or nurse to check compliance with the therapy program PST: Strengthening exercises for quadriceps, hip and trunk extensor muscles, hip abductors, calf, and ankle dorsiflexors, tailored to individual's strength and functional ability. Where possible training is performed in functional tasks such as standing up from a chair, stepping up onto a step etc, using body weight, weighted vests and Thera-band® to progress the resistance. Structured falls risk education will be provided each week. An individualised home practice session of strengthening exercises will also be completed once a week. A single home visit will be conducted by a trained therapist or nurse to check compliance with the therapy program LS: Equivalent duration to the MST and PST groups. Each session led by OTs, PTs, Speech pathologists or social workers and included content such as relaxation, games, or communication activities. Guided discussion. Guided discussion will also include topics such as the impact of PD on the individual and family, support and resources available and fatigue management. None of the content will relate to walking, balance or falls risk education. A home session of reflection activities and relaxation practice will also be completed once per week Not stated whether the drug therapy was constant during treatment
Outcomes	Falls: no. of fallers per group, no. of multiple fallers per group, falls rate over 12 months in each group Number of injurious falls Walking speed 6 minute walk test Timed up and go UPDRS II and III PDQ-39 EuroQol-5D

McGinley 2012 (*Continued*)

Notes	LS arm not included in this review	
Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Eligibility Criteria	Low risk	Inclusion and exclusion criteria stated
Randomisation Method	Unclear risk	Method not stated
Concealment of Allocation	Unclear risk	Method of randomisation not stated
Similarity at Baseline	Unclear risk	Baseline characteristics not split into groups
Intention to Treat Analysis	Low risk	Analysed on an intention-to-treat basis
Withdrawals Described	Low risk	Withdrawals at 7% for post-intervention time point
Cointerventions Constant	Unclear risk	Not stated whether the drug therapy was constant during treatment
Comparable arms	Low risk	Same time and attention given to participants in each physio group
Blinded Assessors	Low risk	Assessors were blinded

Miyai 2000

Methods	Cross-over design Randomisation using the envelope method Analysed on an intention-to-treat basis Inpatients treated for 12 sessions, each lasting 45 minutes, over 4 weeks Assessed at baseline, after first set of treatment at 4 weeks and after second set of treatment at 8 weeks Assessors were not blinded
Participants	5 participants in body-weight supported treadmill training (BWSTT) and 5 in conventional physiotherapy (PT). No dropouts described Participants mean age 66 years (BWSTT), 69.3 years (PT); Male/female ratio 2/3 (BWSTT), 3/2 (PT) ; Hoehn and Yahr 2.8 (BWSTT), 2.9 (PT); Duration of condition 4.9 years (BWSTT), 3.6 years (PT) Inclusion criteria: Hoehn and Yahr stage 2.5 or 3 Parkinson's disease, no dementia MMSE >27. Exclusion criteria not stated
Interventions	BWSTT: Walking with 20% bodyweight support (BWS) for 12 minutes, then 4.5 minutes rest, followed by 10% BWS for 12 minutes, another 4.5 minutes rest and finally 12 minutes walking with 0% BWS. Walking speed started at 0.5 km/hr and was ramped up in 0.5 km/hr increments to 3.0 km/hr as tolerated PT: General conditioning, range of motion exercise, activities of daily living training and gait training

Miyai 2000 (*Continued*)

	Drug therapy was stable during trial period.
Outcomes	UPDRS UPDRS subscales (mental, ADL, motor and complications) Overground ambulation endurance Gait speed No. steps taken for 10 metre walk
Notes	Pre-crossover data only used

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Eligibility Criteria	Low risk	Inclusion criteria stated
Randomisation Method	Unclear risk	Method not stated
Concealment of Allocation	High risk	By the envelope method
Similarity at Baseline	Low risk	Group characteristics similar at baseline
Intention to Treat Analysis	Low risk	Analysed on an intention-to treat basis
Withdrawals Described	Low risk	No withdrawals
Cointerventions Constant	Low risk	Drug therapy was stable during therapy period
Comparable arms	Low risk	Same time and attention given to participants in both arms
Blinded Assessors	High risk	Assessors were not blinded

Miyai 2002

Methods	Parallel group design Randomisation was the envelope method Analysed on an intention-to-treat basis Treatment delivered for 12 sessions over 1 month, sessions lasted 45 minutes Assessed at baseline, at 1 month, 2 months, 3 months, 4 months, 5 months and 6 months Assessors were not blinded
Participants	11 participants in body-weight supported treadmill training (BWSTT) group and 9 in conventional physiotherapy (PT) group. 4 participants not analysed due to changes in their medication Participants mean age 69.5 years (BWSTT), 69.8 years (PT); Male/female ratio 5/6 (BWSTT), 5/4 (PT); Hoehn and Yahr 2.9 (BWSTT), 2.8 (PT); Duration of condition 4.1 years (BWSTT), 4.5 years (PT). Inclusion criteria: Diagnosis of Parkinson's disease based on the presence of rest tremor, bradykinesia,

Miyai 2002 (*Continued*)

	rigidity, positive response to l-dopa and no evidence of vascular lesions on MRI. Hoehn and Yahr stage 2.5 or 3. Exclusion criteria: Dementia, MMSE <27
Interventions	BWSTT: Walking with 20% bodyweight support (BWS) for 12 minutes, then 4.5 minutes rest, followed by 10% BWS for 12 minutes, another 4.5 minutes rest and finally 12 minutes walking with 0% BWS. Walking speed started at 0.5 km/hr and was ramped up in 0.5 km/hr increments to 3.0 km/hr as tolerated PT: General conditioning, range of motion exercise, activities of daily living training and gait training Changes in medication not allowed. Participants who changed their medication were excluded
Outcomes	UPDRS UPDRS subscales (mental, ADL, motor and complications) Gait speed No. steps taken for 10 metre walk
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Eligibility Criteria	Low risk	Inclusion and exclusion criteria stated
Randomisation Method	Unclear risk	Method not stated
Concealment of Allocation	High risk	Envelope method used
Similarity at Baseline	Low risk	Group characteristics similar at baseline
Intention to Treat Analysis	Unclear risk	Analysed on an intention-to-treat basis
Withdrawals Described	High risk	Withdrawals at 17%
Cointerventions Constant	Low risk	Changes in medication not allowed. Participants who changed their medication were excluded
Comparable arms	Low risk	Same time and attention given to participants in both arms
Blinded Assessors	High risk	Assessors were not blinded

Morris 2009

Methods	Parallel group design Randomised using generated random number sequences by an independent university source Method of analysis not stated Treated as inpatients for 2 weeks in 16 sessions each lasting 45 minutes Assessed at baseline, immediately after treatment and at 3 months Assessors were blinded
Participants	14 participants in movement strategies (MS) group and 14 in exercise (Ex) group. 2 participants missing from follow-up in exercise group Participants mean age 68 years (MS), 66 years (Ex); Male/female ratio, disease severity and duration for groups were not stated Inclusion criteria: Aged 21 -80 years, medically stable, diagnosis of IPD confirmed by a neurologist, >23 MMSE with a minimum of 2 out of 3 on the recall question, Hoehn & Yahr II or III, able to walk 10 metres 3 times without assistance. Exclusion criteria: Unsafe to participate in the therapy programs
Interventions	MS: Learn how to use cognitive strategies such as focusing their attention on movement and responding to external cues to enhance walking, turning, standing up from a chair and obstacle negotiation. Based on principles of Victorian comprehensive Parkinson's disease program Ex: Lower limb and trunk strengthening exercises, spinal and lower limb flexibility exercises and receiving feedback on optimal postural alignment for a range positions Not stated whether the drug therapy was constant during treatment
Outcomes	UPDRS Motor UPDRS ADL 10 m walk test Timed up and go 2 min walk test Balance-shoulder tug PDQ-39
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Eligibility Criteria	Low risk	Inclusion and exclusion criteria stated
Randomisation Method	Low risk	Randomised using generated random number sequences by an independent university source
Concealment of Allocation	Low risk	Randomised using generated random number sequences by an independent university source
Similarity at Baseline	Unclear risk	Only average age of groups given
Intention to Treat Analysis	Unclear risk	Method of analysis not stated
Withdrawals Described	Low risk	Withdrawals at 7%

Morris 2009 (*Continued*)

Cointerventions Constant	Unclear risk	Not stated whether the drug therapy was constant during treatment
Comparable arms	Low risk	Same time and attention given to participants in both arms
Blinded Assessors	Low risk	Assessors were blinded

Palmer 1986

Methods	Parallel group design Randomised in pairs matched for stage of disease, sex and age, method not stated Method of analysis not stated Treated as outpatients for 12 weeks in 1 hour sessions 3 times per week Assessed at baseline and immediately after therapy Assessors were blinded
Participants	7 participants in United Parkinson Foundation (UPF) exercise program, 7 in upper body karate (UBK) training program. No dropouts were described Participants mean age 63.9 years (UPF), 65.9 years (UBK); Male/female ratio not stated; Hoehn and Yahr 2.4 (UPF), 2.4 (UBK); Duration of condition not stated Inclusion criteria: IPD, stabilization on a regimen of pharmacologic therapy, ability to attend the scheduled evaluation and exercise sessions. Exclusion criteria: Physical problems that might cause them to risk injury during exercises
Interventions	UPF: Stretch exercises from the UPF exercise program led by a corrective therapist UBK: Trained in upper body Karate techniques by a rehabilitation nursing student who had a black belt in karate. All karate was done in a seated position. Each session consisted of approximately 15 mins warm-up stretching exercises, 35 mins karate training and 10 mins cool down stretching exercises Drug therapy was stable during therapy period.
Outcomes	Forearm pronation/supination rate Pursuit score walk index Degree of activated rigidity Degree of arm tremor Activated rigidity Grip strength 9-hole peg test Minnesota placing and turning test Arm swings test Rapid alternating arm movement test Button board Putting shirt on and off Putting shoes and socks on and off Getting up from chair Long latency stretch response
Notes	

Palmer 1986 (*Continued*)

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Eligibility Criteria	Low risk	Inclusion and exclusion criteria stated
Randomisation Method	Unclear risk	Method not stated
Concealment of Allocation	Unclear risk	Randomisation method not stated
Similarity at Baseline	Low risk	Group characteristics similar at baseline
Intention to Treat Analysis	Unclear risk	Method of analysis not stated
Withdrawals Described	Low risk	No withdrawals
Cointerventions Constant	Low risk	Drug therapy was stable during therapy period
Comparable arms	Low risk	Same time and attention given to participants in both arms
Blinded Assessors	Low risk	Assessors were blinded

Pelosin 2010

Methods	Parallel group design Randomised by computerised random-number generator performed by an independent researcher Method of analysis not stated Treated as outpatients for 4 weeks with hour long sessions delivered 3 times per week Assessed at baseline, 2 days after completion of all therapy sessions and 4 weeks later Assessors were blinded
Participants	9 participants in action group, 9 in landscape group. 2 additional patients were recruited but excluded due to past history of neurological conditions other than PD. No dropouts described Participants mean age 68.8 years (action), 70.2 years (landscape); Male/female ratio not stated; Hoehn & Yahr 2.1 (action), 2.2 (landscape); Duration of condition 11.6 years (action), 9.5 years (landscape) Inclusion criteria: IPD according to the UK PDS BB criteria. All on stable medication regime. Mobile despite occurrence of freezing at least once a week (minimum score of 2 on item 3 of the FOG questionnaire) and for at least 2s (minimum score of 1 on item 4 of FOG-Q). MMSE > 24. Exclusion criteria not stated
Interventions	Action: Instructed to carefully watch 6 video clips (each clip lasting 6 mins) showing strategies useful in circumventing FOG episodes. During each training session 2 video clips (with different sequences of actions) were presented twice. The complexity of movements progressively increased from simple actions to more complex movements. All actions shown in the video clips were performed by a physical therapist. To ensure proper attention during the video presentation, patients were explicitly asked to concentrate on how the actions were performed and were not allowed to imitate any movement. After video clip observation, patients were asked to practice (for the remaining time of the session-36 min)

	the observed actions repetitively and accurately according to the instructions of the physical therapist Landscape: Matched the experimental protocol, with the exception that during each training sessions they watched 2 video clips (presented twice) containing sequences of static pictures of mountains and seaside, countryside, and desert scenes without any living (human or animal) representations. During training sessions, patients in the landscape group performed the same movements/ actions used for the Action group following the physical therapist's instructions, in the exact order and for the same amount of time Drug therapy was stable during trial period.
Outcomes	FOG Questionnaire and FOG diary Timed up and go 10 metre walking test Tinetti scale part I and II Berg balance scale PDQ-39
Notes	Only data for FOG could be extracted from paper

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Eligibility Criteria	Low risk	Inclusion criteria stated
Randomisation Method	Low risk	Randomised by computerised random-number generator
Concealment of Allocation	Low risk	Randomisation performed by an independent researcher
Similarity at Baseline	Low risk	Group characteristics similar at baseline
Intention to Treat Analysis	Unclear risk	Method of analysis not stated. ITT was not used
Withdrawals Described	Low risk	Withdrawals at 10%
Cointerventions Constant	Low risk	Drug therapy was stable during trial period
Comparable arms	Low risk	Same time and attention given to participants in both arms
Blinded Assessors	Low risk	Assessors were blinded

Picelli 2012

Methods	Parallel group design Participants randomised using list, generated by www.randomisation.com kept in locked desk draw Analysed on a per protocol basis Treated as outpatients for 45 minute sessions, 3 times per week for 4 weeks Assessed at baseline, post intervention, and 1 month after treatment Assessors were blinded
Participants	21 participants in Robot assisted gait-training group (RAGT) and 20 participants in physiotherapy group (PT). 3 dropouts in RAGT group and 2 in PT group Participants' mean age 68.1 years (RAGT), 68.7 years (PT). Male/female ratio, 10/8 (RAGT), 6/12 (PT). Hoehn and Yahr 2.7 (RAGT), 2.7 (PT). Duration of PD 6.6 years (RAGT), 7.4 years (PT). Baseline data not given for drop-outs Inclusion criteria: Confirmed PD, Hoehn and Yahr score 2.5 or 3, MMSE score > 23. Exclusion criteria: Severe dyskinesias of "on-off" phases, change of PD medications during the study, deficits of somatic sensation in the lower limbs, vestibular disorders or paroxysmal vertigo, other neurological orthopaedic conditions involving the lower limbs and cardiovascular comorbidity
Interventions	RAGT: 2 motor driven footplates positioned on 2 bars that provide a Robot assisted propulsion by means of a planetary gear system, simulating stance and swing with a ratio of 60% to 40% between the two phases. A progressive reduction of body weight combined with an increase in gait speed. Each training session consisted of 3 parts (each one lasting 10 minutes), with a 5-minute rest after each of them. Patients were first trained at 20% of body weight supported and at a speed of 1 km/h for 10 minutes; then at 10% of body weight supported and a speed of 1.3 km/hr for 10 mins; and finally, at 0% of body weight supported and a speed of 1.6 km/hr for 10 mins. Patients were instructed to "help" the gait trainer (GT1) gait-like movement during training. Any patient unable to maintain the chosen pace was excluded from the study PT: Program included active joint mobilization and conventional gait training. Each treatment session consisted of 2 parts with a 5-minute rest between them. First patients performed active joint mobilization of the lower limbs (hip, knee and ankle) in the supine and prone positions (10 repetitions of 6 exercises) for 10 minutes (5 minutes per position). Then they performed conventional gait therapy based on the proprioceptive neuromuscular facilitation (PNF) concept for 30 minutes. Among the PNF techniques we facilitated pelvic motion to improve control of the pelvis as a "key point of control" for maintaining a gait pattern. Conventional gait therapy consisted of 10 minutes each of rhythmic initiation, slow reversal and agonistic reversal exercises applied to the pelvic region. The time spent in PNF was equal to that spent in RAGT. The same trained therapist treated all the patients in this group and standardized the duration of each part of the treatment No changes in medications as this was a criterion for exclusion
Outcomes	10 m walk test 6 min walk test Spatiotemporal gait parameters including stride length Parkinson's fatigue scale UPDRS Total
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement

Picelli 2012 (*Continued*)

Eligibility Criteria	Low risk	Inclusion and exclusion criteria stated
Randomisation Method	Low risk	List generated using www.randomization.com
Concealment of Allocation	High risk	List kept by principal investigator
Similarity at Baseline	Low risk	No significant difference between groups
Intention to Treat Analysis	Unclear risk	Per protocol analysis used
Withdrawals Described	High risk	Withdrawals at 12%
Cointerventions Constant	Low risk	No changes in medications as this was a criterion for exclusion
Comparable arms	Low risk	Same time and attention given to both groups
Blinded Assessors	Low risk	Assessors blinded

Poliakoff 2009

Methods	Parallel group design Randomisation method was done by drawing lots and placing allocations in two sets of sealed envelopes for high and low severity of Parkinson's disease Method of analysis was unclear Treatment delivered in two 1 hour sessions per week for 10 or 20 weeks Assessed at baseline, at 10 weeks and 20 weeks Assessors were not blinded
Participants	16 participants in 20 week gym group (gym), 16 in 10 week gym group (control). 4 dropouts from gym group and 6 dropouts from control group Participant mean age 66.6 years (gym), 63.7 years (control); Male/female ratio, 11/5 (gym), 10/6 (control); Hoehn and Yahr not stated; Duration of condition 7.4 years (gym), 4.7 years (control) Inclusion criteria: mild to moderate PD. Exclusion criteria: diagnosed with dementia, attendance of a group exercise class for Parkinson's disease, other neurodegenerative disease, >2weeks holiday booked during the study period
Interventions	20 Week: 20 week biweekly gym training programme at local leisure complex. 1 hours weekly training in the studio and 1 hour in the gym, each run by gym staff with experience of working with PD. Gym sessions consisted of mainly cardiovascular activity, studio sessions emphasised on gait and agility. The patients used external stimuli (such as music) and team working was encouraged 10 Week: 10 week programme as above starting 10 weeks after baseline assessment Not clear whether the drug therapy was constant during treatment
Outcomes	Simple, choice and serial reaction time Videotaped motor performance PDQ-39 UPDRS III

Poliakoff 2009 (*Continued*)

	Illness perceptions (BIPQ) Questionnaire assessing experiences of programme
Notes	Abstract and manuscript accepted for publication in Neurorehabilitation Data used from assessments at baseline and 20 weeks

Risk of bias

Bias	Authors' judgement	Support for judgement
Eligibility Criteria	Unclear risk	Characteristics of included patients described but not stated whether these items were used for the selection of patients for trial
Randomisation Method	High risk	Drawing lots
Concealment of Allocation	High risk	Drawing lots
Similarity at Baseline	Unclear risk	Limited baseline data
Intention to Treat Analysis	Unclear risk	Attempted to assess all participants regardless of whether they had started or completed intervention. ITT not used
Withdrawals Described	High risk	Withdrawals at 31%
Cointerventions Constant	Unclear risk	Not clear whether the drug therapy was constant during treatment
Comparable arms	Unclear risk	Half the amount of time and attention spent with delayed start group
Blinded Assessors	High risk	Assessors were not blinded

Reuter 2011

Methods	Parallel group design Randomisation was conducted using a computer generated sequence Method of analysis not stated Treatment delivered in 70 minute sessions 3 times per week for 6 months Assessed at baseline and post-intervention Assessors were blinded
Participants	30 participants in Nordic walking group (NW), 30 in walking group (W) and 30 in flexibility and relaxation group (FR). No dropouts from any group Participant mean age 62.0 years (NW), 63.0 years (W), 62.1 years (FR); Male/female ratio not stated; Hoehn & Yahr 2.5 (NW), 2.5 (W), 2.4 (FR); Duration of condition 5.3 years (NW), 6.0 years (W), 5.2 years (FR)

Reuter 2011 (*Continued*)

	Inclusion criteria: PD diagnosed using UKBB criteria assessed by movement disorder specialist, Hoehn and Yahr stage II-III. Exclusion criteria: Severe concomitant disease which limit physical performance, second neurological disease
Interventions	NW: Consisted of warming up including some flexibility and strength exercises with and without the poles. One session per week was dedicated to practising NW technique, the other sessions focused on endurance training. Participants were encouraged to increase the intensity of the training by walking faster or uphill and to increase the distance walked. Each training session finished with a cooling down programme. Training sessions took place in a park and a forest near to the university hospital W: Consisted of warming up, technique training, endurance training and cooling down. Instructors emphasised on arm swing and coordination of upper and lower limbs. One session per week included walking uphill to improve muscle strength FR: Performed flexibility exercises and relaxation training. The training focused on stretching, improving balance and range of movements. The flexibility and relaxation programme did not include aerobic exercises Medical treatment was optimised prior to study and minor changes were allowed in 5 patients during trial period
Outcomes	Max walking speed on treadmill 12 m and 24 m walking test Stride length Gait variability UPDRS PDQ-39 Physical activity in everyday life Adverse effects
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Eligibility Criteria	Low risk	Inclusion and exclusion criteria stated
Randomisation Method	Low risk	Computer generated sequence
Concealment of Allocation	Unclear risk	Method not stated
Similarity at Baseline	Low risk	No significant difference in baseline demographic data
Intention to Treat Analysis	Unclear risk	Analysis method not stated
Withdrawals Described	Low risk	No dropouts
Cointerventions Constant	Unclear risk	Minor changes in 5 patients

Reuter 2011 (*Continued*)

Comparable arms	Low risk	Same time and attention given to participants in both arms
Blinded Assessors	Low risk	Assessors were blinded

Ridgel 2009

Methods	Parallel group design Randomisation method not stated Method of analysis not stated Treatment delivered in 1 hour sessions, 3 times per week for 8 weeks Assessed at baseline, immediately after completion of treatment, and four weeks after completion of treatment Assessors blinded for UPDRS outcome only
Participants	5 participants in forced exercise group, 5 in voluntary exercise. No dropouts described Participants mean age 58 years (forced), 64 years (voluntary); Male/female ratio not stated; Hoehn and Yahr stage not stated; Duration of condition 7.9 years (forced), 4.4 years (voluntary) Inclusion criteria: IPD. Exclusion criteria not stated.
Interventions	Forced: Tandem stationary bicycle with trainer. Lower extremity forced exercise (FE) intervention using a stationary tandem bicycle. Patient's pedaling rate was increased to approximately 30% more than their preferred rate Voluntary: Exercise on a stationary single bicycle. Drug therapy was stable during trial period.
Outcomes	UPDRS part III Manual functional dexterity Bimanual dexterity Centre of pressure (CoP)
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Eligibility Criteria	Unclear risk	Criteria not stated
Randomisation Method	Unclear risk	Method not stated
Concealment of Allocation	Unclear risk	Method of randomisation not stated
Similarity at Baseline	Unclear risk	Hoehn and Yahr not stated
Intention to Treat Analysis	Unclear risk	Method of analysis not stated
Withdrawals Described	Low risk	Withdrawals at 10%

Ridgel 2009 (*Continued*)

Cointerventions Constant	Low risk	Drug therapy was stable during trial period
Comparable arms	Low risk	Same time and attention given to participants in both arms
Blinded Assessors	High risk	Assessors blinded for UPDRS outcome only

Robichaud 2012

Methods	Parallel group design Method of randomisation not stated Method of analysis not stated Treatment was delivered in 1 hour sessions twice per week for 24 months Assessed at baseline, 6, 12, 18 and 24 months Assessors were blinded
Participants	Number randomised not stated. 48 patients assessed at 6 months, down to 38 at 24 months. Group split not stated Group baseline characteristics not stated. Total mean age 59 years, total mean duration of condition 7 years Eligibility criteria not stated.
Interventions	Progressive resistance exercise: Weight lifting program. Fitness counts: Flexibility, balance and strengthening program Not stated whether the drug therapy was constant during treatment
Outcomes	UPDRS motor Timed up and go Berg balance scale Modified physical performance test
Notes	Abstracts and trial registrations only

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Eligibility Criteria	Unclear risk	Eligibility criteria not stated
Randomisation Method	Unclear risk	Method not stated
Concealment of Allocation	Unclear risk	Method of randomisation not stated
Similarity at Baseline	Unclear risk	Group baseline characteristics not stated
Intention to Treat Analysis	Unclear risk	Method of analysis not stated

Robichaud 2012 (*Continued*)

Withdrawals Described	High risk	21% lost between 6 and 24 months
Cointerventions Constant	Unclear risk	Not stated whether the drug therapy was constant during treatment
Comparable arms	Low risk	Same time and attention given to both groups
Blinded Assessors	Low risk	Assessors blinded

Schenkman 2012a

Methods	Parallel group design Randomised using computer generated assignments kept in opaque, sealed envelopes, unsealed by research assistant after baseline assessment Analysed on an intention-to-treat basis Treatment was delivered in 1 hour sessions, 3 times per week for the first 4 months then tapered for 1 month to once monthly sessions out to 16 months. Home exercise group received just once monthly supervised sessions throughout Assessed at baseline, 4 months, 10 months and 16 months Assessors blinded
Participants	39 participants in Flexibilty/balance/function exercise group (FBF), 41 in Aerobic exercise group (AE) and 41 in Home exercise group (HE) Participant mean age 64.5 years (FBF), 63.4 years (AE), 66.3 years (HE); Male/female ratio 24/15 (FBF), 26/15 (AE), 26/15 (HE); Hoehn and Yahr 2.3 (FBF), 2.2 (AE), 2.3 (HE); Duration of condition 4.9 years (FBF), 3.9 years (AE), 4.5 years (HE) Inclusion criteria: Primary PD diagnosed by a movement disorders specialist using the UKBBC, lived in the community, ambulated independently, Hoehn & Yahr stage II-III. Exclusion criteria: Uncontrolled hypertension, on-state freezing or exercise limitations from other disorders, MMSE<24
Interventions	FBF: Individualised spinal and extremity flexibility exercises followed by group balance/functional training. 2 months of flexibility training one-on-one with a physical therapist followed by 2 months of small group exercise (up to 6 participants) that included flexibility, balance and functional exercise AE: Treadmill, bike and/or elliptical trainer. Included 5-10 min of warm-up, 30 minutes exercise at 65% to 80% HR max and 5-10min of cool down. Participants were encouraged to use a treadmill but were permitted to use a stationary bicycle or elliptical trainer HE: Exercised at home using the National PD Foundation 'Fitness counts' program. Consisted of exercises in the home setting utilizing Fitness Counts with a single monthly group exercise session supervised by a physical therapist. Flexibility and strengthening exercises in sitting and standing. Daily walking (no specific guidelines) All participants regardless of group assignment were assisted to develop long term exercise habits. After randomisation and before beginning to exercise, participants met with their trainer to discuss motivation to exercise, potential barriers and strategies to develop exercise habits Participants were asked to record supervised and home exercise throughout the 16 months Drug therapy was kept constant for the first 4 months.

Schenkman 2012a (*Continued*)

Outcomes	Overall physical function Balance - functional reach Walking economy - VO_2 UPDRS ADL UPDRS Motor PDQ-39
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Eligibility Criteria	Low risk	Inclusion and exclusion criteria stated
Randomisation Method	Low risk	Computer generated assignment
Concealment of Allocation	High risk	Sealed envelopes
Similarity at Baseline	Low risk	Group characteristics similar at baseline
Intention to Treat Analysis	Unclear risk	Intention-to-treat analysis used
Withdrawals Described	High risk	Withdrawals at 21%
Cointerventions Constant	Unclear risk	Drug therapy kept constant for first four months only
Comparable arms	Unclear risk	HE group received less time and attention than experimental groups
Blinded Assessors	Low risk	Assessors were blinded

Shankar 2009

Methods	Parallel group design Randomisation method not stated Method of analysis not stated Treatment was delivered in 30 min sessions, twice a week for 8 weeks Assessed at baseline and at 2 months Assessors were blinded
Participants	10 participants in Treadmill with Cueing (TwC) group, 9 in Treadmill without Cueing (T) group and 10 in Cueing only (C) group. No dropouts described Baseline characteristics not stated for groups. Inclusion criteria: Moderate Parkinson's disease. No exclusion criteria

Shankar 2009 (*Continued*)

Interventions	TwC: Walking on the treadmill with music for 30 min twice a week. Music was selected based upon participant input and cadence-matched to the participant's preferred walking speed T: Walking on the treadmill without music for 30 min twice a week C: Listening to music for 30 min twice a week. Not stated whether the drug therapy was constant during trial
Outcomes	Gait and Balance Scale UPDRS III PDQ-39 Not stated when examinations took place
Notes	Abstract only

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Eligibility Criteria	Unclear risk	Criteria not stated
Randomisation Method	Unclear risk	Method not stated
Concealment of Allocation	Unclear risk	Method of randomisation not stated
Similarity at Baseline	Unclear risk	Baseline characteristics not stated
Intention to Treat Analysis	Unclear risk	Method of analysis not stated
Withdrawals Described	Unclear risk	Withdrawals not described
Cointerventions Constant	Unclear risk	Not stated whether the drug therapy was constant during trial
Comparable arms	Low risk	Same time and attention given to participants in both T and TwC arms
Blinded Assessors	Low risk	Assessors were blinded

Shen 2011

Methods	Parallel group design Randomisation method not stated Method of analysis not stated Treatment delivered over 12 weeks Assessed at baseline and immediately after training and at 12 weeks follow-up Assessors were blinded

Participants	23 participants in balance group, 22 in control group. No dropouts described Participants baseline characteristics not stated. Inclusion criteria: PD patients. Exclusion criteria not stated
Interventions	Balance: Task specific to facilitate reaction time and length of compensatory steps during activities with self-induced perturbation and in response to external perturbation Control: Strength training of lower limb muscles with moderate intensity Not stated whether the drug therapy was constant during trial
Outcomes	Limit of stability Walking speed One leg stance time Activities-specific balance confidence scale UPDRS III
Notes	Abstract only

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Eligibility Criteria	Unclear risk	Criteria not stated
Randomisation Method	Unclear risk	Method not stated
Concealment of Allocation	Unclear risk	Method of randomisation not stated
Similarity at Baseline	Unclear risk	Group characteristics not stated
Intention to Treat Analysis	Unclear risk	Method of analysis not stated
Withdrawals Described	Unclear risk	Withdrawals not described
Cointerventions Constant	Unclear risk	Not stated whether the drug therapy was constant during trial
Comparable arms	Low risk	Same time and attention given to participants in both arms
Blinded Assessors	Low risk	Assessors were blinded

Shiba 1999

Methods	Cross-over group design Method of randomisation not stated Method of analysis of the data not stated Treated as outpatients for an unknown period of time. 1 week between each training regimen Assessed at baseline and immediately after treatment Not stated whether the assessors were blinded
Participants	8 participants took part in the study. No dropouts described Baseline characteristics not stated for groups. Total mean age 65 years; total male/female ratio 3/5. Inclusion criteria: Stable mild to moderate Parkinson's disease. Exclusion criteria not stated
Interventions	Visual training: Patients walked over parallel lines at 90 degrees to the direction of travel. Distance apart of lines dependant on patients normal stride length Auditory stimulation: Patients walked to a rhythm that was 30% of their comfortable walking rhythm. Not stated whether the drug therapy was constant during trial
Outcomes	Stride length
Notes	Abstract only. No numerical data available

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Eligibility Criteria	Unclear risk	Criteria not stated
Randomisation Method	Unclear risk	Method not stated
Concealment of Allocation	Unclear risk	Method of randomisation not stated
Similarity at Baseline	Unclear risk	Baseline characteristics not stated
Intention to Treat Analysis	Unclear risk	Method of analysis not stated
Withdrawals Described	Unclear risk	Dropouts not described
Cointerventions Constant	Unclear risk	Not stated whether the drug therapy was constant during trial
Comparable arms	Unclear risk	Treatment schedules not stated
Blinded Assessors	Unclear risk	Not stated whether the assessors were blinded

Sigurgeirsson 2009

Methods	Parallel group design Method of randomisation not stated Method of analysis not stated Treatment delivered in 30 min sessions, 4 sessions per week for 4 weeks Assessed at baseline, immediately after treatment and 3 months after treatment Not stated whether the assessors were blinded
Participants	26 participants randomised, group split not stated. No dropouts described Baseline characteristics of groups not stated.Total mean Hoehn Yahr 2.1 Inclusion and exclusion criteria not stated.
Interventions	Exercise: Walking with visual cues. Control: Walking without cues. Not stated whether the drug therapy was constant during trial
Outcomes	Timed up and go PDQ-39
Notes	Abstract only

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Eligibility Criteria	Unclear risk	Criteria not stated
Randomisation Method	Unclear risk	Method not described
Concealment of Allocation	Unclear risk	Method of randomisation not described
Similarity at Baseline	Unclear risk	Baseline characteristics of groups not stated
Intention to Treat Analysis	Unclear risk	Method of analysis not stated
Withdrawals Described	Unclear risk	Withdrawals not described
Cointerventions Constant	Unclear risk	Not stated whether the drug therapy was constant during trial
Comparable arms	Unclear risk	Same time and attention given to participants in both arms
Blinded Assessors	Unclear risk	Not stated whether the assessors were blinded

Smania 2010

Methods	Parallel group design Randomisation list used Method of analysis not stated Treated as outpatients in 50 min sessions, 3 times per week for 7 weeks Assessed at baseline, immediately post treatment and 1 month post-treatment Assessors were blinded
Participants	33 participants in balance group, 31 in control group. 5 dropouts in balance group, 4 in control group Participants mean age 67.6 years (balance), 67.3 years (control); Male/female 14/14 (balance), 15/12 (control); Hoehn and Yahr not stated; Duration of condition 10.4 years (balance), 8.6 years (control) Inclusion criteria: Idiopathic PD and postural instability, Hoehn & Yahr 3-4, did not require assistance to rise from chairs or beds. Exclusion criteria: Unstable cardiovascular disease or other chronic conditions that could interfere with their safety during testing or training procedures, other neurological conditions or mental deterioration (MMSE <23), severe dyskinesias or 'on-off' phases
Interventions	Balance: Each patient was submitted to balance training consisting of exercises aimed at improving both feedforward and feedback postural reactions. Patients were required to repeat exercises from 3 different groups. Group 1: self-destabilisation of the centre-of-body mass (feedforward), group 2 : externally induced destabilisation of the centre-of-body mass (feedback), group 3: emphasis of coordination between leg and arm movements during walking as well as locomotor dexterity over an obstacle course and other potentially destabilising activities (continuous feedback and feedforward adjustments). During each session 10 exercises were undertaken, 4 from group 1, 4 from group 2 and 2 from group 3. 5 - 10 repeats of each for 5 mins. Complexity of exercises was increased with patient's ability. Support was provided by therapist at pelvis or chest when required Control: Exercises not specifically designed to improve postural reactions. Active joint mobilisation, muscle stretching and motor coordination exercises. During each session 10 exercises were undertaken, 6 in supine position, 2 in the sitting position and 2 in the standing position. 5 - 10 repeats of each for 5 mins. Complexity of exercises was increased with patient's ability Drug therapy was stable during trial period.
Outcomes	Berg balance scale Activities specific balance confidence Postural transfer test Self destabilization of the centre of foot pressure test Falls diary UPDRS Total Modified Hoehn and Yahr Geriatric depression scale
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Eligibility Criteria	Unclear risk	Charateristics of included patients described but not stated whether these items were used for the selection of patients for trial

Smania 2010 (*Continued*)

Randomisation Method	Unclear risk	Randomisation list used
Concealment of Allocation	High risk	Randomisation list kept in locked desk of principal investigator
Similarity at Baseline	Unclear risk	Hoehn and Yahr scores not stated
Intention to Treat Analysis	Unclear risk	Method of analysis not stated
Withdrawals Described	High risk	Withdrawals at 14%
Cointerventions Constant	Low risk	Drug therapy was stable during trial period
Comparable arms	Low risk	Same time and attention given to participants in both arms
Blinded Assessors	Low risk	Assessors were blinded

Talakkad 2011

Methods	Parallel group design Method of randomisation not stated Method of analysis not described Treated for 8 hours over 4 weeks Assessed at baseline and after 4 weeks of intervention Not stated whether assessors were blinded
Participants	60 participants were randomised into this trial. Dropouts were not described Baseline characteristics of participants were not stated. Eligibility criteria not stated.
Interventions	Conventional gait training (CGT). Partial weight supported treadmill training: 20% unweighting Control: No specific intervention. Drug therapy not described.
Outcomes	Dynamic posturography UPDRS (total and motor subscore) Beat-to-beat finger blood pressure
Notes	Abstract only Control arm not included in this review

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Eligibility Criteria	Unclear risk	Eligibility criteria not stated

Talakkad 2011 (*Continued*)

Randomisation Method	Unclear risk	Method of randomisation not stated
Concealment of Allocation	Unclear risk	Method of randomisation not stated
Similarity at Baseline	Unclear risk	Baseline characteristics not stated
Intention to Treat Analysis	Unclear risk	Method of analysis not described
Withdrawals Described	Unclear risk	Dropouts not described
Cointerventions Constant	Unclear risk	Drug therapy not described
Comparable arms	Low risk	Same time and attention given to participants in both arms
Blinded Assessors	Unclear risk	Not stated whether assessors were blinded

Thaut 1996

Methods	Parallel group design Randomised using a computerised random number generator Analysed on an intention-to-treat basis Treated at home or in the community, for 10.5 hours over 3 weeks. Assessed in laboratory, at baseline and immediately after treatment Not stated whether assessors were blinded
Participants	15 patients in novel rhythmic auditory stimulation group (RAS), 11 in standard self paced training group (SPT) and 11 in no treatment group (NT). No dropouts noted Patients mean age 69 years (RAS), 74 years (SPT), 71 (NT); Male/female 10/5 (RAS), 8/3 (SPT), 8/3 (NT); Hoehn and Yahr 2.4 (RAS), 2.5 (SPT), 2.6 (NT); Duration of condition 7.2 years (RAS), 5.4 years (SPT), 8.5 years (NT). Inclusion criteria: IPD with significant gait deficits but able to walk without physical assistance. Exclusion criteria not stated
Interventions	RAS: Individual. 30 min/day walking to 3 different tempos of music. For 1st week; normal tempo = pretest cadence, quick = 5-10% faster, fast = an additional 5-10% faster. After each week each tempo was increased by 5-10% to a maximum pace of 130 steps/min. SPT: Individual. 30 min/day walking at normal, quick and fast speeds NT: No treatment. Drug therapy was stable during trial period.
Outcomes	Stride velocity Stride cadence Stride length EMG analysis on leg muscles

Thaut 1996 (*Continued*)

Notes	3 arms to trial; RAS, SPT and no treatment. SPT versus no treatment are compared in 'Physiotherapy for patients with Parkinson's disease' Cochrane review. New correspondence with author on randomisation method

Risk of bias

Bias	Authors' judgement	Support for judgement
Eligibility Criteria	Low risk	Inclusion and exclusion criteria confirmed with author correspondence
Randomisation Method	Low risk	Randomised using a computerised random number generator
Concealment of Allocation	Unclear risk	Method not stated
Similarity at Baseline	Low risk	Group characteristics similar at baseline
Intention to Treat Analysis	Low risk	Analysed on an intention-to-treat basis
Withdrawals Described	Low risk	No withdrawals
Cointerventions Constant	Low risk	Drug therapy was stable during trial period
Comparable arms	Low risk	Same time and attention given to participants in both arms
Blinded Assessors	Unclear risk	Not stated whether assessors were blinded

Toole 2005

Methods	Parallel group design Randomised using table of random numbers Method of analysis not stated Treatment delivered in 20 mins sessions, 3 times per week for 6 weeks Assessed at baseline, within 1 week of completing intervention and 4 weeks later Not stated whether assessors were blinded
Participants	23 participants randomised, group split not stated. No dropouts described Participants mean age 75.4 years standard treadmill group (ST), 76.4 years unweighted treadmill group (UT), 72.0 years weighted treadmill group (WT); Male/female ratio not stated; Hoehn & Yahr 4.8 (ST), 3.6 (UT), 3.4 (WT); Duration of condition not stated Inclusion criteria: Parkinsonism, Hoehn and Yahr 1-4. Exclusion criteria: Uncompensated cardiovascular disease, uncontrolled high blood pressure, leg claudication, significant dementia, other disorders of comprehension and/or other medical conditions that would interfere with the participants safety and comfort during submaximal exercise

Toole 2005 (*Continued*)

Interventions	ST: Treadmill training with no loading or unloading. UT: Treadmill training assisted by the biodex unweighting system at a 25% body weight reduction for 15 mins then 5 mins with system removed WT: Treadmill training wearing weighted scuba-diving belt which increased normal body weight by 5% for 15 mins then 5 mins without belt Not stated whether the drug therapy was constant during trial
Outcomes	Balance from dynamic posturography Berg balance scale UPDRS Biomechanical assessment of strength and range of motion Gait
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Eligibility Criteria	Low risk	Criteria stated
Randomisation Method	Unclear risk	Table of random numbers, unclear how generated
Concealment of Allocation	Unclear risk	Randomised using table of random numbers
Similarity at Baseline	Low risk	Group characteristics similar at baseline
Intention to Treat Analysis	Unclear risk	Method of analysis not stated
Withdrawals Described	Unclear risk	Withdrawals not described
Cointerventions Constant	Unclear risk	Not stated whether the drug therapy was constant during trial
Comparable arms	Low risk	Same time and attention given to participants in both arms
Blinded Assessors	Unclear risk	Not stated whether assessors were blinded

Vivas 2011

Methods	Parallel group design Randomisation method not stated Method of analysis not stated Treated as outpatients with twice weekly 45 minute sessions for 4 weeks Assessed at baseline, after 4 weeks treatment and at 17 days follow-up Assessors were not blinded
Participants	6 participants in water based exercise group (Water), 6 in land based exercise group (Land). 1 dropout in Water group Participant mean age 65.7 years (Water), 68.3 years (Land); Male/female ratio 3/3 (Water), 4/2 (Land) ; Hoehn and Yahr 2.7 (Water), 2.4 (Land); Duration of condition 4.2 (Water), 7.8 (Land) Inclusion criteria: IPD, ability to follow a stable medication schedule, Hoehn & Yahr stage II-III (Off medication), lack of dementia (MMSE $\geq$ 24). Exclusion criteria: unable to walk independently, undergone surgical treatment for PD
Interventions	Water: Warm-up exercises, trunk mobility exercises, postural stability exercises, transferring oneself and changing body positions, all carried out in water. Progression was encouraged with introduction of more complex exercises as appropriate Land: Warm-up exercises, trunk mobility exercises, postural stability exercises, transferring oneself and changing body positions, all carried out on land. Progression was encouraged with introduction of more complex exercises as appropriate Medication withheld for 12 hours before evaluations, for OFF-dose performance
Outcomes	Functional reach test Berg balance scale Gait - turn time, velocity, cadence, step amplitude Timed up and go UPDRS
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Eligibility Criteria	Low risk	Inclusion and exclusion criteria stated
Randomisation Method	Unclear risk	Method not stated
Concealment of Allocation	Unclear risk	Randomisation method not stated
Similarity at Baseline	Low risk	Group characteristics similar at baseline
Intention to Treat Analysis	Unclear risk	Analysis method not stated
Withdrawals Described	Low risk	Withdrawals at 8%
Cointerventions Constant	Unclear risk	Not stated whether the drug therapy was constant during trial

Comparable arms	Low risk	Same time and attention given to both groups
Blinded Assessors	High risk	Assessors not blinded

Werner 2010

Methods	Parallel group design Randomised by individual not involved in testing or treatment using a computer generated number list for allocation Analysed on an Intention-to-treat basis Treatment delivered in 90 min sessions, 2 times per week for 2 weeks Assessed at baseline (4-5 days prior to start of intervention), 1 week after training and at 3, 6 and 12 months Assessors were blinded
Participants	6 participants in Verbal instruction with augmented feedback group (VIAF), 6 in Verbal instruction only group (VI). 5 dropouts at follow-up time-points, group split not stated Participant mean age 72.8 years (VIAF), 69.3 years (VI); Male/female ratio 5/1 (VIAF), 5/1 (VI); Hoehn and Yahr 2.3 (VIAF), 2.5 (VI); Duration of condition not stated Inclusion criteria: Adequate vision. Exclusion criteria: MMSE<21, marked dyskinesia or other neurological impairments in addition to PD. Cardiac or musculoskeletal pathology that might impact gait, required an assistive device to walk, had video feedback or gait training previously or had difficulty understanding English
Interventions	VIAB: 15 trials, of walking 7.5 m then returning to starting position with instruction to 'Walk as well as you can', per session. Verbal instruction and augmented feedback before each trial and 3 minutes of seated rest between each trial. Verbal instructions were to 'take big step' prior to each trial, during rest period participants were given 3 viewings of video playback of their walking performance from prior trial. On each viewing they were asked to a) focus on step length and comment on what they observed, b) indicate what they planned to do on next attempt. If subject did not comment accurately after viewing video or did not verbalise what they planned to do next, additional verbal 'knowledge of performance' (KP) or suggestions/corrections ('transitional information' (TI)) were provided by the experimenter VI: Trials conducted in same manner as for VIAB group but during rest period the group engaged in discussion or were given something to read Drug therapy was stable during trial period.
Outcomes	Stride length Cadence Gait velocity Shoulder excursion
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**

Werner 2010 (*Continued*)

Eligibility Criteria	Low risk	Inclusion and exclusion criteria stated
Randomisation Method	Low risk	Computer generated randomisation
Concealment of Allocation	Low risk	Randomised by individual not involved in testing or treatment
Similarity at Baseline	Low risk	Group characteristics similar at baseline
Intention to Treat Analysis	Low risk	Analysed on an intention-to-treat basis
Withdrawals Described	Low risk	No withdrawals at post-intervention time point. Withdrawals at 42% for follow up
Cointerventions Constant	Low risk	Drug therapy was stable during trial period
Comparable arms	Low risk	Same time and attention given to both groups
Blinded Assessors	Low risk	Assessors were blinded

Yang 2010

Methods	Parallel group design Randomised by independent arbiter who picked out a sealed envelopes 30 mins before the start of the intervention Method of analysis not stated Treatment delivered in 30 mins sessions, 3 times per week for 4 weeks Assessed at baseline, within 7 days of completion of treatment, 1 month after treatment Assessors were not blinded
Participants	16 participants in downhill walking group (DW), 17 in physiotherapy group (PT). 2 dropouts in DW group, 5 dropouts in PT group Participants mean age 68.1 years (DW), 66.3 years (PT); Male/female 9/6 (DW), 7/8 (PT); Hoehn and Yahr 2.2 (DW), 2.2 (PT); Duration of condition 4.8 years (DW), 5.3 years (PT) Inclusion criteria: Diagnosed with IPD (as defined by the UK Brain Bank Criteria) by a neurologist, Hoehn and Yahr stages I through III, ability to walk independently, stable medication usage, freedom from any other problems that might affect training and ability to understand instructions and follow commands. Exclusion criteria not stated
Interventions	DW: Downhill walking training using a treadmill. Subjects walked on a motorized treadmill with a body weight support (BWS) system under the close supervision of a physical therapist. Initially the downhill grade was set at 3%. If subjects could walk with correct erect posture and large strides without stumbling during the training period, the downhill grade was then increased by 1% per training period. Treadmill speed was set at a level that was comfortable for each participant. A BWS of <40% of the body weight was provided and decreased to the maximum extent possible. Rest periods were provided as needed PT:Conventional therapy training program consisted of flexibility exercises (5 mins), strengthening exercises (7 mins), proprioceptive neuromuscular facilitation, coordination training, balance training

	(8 mins) and overground walking training (10 mins) Drug therapy was stable during trial period.
Outcomes	Speed Cadence Stride length Thoriacic kyphosis Muscle strength
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Eligibility Criteria	Low risk	Inclusion criteria stated
Randomisation Method	High risk	Randomised by independent arbiter who picked out a sealed envelopes
Concealment of Allocation	High risk	Randomised by sealed envelopes
Similarity at Baseline	Low risk	Group characteristics similar at baseline
Intention to Treat Analysis	Unclear risk	Method of analysis not stated
Withdrawals Described	High risk	Withdrawals at 21%
Cointerventions Constant	Low risk	Drug therapy was stable during trial period
Comparable arms	Low risk	Same time and attention given to participants in both arms
Blinded Assessors	High risk	Assessors were not blinded

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Byl 2009	After contacting the author it was found that the study was not properly randomised
Cheon 2012	Not stated whether patients were randomised into trial. Author contacted but no response
Chouza 2011	Whole body vibration technique not usually used by physiotherapists

(*Continued*)

Cianci 2010	Excluded as confounded due to use of rolling walker
Donovan 2011	Quasi randomised using alternate allocation
Farley 2005	Insufficient information available from abstract for review and no author correspondence was achieved
Filippin 2010	Single arm study, so not randomised trial
Frazzitta 2012	Comparator arm consists of suggested home exercise and usual care only
Gobbi 2009	Insufficient information available from abstract for review and not stated whether randomisation was carried out
Haase 2011	Single short session of intervention; treatment under one day. Not rehabilitative therapy
Kamsma 1995	Partially randomised with a portion of patients placed in a convenient group based on practical grounds such as availability of transport
Klassen 2007	Difference between the two physiotherapy arms is multidisciplinary education for which the physiotherapy component is unknown
Knobl 2011	Not properly randomised, placed in groups
Lee 2011	Outcomes not relevant, stroke outcomes used and patients trained on one side of the body only
Ma 2009	Crossover trial carried out over one day only
Marchese 2000	Not properly randomised, pseudo-random number list used
Modugno 2010	Trial included a theatre training arm which could not be considered solely as physiotherapy
Munneke 2010	Randomised trial of systems of care for delivery of physiotherapy, not comparing different physiotherapy techniques
Pacchetti 2000	Two arm trial included active music therapy arm, not considered to be solely physiotherapy intervention
Pohl 2003	Randomised multiple intervention cross-over, over 4 consecutive days. Randomisation was of the sequence of the interventions, therefore not RCT
Rochester 2011	Excluded as the study was a randomised crossover over a couple of hours
Sage 2009a	After contacting the author it was found that the study was not properly randomised
Sage 2009b	After contacting the author it was found that the study was not properly randomised
Sage 2010	After contacting the author it was found that the study was not properly randomised

(*Continued*)

Stallibrass 2001	The method of therapy used - Alexander Technique - is not used by physiotherapists. Therefore this trial was excluded
Tamir 2007	Quasi-randomised trial using alternate allocation of patients to arms
Tickle-Degnen 2010	Multidisciplinary rehabilitation trail. Percentage component of physiotherapy was not specified, therefore unable to differentiate the contribution of physiotherapy to any change in the outcome measures
Wulf 2009	Multiple cross-over trial over a short period of time
Yen 2011	No outcome measures relevant to our review

Characteristics of ongoing studies *[ordered by study ID]*

Brauer 2011

Trial name or title	Single and dual task gait training in people with Parkinson's disease: A protocol for a randomised controlled trial
Methods	Parallel group design Randomised with opaque envelopes containing allocations from a computer generated random number sequence prepared by offsite investigator not involved in recruitment, intervention or data collection Analysed on an intention-to-treat basis Treated as outpatients for 40 - 60 minutes session 3 times a week for 4 weeks, setting not stated Assessed at baseline, immediately after treatment and after 6 months follow-up Assessors blinded
Participants	Planning to recruit 60 participants. Inclusion criteria: 18 years or older, IPD diagnosed using UKBB criteria, able to walk 100 m independently with or without gait aids, report reduced step length or slowed gait speed, confirmed by clinical examination, Hoehn and Yahr stage I-IV. Exclusion criteria: Neurological condition other than PD, musculoskeletal or cardiopulmonary conditions that affect the ability to safely walk, had surgery for PD such as deep brain stimulation, score <24 on the mini-mental status examination
Interventions	Single task training: One-to-one therapy sessions with therapist. Individually progressed program of gait training aimed at improving step length via repeated practice of straight line walking, turning, obstacle negotiation and challenging gait tasks such as increasing speed and altering surface challenges. External cues to increase step length will be used when needed. Instructions will not be given while participant is walking to avoid dual tasking. A home program will be incorporated at week 2 for 6 months, which includes a walking program and a range of balance, strengthening and postural exercises Dual task training: One-to-one therapy sessions with therapist. Aim to improve step length under dual task conditions that is when concurrently performing added cognitive or motor tasks. Participants will undertake repeated practice of walking aiming to improve step length using external cueing techniques including verbal, visual or auditory approaches. Progressing to internal concurrent cueing of appropriate step length. The gait tasks undertaken will be progressed from simple to more complex tasks as outlined for the single task group. In addition a variety of added tasks will be progressively integrated into the training program. These include tasks such as listening, speaking, conversing, generation of simple and complex lists, language, calculation

Brauer 2011 (*Continued*)

	and motor tasks increasing in complexity. Tasks will include those designed to reflect functional everyday activities such as carrying bags, getting keys out of a pocket, counting money, recalling directions or making a shopping list. Complexity will be progressively integrated as more complex tasks result in greater dual task interference with gait in people with PD. If able, participants will be progressed to performing increasingly complex cognitive tasks while concurrently walking. Motor tasks such as carrying and manipulation will also be included as added tasks
Outcomes	Step length Gait speed Cadence Stride length Step length coefficient of variation Double support time Trail making A&B tests Strop colour-word interference test Digit span test Timed up and go 6-minute walk test Measures of community mobility questionnaire Activity measured using ActivPAL Quality of life PDQ-39 EQ-5D Hoehn and Yahr UPDRS III Freezing of Gait questionnaire Ambulatory self confidence questionnaire Compliance
Starting date	
Contact information	s.brauer@uq.edu.au
Notes	Protocol only

Protas 2005

Trial name or title	Gait and step training to prevent falls in Parkinson's disease
Methods	Parallel group design Treatment delivered for 1 hour per day, 3 times per week for 8 weeks Assessed at baseline, at 8 weeks, at 1 month follow-up and 5 month follow-up Assessors blinded
Participants	Planning to recruit 90 participants. Inclusion criteria: Diagnosis of PD, postural instability - gait disorder predominant PD, history of falls, gait freezing or a positive pull test, stable regimen of medications, ability to stand and walk 3 m without assistance, stage 2 or 3 of the Hoehn and Yahr disability scale and moderate or higher cognitive scores

Protas 2005 (*Continued*)

Interventions	GSP: Gait and step perturbation. Gait training on a treadmill and in a safety harness while walking in four directions: frontwards, backwards, left sideways and right sideways. Training will start with a treadmill speed that is equivalent to fastest overground walking speed for forward walking and fastest possible for other directions and will increase during training. This group will also receive step training while positioned in 4 directions consisting of suddenly turning the treadmill on/off. The subjects will be required to maintain their balance during perturbations SPT: Seated exercise. This group will receive seated active range of motion, and upper and lower extremity aerobic training
Outcomes	Usual and fastest gait speed 5-step test UPDRS Gait and balance scale Center for Epidemiological Studies depression scale Cognistat - a co-morbidity scale Activities balance confidence Physical activity scale for the elderly Limits of stability Falls frequency
Starting date	25th September 2006
Contact information	shinowara@nih.gov
Notes	

Schenkman 2012b

Trial name or title	Endurance exercise in Parkinson's disease
Methods	Parallel group design Randomisation method not stated Treatment was delivered four times a week for 6 months Assessors were blinded
Participants	Estimated total enrolment, 126 participants. Three arm trial: No intervention control group (NT), vigorous exercise group (VE), moderate exercise group (ME) Inclusion Criteria: Clinical diagnosis of primary Parkinson's disease, in a Hoehn and Yahr stage less than stage III, disease duration is less than 5 years, not likely to require dopaminergic therapy within 6 months. Exclusion Criteria: Use of any PD medication within 60 days prior to the beginning the study, including levodopa, direct dopamine agonists, amantadine, Rasagiline (Azilect), Selegiline (Eldepryl), Artane (trihexyphenidyl). Duration of previous use of medications for PD that exceeds 90 days. Expected to require dopaminergic therapy in the next 6 months. Poorly controlled or unstable cardiovascular disease. Uncontrolled hypertension. Hypo- or hyperthyroidism, abnormal liver function, abnormal renal function. Mild cognitive impairment (Montreal Cognitive Assessment score<26/30). Depression that precludes ability to exercise (Beck depression score>13). Disorders that interfere with ability to perform endurance exercises. Regular participation in vigorous endurance exercise. Evidence of serious arrhythmias or ischemic heart disease. Any clinically significant medical condition, psychiatric condition, drug or alcohol abuse, or laboratory

Schenkman 2012b (*Continued*)

	abnormality that would, in the judgment of the investigators, interfere with the ability to participate in the study
Interventions	NT: Control Group. Wait listed to moderate or vigorous exercise after 6 months of no exercise VE: Endurance exercise at 80-85% HR max. ME: Endurance exercise at 60 - 65% HR max.
Outcomes	Adherence to exercise UPDRS Motor Adverse events
Starting date	April 2012
Contact information	lindsey.pederson@ucdenver.edu
Notes	

Smith 2009

Trial name or title	Strength training and medication effects in Parkinson's disease: effects on hypokinesia in Parkinson's disease
Methods	Treated for 12 weeks
Participants	Inclusion criteria: Male or female at least 40 years of age, neurologist diagnosed idiopathic PD (using UK Brain Bank Criteria), ambulatory and medically cleared by their physician to participate in an exercise regimen, clinical signs of hypokinesia or postural instability, Folstein Mini-Mental State Examination score > 23, currently taking dopamine replacement medication Exclusion criteria: Previous surgical management of PD (pallidotomy, DBS), motor fluctuations and/or dyskinesias uncontrolled by medications, central nervous system disorder (other than PD), myopathic disease (e.g. focal myopathy) that affects skeletal muscle structure/function rheumatological disease that has an effect on muscle and/or mobility, unstable cardiovascular disease that limits exercise abilities, impaired knee flexion, <90°, extreme claustrophobia (secondary to the inability to perform the MRI scans) regular (2-3 times/week) aerobic or resistance exercise performed over the past 6 months
Interventions	High force resistance training Standard care
Outcomes	Muscle structure Muscle force output Hypokinesia
Starting date	August 2007
Contact information	sheldon.smith@hsc.utah.edu
Notes	

Uc 2010

Trial name or title	Effects of aerobic exercise in Parkinson's disease
Methods	Assessors blinded
Participants	100 participants to be enrolled. Inclusion criteria: Veteran or non-veteran, presence of all 3 cardinal features of Parkinson's disease (resting tremor, bradykinesia and rigidity) which must be asymmetrical, Hoehn & Yahr stage I-III, men or women aged 50-80 capable of performing the planned exercise programs, intention to remain in the local area over the study period, stable dopaminergic treatment regimen for at least 4 weeks prior to baseline without any clinical need for medication adjustment at the time of screening Exclusion criteria: Secondary parkinsonism, Parkinson-plus syndromes, MMSE score<24, participating in an aerobic exercise program, an unstable dosage of drugs active in the central nervous system during the 60 days before the baseline visit, participation in drug studies or the use of investigational drugs within 30 days before screening, structural brain disease, active epilepsy, acute illness or active confounding medical, neurological or musculoskeletal conditions, alcoholism or other forms of drug addiction, inability to complete the graded exercise test, lack of medical clearance from our pulmonologist, intention to move or take > 1 month vacation during the study period, contraindications to MRI or claustrophobia requiring sedation
Interventions	Aerobic exercise in the form of brisk walking using different training formats, four arms: group/continuous, group/interval, single/continuous and single/interval
Outcomes	Cycle ergonometry Functional and morphometric MRI Trophic factor Biomarker assays Safety exams Lab results (ECG, biochemistry, CBC) Tests for Parkinsonism and cognition Questionnaires about quality of life, mood and activities of daily living
Starting date	February 2009
Contact information	ergun-uc@uiowa.edu
Notes	

van Nimwegen 2010

Trial name or title	ParkFit study: A randomised controlled trial evaluating the effectiveness of a multifaceted behavioural program to increase physical activity in Parkinson patients
Methods	Parallel group design Randomised assigned using minimisation algorithm Treatment delivered over 2 years, offered a maximum of 35 sessions per year, each session lasting 30 mins Assessed at baseline, at 6 months, 12 months 18 months and 24 months Assessors were blinded

Participants	586 participants randomised, 299 in ParkFit group and 287 in ParkSafe group. No dropouts described Baseline characteristics for groups not stated Inclusion criteria: PD according to UKBB criteria, aged between 40 and 75 years, sedentary lifestyle (<3 times a week vigorous-intensity physical activity for <60 mins or <3 times a week moderate-intensity physical activity for <150 mins), Hoehn & Yahr score ≤3. Exclusion criteria: Unclear diagnosis (no gratifying and sustained response to dopaminergic therapy), MMSE score <24, unable to complete dutch questionnaires, severe co-morbidity interfering with daily functioning, daily institutionalised care, deep brain surgery
Interventions	Both interventions were delivered exclusively by experienced therapists who participate in the Dutch ParkinsonNet ParkFit: Brochure provided, *ParkFit*, covering specific strategies to promote behavioural change. Physical therapists serve as personal activity coaches who guide patients towards a more active lifestyle, during specific coaching sessions. Patient and coach create activity goals in order to obtain the 6-month goals. Patients receive a personal ambulatory monitor with automated visual feedback showing the amount of actually delivered daily physical activity, recorded by a triaxial accelerometer. The ParkFit program also included a maximum of 19 physical therapy sessions in year 1 and 23 in year 2. Based on individual disabilities, therapist and patient jointly formulate treatment aims based on the evidence-based guideline of physical therapy for PD ParkSafe: Patients receive a brochure, *ParkSafe* with information about the benefits of physical therapy. Specific emphasis is given to the importance of safety when performing daily activities. Patients receive an individualised physical therapy program. Total of 35 sessions per year: 19 physiotherapy plus 16 coach sessions). Physical therapist and patient jointly formulate the aims of the projected treatment plan, based on individual problems and disabilities Not stated whether the drug therapy was constant during trial
Outcomes	Level of physical activity 6 minute walk test PDQ-39
Starting date	September 2008
Contact information	m.munneke@neuro.umcn.nl
Notes	Subgroup analysis of those who succeeded in increasing their activity levels versus those who didn't, assessed for disease progression and physical fitness

DATA AND ANALYSES

This review has no analyses.

ADDITIONAL TABLES

Table 1. Included trials: summary table of results

Study Group	Location	Interventions				Withdrawals at post-test (with reasons)				Outcomes	Summary of results at post-test
		Arm 1	Arm 2	Arm 3	Arm 4	Arm 1	Arm 2	Arm 3	Arm 4		
Almeida 2012	Waterloo, Canada	Visual cueing on the ground (n=14; 30 minutes, 3 times per week, 6 weeks)	Visual cueing on the treadmill (n=14; 30 minutes, 3 times per week, 6 weeks)	Control (n=14)		0	0	0		Primary: Step length Secondary: UPDRS III, timed up and go, gait speed, cadence, double support time, step time, step-to-step variability, step time variability, 30 second chair stand	There was no difference between treatment arms
Braun 2011	Netherlands	Physiotherapy with mental practice (n=25; 1 hour (or 2 x	Physiotherapy with relaxation (n=25; 1 hour (or 2 x 30 min-			3 (n=2; hospitalised with relapse, n=1; too confronting)	4 (n=3; hospitalised with relapse, n=1 died)			Visual analogue scale, timed up and go, 10 m	There was no difference between treatment

Table 1. Included trials: summary table of results (*Continued*)

		30 minutes) weekly, 6 weeks)	utes) weekly, 6 weeks)							walk test	arms
Burini 2006	Ancona, Italy	Aerobic training (n=13; 45 minutes, 3 times per week, 7 weeks)	Qigong group (n=13; 45 minutes, 3 times per week, 7 weeks)			2 (n=1; poor compliance, n=1; back pain after 3rd session)	2 (n=1; poor compliance, n=1; fall-related fracture)			Primary: UPDRS III, UPDRS II, Brown's disability scale (BDS), 6 minute walk test, Borg scale for breathlessness, Beck depression inventory (BDI), PDQ-39 Secondary: Spirometry test, Maximum cardiopulmonary exercise test	There was no difference between treatment arms for primary outcomes
Chaiwanichsiri 2011	Bangkok, Thailand	Treadmill with music cue (n=10; 30 minutes, 3 times per	Treadmill (n=10; 30 minutes, 3 times per week, 4 weeks)	Home walking (n=10; 30 minutes, 3 times per week, 4 weeks)		0	0	0		Timed up and go, Walking speed, Step length, Ca-	There was no difference between treatment arms

Table 1. Included trials: summary table of results (*Continued*)

		week, 4 weeks)								dence, Stride length, 6-minute walk test, 6 metre walk time, Single leg stance, UPDRS I, II, III	
Dias 2005	Brasil, South America	Physiotherapy and cardiovascular exercise with visual cues (n=8; total 20 sessions)	Conventional physiotherapy (n=8; total 20 sessions)			0	0			UPDRS, Functional independence measurement scale, Berg balance scale, H&Y scale	Physiotherapy and cardiovascular exercise with visual cues significantly improved functional independent measure, step length, velocity (gait speed) and cadence compared to conventional physiotherapy

Table 1. Included trials: summary table of results (*Continued*)

Diehl 2011	Indiana, USA	Group Box training (n=unknown, total n=20)	Traditional group exercise (n=unknown, total n=20)			unknown	unknown			Berg balance scale, Activities specific balance confidence scale, Functional reach test, Parkinson's disease quality of life scale	There was no difference between treatment arms
Ebersbach 2010	Beelitz-Heilsätten Germany	LSVT BIG training (n=20; 1 hour, 4 times per week, 4 weeks)	Nordic Walking (n=20; 1 hour, twice a week, 8 weeks)	Home exercise (n=20; 1 session)		0	1 (n=1; withdrawal of consent)	1 (n=1; withdrawn due to psychosis)		Primary: UPDRS III. Secondary: PDQ-39, Timed up and go, time to walk 10 m	Significant improvement of UPDRS, timed up and go and timed 10m walking in LSVT BIG group compared to Nordic walking and home exercise. There was no

Table 1. Included trials: summary table of results (*Continued*)

											difference between treatment arms for PDQ-39
Fisher 2008	Los Angeles, California	Treadmill group (n=10; 1 hour, 3 times per week, 8 weeks)	Physiotherapy group (n=10; 1 hour, 3 times per week, 8 weeks)	Control group (n=10; 1 hour, total of 6 sessions over 8 weeks)		0	0	0		UPDRS (Total, I, II and III subscores), Hoehn and Yahr, Functional assessments, Walking tests: average gait velocity, step length, stride length, cadence, double limb support time, ankle, knee, hip rotation Sit-to-stand test, Transcranial magnetic stimulation (subset)	There was no difference between treatment arms

Table 1. Included trials: summary table of results (*Continued*)

Frazzitta 2009	Montescano, Italy	Treadmill with auditory and visual cues (n=20; 20 minutes daily, 4 weeks)	Auditory and visual cues (n=20; 20 minutes daily, 4 weeks)			0	0			UPDRS III, Gait speed, Freezing of gait questionnaire, Stride length, 6 minute walking test	The treadmill with auditory and visual cues had significant improvement in gait speed, freezing of gait questionnaire, stride length and 6 minute walking test when compared to the auditory and visual cues group. There were no differences between treatment arms for UPDRS III
Hackney 2007	St. Louis, Missouri,	Tango (n=9; 1 hour, 20 sessions	Exercise (n=10; 1 hour, 20 sessions			0	0			UPDRS III, Berg balance	There was no differ-

Table 1. Included trials: summary table of results (*Continued*)

	USA	within 13 weeks)	within 13 weeks)							scale, Freezing of gait, Timed up and go, Velocity of walking and dual-task walking	ence between treatment arms
Hackney 2009	St. Louis, Missouri, USA	Tango group (n=19; 1 hour, twice weekly, total 20 sessions in 13 weeks)	Waltz/ foxtrot group (n=19; 1 hour, twice weekly, total 20 sessions in 13 weeks)	Tai Chi group (n=17; 1 hour, twice weekly, total 20 sessions in 13 weeks)	Control group (n=20; 13 weeks)	5 (n= 1; personal problems, n= 1; knee pain, n= 2; transportation problems, n= 1; change in medication)	2 (n= 1; injury at home, n=1; infrequent attendance (unknown))	4 (n= 2; transportation problems, n= 1; hospitalisation (unrelated) , n=1; insufficiently intense exercise)	3 (n= 1; hospitalisation (unrelated), n=1; ankle injury, n= 1; death in family)	PDQ-39, UPDRS III, Berg balance scale, Tandem stance test, Timed up and go test, One leg stance test 6 minute walk test, Gait	PDQ-39 significantly improved in the tango arm compared to the waltz/ foxtrot and Tai Chi arms. Timed up and go test was significantly improved in the tango arm compared to the

Table 1. Included trials: summary table of results (*Continued*)

											waltz/ foxtrot and Tai Chi arms. There was no difference between treatment arms in UPDRS III
Hackney 2010	St. Louis, Missouri, USA	Partnered tango (n=19; 1 hour, twice weekly, 10 weeks)	Non-partnered tango (n=20; 1 hour, twice weekly, 10 weeks)			7 (n=1; progressive decline in mental status, n=2; excessive travelling distance, n=1; felt classes were too fatiguing, n=3; unable to return for follow-up measures)	5 (n=1; expressed lack of interest, n=1; new job interfered with class, n=1; unrelated medical problems, n=1; work commitments, n=1; unable to return for follow-up measures)			Tandem stance, one leg stance, Timed up and go, 6 minute walk test, Gait velocity, Cadence, Stride length, Swing percentage, Double support percentage	There was no difference between treatment arms
Hass 2006	Florida, USA	Tai Chi (n=unknown, total n=23; 1 hour,	Qi-gong (n=unknown, total n=23; 1 hour,			Unknown	Unknown			Gait initiation, Gait velocity, Stride length,	There was no difference between treat-

Table 1. Included trials: summary table of results (*Continued*)

		twice weekly, 16 weeks)	twice weekly, 16 weeks)							Stance, Double limb support, Step duration	ment arms
Hirsch 1996	North Carolina, USA	Combined balance and resistance training (n=6; 45 minutes, 3 times per week, 10 weeks)	Balance training group (n=9; 30 minutes, 3 times per week, 10 weeks)			0	0			Balance, Muscle strength (subset group): knee extensors, knee flexors, ankle plantar flexors Latency to fall, % of trials resulting in falls	Combined balance and resistance training improved balance scores significantly more than the balance training group. There were no differences between treatment arms for the falls outcomes
Joudoux 2011	Crétil, France	Asymmetric motor training program (n=unknown, total n=50; 1 hour, 3 times per	Broad program (n=unknown, total n=50; 1 hour, 3 times per week, 8 weeks)			Unknown	Unknown			UPDRS III, GMT score, Rapid alternating movements, Handwriting and	Abatract describing methodology. No result data

Table 1. Included trials: summary table of results (*Continued*)

		week, 8 weeks)								spiralography, PDQ-39, Dpression (GDS-15), Video recording of 8 activities of daily living and biomechanical evaluations	
Juncos 2006	Georgia, USA	Aerobic exercise (n=unknown, total n=56; 6 months)	Tai Chi (n=unknown, total n=56; 6 months)	Qi-gong (n=unknown, total n=56; 6 months)		Unknown (total n=16: n=2; serious adverse events, n=14; unrelated medical or logistical problems)	Unknown (total n=16: n=2; serious adverse events, n=14; unrelated medical or logistical problems)	Unknown (total n=16: n=2; serious adverse events, n=14; unrelated medical or logistical problems)		UPDRS total, UPDRS motor, UPDRS ADL, PDQ-39, Clinical global impression, Walking speed, Falls	UPDRS ADL scores improved significantly more with Qi-gong than aerobic exercise. There was no difference between treatment arms for PDQ-39 and UPDRS total and

Table 1. Included trials: summary table of results (*Continued*)

											motor sub-scores. There was insufficient information on clinical global impression, walking speed and falls
Khallaf 2011	Saudi Arabia	Physiotherapy and treadmill (n=15)	Physiotherapy (n=15)			Unknown	Unknown			UPDRS II & III, Hamilton rating scale of depression, Walking speed, Walking distance	Both treatment arms showed significant improvement in walking distance, speed and ADL. A significant improvement in depression only observed in physiotherapy and treadmill group.

Table 1. Included trials: summary table of results (*Continued*)

											Unclear if there were any differences between treatment arms
Li 2012	Oregon, USA	Tai Chi (n=65; 1 hour, twice weekly, 24 weeks)	Resistance training (n=65; 1 hour, twice weekly, 24 weeks)	Control, stretching group (n=65; 1 hour, twice weekly, 24 weeks)		9 (n=4; health problem, n=3; non-committal/time conflict, n=2; relocating)	6 (n=4; health problem, n=1; non-committal/time conflict, n=1; relocating)	4 (n=3; health problem, n=1; non-committal/time conflict)		Primary: Two indicators of postural stability: maximum excursion and directional control Secondary: Stride length, Walking velocity, Strength of bilateral knee extensors and flexors, Functional reach test, Timed up and go, UPDRS III, Number of falls	The Tai Chi group performed significantly better than those in the resistance training and stretching groups on the primary outcomes. The Tai Chi group had significantly better performance/ scores in many outcomes

Table 1. Included trials: summary table of results (*Continued*)

											compared to the stretching group. The Tai Chi group out performed the resistance training group on the stride length and functional reach
Loureiro 2010	Católica do Paraná, Brazil	Conventional physical therapy (n=6, sessions, twice weekly, total 12 sessions)	Complementary activities (n=6, sessions, twice weekly, total 12 sessions)			Unknown	Unknown			Timed up and go, Anterior functional reach	There was no difference between treatment arms
Mak 2008	Hong Kong, China	Audio-visual cued task-specific training (n=21; 20 minutes, 3 times per week, 4 weeks)	Conventional exercise (n=21; 45 minutes, twice weekly, 4 weeks)	Control (n=18; 4 weeks)		2 (n=1; change of medication, n=1; heel pain)	2 (n=1; fall with fracture, n=1; went overseas)	4 (n=2; declined to come back, n=2; went overseas)		Peak horizontal velocity, Peak vertical velocity, Movement time,3 D Kinematics data of sit-to-	The audio-visual cued task-specific training group increased both peak

Table 1. Included trials: summary table of results (*Continued*)

										stand	horizontal and vertical velocities and reduced time taken to complete sit-to-stand. These improvements were greater than those of the conventional exercise group and control
McGinley 2012	Carlton, Australia	Movement strategy training (n=69; 2 hours + 2 hours home practice program, once a week, 8 weeks)	Progressive strength training (n=70; 2 hours + 2 hours home practice program, once a week, 8 weeks)	Life skills control (n=71; 2 hours + 2 hours home practice program, once a week, 8 weeks)		2 (n=1; unable or unwilling to attend, n=1; death)	1 (n=1; health reasons)	12 (n=2; unable or unwilling to attend, n=2; poor health, n=1; preference for exercise group, n=1; death, n=2; health reasons, n=1;		Primary: Falls: no. of fallers per group, no. of multiple fallers per group, falls rate over 12 months in each group Secondary: Number of in-	Time to first fall during the intervention phase did not differ across groups. Full trial results not yet published

Table 1. Included trials: summary table of results (*Continued*)

								unspecified, n=1; group was "depressing", n=2, not exercising or receiving falls education)		jurious falls, Walking speed, 6 minute walk test, Timed up and go, UPDRS II and III, PDQ-39, EuroQol-5D	
Miyai 2000	Osaka, Japan	Body weight supported treadmill training (n=5; 45 minutes, three times per week, 4 weeks)	Physical therapy (n=5; 45 minutes, three times per week, 4 weeks)			0	0			UPDRS, UPDRS subscales (mental, ADL, motor and complications), Overground ambulation endurance, Gait speed, No. steps taken for 10 metre walk	Crossover trial, combined data presented. Body weight-supported treadmill training showed greater improvement in UPDRS total, ambulation speed and number of steps than

Table 1. Included trials: summary table of results (*Continued*)

											physical therapy arm. Additional data supplied by author allowed data to be separated and there was no difference between arms
Miyai 2002	Osaka, Japan	Body weight supported treadmill training (n= 11; 45 minutes, three times per week, 4 weeks)	Physical therapy (n=9; 45 minutes, three times per week, 4 weeks)			1 (n= 1, medication changed)	3 (n= 3, medication changed)			Primary: UPDRS, Gait speed, No. steps taken for 10 metre walk Secondary: UPDRS subscales (mental, ADL, motor and complications)	Body weight-supported treadmill training had significantly greater improvement than the physical therapy group in gait speed at 1 month; and in the number of steps at 1, 3 and 4 months

Table 1. Included trials: summary table of results (*Continued*)

Morris 2009	Melbourne, Australia	Movement strategy training (n=14; 45 minutes, max 16 sessions over 2 weeks)	Musculoskeletal exercise (n=14; 45 minutes, max 16 sessions over 2 weeks)			0	2 (n=2; lost to follow up, no details)			Primary: UPDRS Motor and ADL (combined). Secondary: 10 m walk test, Timed up and go, 2 min walk test, Balance-shoulder tug, PDQ-39	The movement strategy training group had a significant improvement in balance compared to the musculoskeletal arm. There were no other differences between treatment arms
Palmer 1986	Minneapolis, Minnesota, USA	United Parkinson Foundation exercise program (n=7; 1 hour, three times per week, 12 weeks)	Upper body karate training program (n=7; 1 hour, three times per week, 12 weeks)			0	0			Forearm pronation/supination rate, Pursuit score walk index, Degree of activated rigidity, Degree of arm tremor, Acti-	Study did not compare differences between treatment arms

Table 1. Included trials: summary table of results (*Continued*)

										vated rigidity, Grip strength, 9-hole peg test, Minnesota placing and turning test, Arm swings test, Rapid alternating arm movement test, Button board, Putting shirt on and off, Putting shoes and socks on and off, Getting up from chair, Long latency stretch response	
Pelosin 2010	Genova, Italy	Action plus physical therapy group (n=9; 1 hour, three times per	Landscape plus physical therapy group (n=9; 1 hour, three times			1 (n=1; found to have past history of neurological conditions other	1 (n=1; found to have past history of neurological conditions			FOG Questionnaire and FOG diary, Timed up and	At post-test there was no difference between treatment arms

Table 1. Included trials: summary table of results (*Continued*)

		week, 4 weeks)	per week, 4 weeks)			than PD or implantation for deep brain stimulation)	other than PD or implantation for deep brain stimulation)			go, 10 metre walking test, Tinetti scale part I and II, Berg balance scale, PDQ-39	
Picelli 2012	Verona, Italy	Robot assisted gait-training group (n=21; 45 minutes, three times per week, 4 weeks)	Physiotherapy group (n=20; 45 minutes, three times per week, 4 weeks)			3 (n=3; lack of cooperation)	2 (n=2; lack of cooperation)			Primary: 10 m walk test, 6 min walk test. Secondary: Spatiotemporal gait parameters including stride length, Parkinson's fatigue scale, UPDRS Total	Robot assisted gait-training significantly improved 10 m walk test, 6 min walk test, Parkinson's fatigue scale, UPDRS Total compared to the physiotherapy group
Poliakoff 2009	Manchester, UK	20 week gym group (n=16; 1 hour, twice a week, 20 weeks)	10 week gym group (n=16; 1 hour, twice a week, 10 weeks)			4 (n=1; randomised but did not start intervention, n=3; did	6 (n=1; randomised but did not start intervention, n=5; did			Simple, choice and serial reaction time, Video-	No significant differences between arms, except for

Table 1. Included trials: summary table of results (*Continued*)

						not complete or insufficient sessions)	not complete or insufficient sessions)			taped motor performance, PDQ-39, UPDRS III, Illness perceptions (BIPQ), Questionnaire assessing experiences of programme	the learning sequence RT outcome
Reuter 2011	Giessen, Germany	Nordic walking group (n=30; 70 minutes, three times per week, 6 months)	Walking group (n=30; 70 minutes, three times per week, 6 months)	Flexibility and relaxation group (n=30; 70 minutes, three times per week, 6 months)		0	0	0		Max walking speed on treadmill, 12 m and 24 m walking test, Stride length, Gait variability, UPDRS, PDQ-39, Physical activity in everyday life, Adverse effects	Main reported differences were that the Nordic walking group was superior to the walking and flexibility and relaxation programme in improving postural stability, stride length,

Table 1. Included trials: summary table of results (*Continued*)

											gait pattern, and gait variability
Ridgel 2009	Cleveland, Ohio, USA	Forced exercise group (n=5; 1 hour, 3 times per week, 8 weeks)	Voluntary exercise group (n=5; 1 hour, 3 times per week, 8 weeks)			0	0			UPDRS part III Manual functional dexterity, Bimanual dexterity, Centre of pressure (CoP)	UPDRS motor scores showed a significantly greater improvement in the forced exercise arm compared to the voluntary exercise arm. Only forced exercise resulted in significant improvements in bimanual dexterity
Robichaud 2012	Chicago, Illinois, USA	Progressive resistance exercise (n=unknown (total n=48 at 6 month time	Fitness counts (n=unknown (total n=48 at 6 month time point); 1 hour,			Unknown	Unknown			UPDRS motor, Timed up and go, Berg balance scale, Modified	There was no difference between treatment arms

Table 1. Included trials: summary table of results (*Continued*)

		point); 1 hour, twice per week, 24 months)	twice per week, 24 months)							physical performance test	
Schenkman 2012a	Denver, Colorado, USA	Flexibilty/ balance/ function exercise group (n=39; 1 hour, 3 times per week for the first 4 months then tapered for 1 month to once monthly sessions out to 16 months)	Aerobic exercise group (n=41; 1 hour, 3 times per week for the first 4 months then tapered for 1 month to once monthly sessions out to 16 months)	Home exercise group (n=41; once monthly supervised sessions)		3 at 4 months (n=1; health problems, n=2; personal issues)	7 at 4 months (n=1; not happy with the program, n=2; missed appointment, n=2; health problems, n=1; moved, n=1; deceased)	6 at 4 months (n=3; not happy with the program, n=1; did not return calls, n=1 unable to commit the time, n=1; missed appointment)		Primary: Overall physical function, Balance - functional reach, Walking economy - VO_2 Secondary: UPDRS ADL, UPDRS Motor, PDQ-39	Overall physical function: improvement at 4 months was greater in the Flexibilty/ balance/ function exercise group than the aerobic and home exercise group. Functional reach was not different between groups. Walking economy: aerobic exercise improved

Table 1. Included trials: summary table of results (*Continued*)

											compared to Flexibilty/ balance/ function exercise group. The only secondary outcome that showed significant differences was UPDRS ADL: Flexibilty/ balance/ function exercise group performed better than home exercise group at 4 months
Shankar 2009	Calgary, Canada	Treadmill with cueing group (n=10; 30 minutes, twice a week, 8 weeks)	Treadmill without cueing (n=9; 30 minutes, twice a week, 8 weeks)	Cueing only group (n=10; 30 minutes, twice a week, 8 weeks)		0	0	0		Gait and Balance Scale, UPDRS III, PDQ-39	Limited data. There was no difference between treatment arms

Table 1. Included trials: summary table of results (*Continued*)

Shen 2011	Hong Kong, China	Balance group (n=23; treatment delivered over 12 weeks)	Strength training (n=22; treatment delivered over 12 weeks)			0	0			Limit of stability, Walking speed, One leg stance time, Activities-specific balance confidence scale, UPDRS III	Limited data. The balance group improved significantly more than the strength group in movement velocity and one leg stance
Shiba 1999	Kanagawa, Japan	Visual stimulation (n= unknown, total n= 8; treated for an unknown period of time)	Auditory stimulation (n= unknown, total n= 8; treated for an unknown period of time)			0	0			Stride length	Stride length was significantly greater after visual stimulation than after auditory stimulation gait training
Sigurgeirsson 2009	Reykjalundur, Iceland	Walking with visual cues (n=unknown, total n=26; 30 minutes, 4 sessions per week, 4	Walking without cues (n= unknown, total n=26; 30 minutes, 4 sessions per			Unknown	Unknown			Timed up and go, PDQ-39	Limited data. There was no difference between treatment arms for

Table 1. Included trials: summary table of results (*Continued*)

		weeks)	week, 4 weeks)								Timed up and go
Smania 2010	Verona, Italy	Balance training (n=33; 50 minutes, 3 times per week, 7 weeks)	General physical exercise (n=31; 50 minutes, 3 times per week, 7 weeks)			5 (n=2; uncooperativeness, n=3; medical complications)	4 (n=2; uncooperativeness, n=2; medical complications)			Primary: Berg balance scale, Activities-specific balance confidence, Postural transfer test, Self destabilization of the centre of foot pressure test, Falls diary Secondary: UPDRS Total, Modified Hoehn and Yahr, Geriatric depression scale	There was a significant difference in favour of the balance training arm in the Berg Balance Scale and the self destabilization of the centre of foot pressure test when compared to the general physical exercise group
Talakkad 2011	Bangalore, India	Conventional gait training (n=unknown, total n=60; 8 hours	Partial weight supported treadmill training: 20% unweight-	Control: No specific intervention (n=unknown, total n=60)		Unknown	Unknown	Unknown		Dynamic posturography, UPDRS (total and motor sub-	Limited data. Partial weight supported (-20%) tread-

Table 1. Included trials: summary table of results (*Continued*)

		over 4 weeks)	ing (n= unknown, total n= 60; 8 hours over 4 weeks)							score), Beat-to-beat finger blood pressure	mill training had a significantly greater improvement in UPDRS motor score compared to conventional gait training
Thaut 1996	Colorado, USA	Novel rhythmic auditory stimulation group (n=15; 30 minutes per day, total 10. 5 hours over 3 weeks)	Standard self paced training group (n=11; 30 minutes per day, total 10. 5 hours over 3 weeks)	No treatment group (n=11)		0	0	0		Stride velocity, Stride cadence, Stride length, EMG analysis on leg muscles	Rhythmic auditory stimulation group improved significantly for flat and incline velocity compared to the self paced training. The rhythmic auditory stimulation group's

Table 1. Included trials: summary table of results (*Continued*)

											improvements in stride length were only significantly better than the no treatment group and changes in cadence were only significantly higher than the self paced training group
Toole 2005	Florida, USA	Standard treadmill group (n=unknown, total n=23; 20 minutes, 3 times per week, 6 weeks)	Unweighted treadmill group (n=unknown, total n=23; 20 minutes, 3 times per week, 6 weeks)	Weighted treadmill group (n=unknown, total n=23; 20 minutes, 3 times per week, 6 weeks)		Unknown	Unknown	Unknown		Balance from dynamic posturography, Berg balance scale, UPDRS, Biomechanical assessment of strength and range of motion, Gait	There was no difference between treatment arms for function and stability in gait and dynamic balance

Table 1. Included trials: summary table of results (*Continued*)

Vivas 2011	A Coruña, Spain	Water based exercise group (n=6; 45 minutes, twice weekly, 4 weeks)	Land based exercise group (n=6; 45 minutes, twice weekly, 4 weeks)			1 (n=1; influenza - did not receive intervention)	0			Functional reach test, Berg balance scale, Gait - turn time, velocity, cadence, step amplitude, Timed up and go, UPDRS	The water based exercise group significantly improved Berg Balance Scale and UPDRS compared to the land based exercise group. There was no difference between treatment arms for the remaining outcomes
Werner 2010	New York, USA	Verbal instruction with augmented feedback group (n=6; 90 minutes, 2 times per week, 2 weeks)	Verbal instruction only group (n=6; 90 minutes, 2 times per week, 2 weeks)			0	0			Stride length, Cadence, Gait velocity, Shoulder excursion	There was no difference between treatment arms

Table 1. Included trials: summary table of results (*Continued*)

Yang 2010	Taipei, Taiwan	Downhill walking group (n=16; 30 minutes, 3 times per week, 4 weeks)	Physiotherapy group (n=17; 30 minutes, 3 times per week, 4 weeks)			1 (n=1; low motivation)	2 (n=1; conflicting work schedule, n=1; transport problem)			Speed, Candence, Stride length, Thoriacic kyphosis, Muscle strength	Downhill walking significantly improved gait speed, stride length and muscle strength of knee extensors compared to physiotherapy

APPENDICES

Appendix 1. Search strategies

Cochrane Movement Disorders Specialised Register (search end of January 2012).
#1. SR-Movement
#2. physiotherapy
#3. exercise
#4. physical therapy
#5. rehabilitation
#6. #2 or #3 or #4 or #5
#7. Parkinson
#8. Parkinsons disease
#9. parkinsonism
#10. #7 or #8 or #9
#11. #1 and #6 and #10
The Cochrane Library and The Cochrane Controlled Trials Register (Wiley online library) (Issue 1, 2012).
#1. MeSH descriptor: [Parkinson Disease] explode all trees
#2. parkinson*
#3. parkinsonism
#4. {or #1-#3}
#5. MeSH descriptor Physical Therapy (Speciality) explode all trees
#6. MeSH descriptor Physical Therapy Modalities explode all trees

#7. physical therapy
#8. physiotherapy
#9. MeSH descriptor Exercise explode all trees
#10. exercise
#11. MeSH descriptor Rehabilitation explode all trees
#12. rehabilitation
#13. {or #5-#13}
#14. #4 and #13

MEDLINE (Ovid) 1966 - Jauary (Week 4) 2012.

1. randomized controlled trial.pt
2. controlled clinical trial.pt
3. randomized.ab.
4. placebo.ab.
5. drug therapy.fs.
6. randomly.ab.
7. trial.ab.
8. groups.ab.
9. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8
10. exp animals/ not humans.sh.
11. 9 not 10
12. exp Parkinson Disease/
13. "parkinson*".ab.ti.
14. 12 or 13
15.exp "Physical Therapy (Specialty)"/
16. physiotherapy.mp.
17. exp Exercise/
18. exp Rehabilitation/
19. exercise*.mp. [mp=title, original title, abstract, name of substance word, subject heading word, unique identifier]
20. rehabilitation*.mp. [mp=title, original title, abstract, name of substance word, subject heading word, unique identifier]
21. 15 or 16 or 17 or 18 or 19 or 20
22. 11 and 14 and 21
23. limit 22 to yr="2001 -Current"

EMBASE (Ovid) 1974 - January (Week 4) 2012.

1. random$.mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer name]
2. factorial$.mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer name]
3. (crossover$ or cross-over$).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer name]
4. placebo$.mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer name]
5. (doubl$ adj blind$).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer name]
6. (singl$ adj blind$).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer name]
7. assign$.mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer name]
8. allocat$.mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer name]
9. volunteer$.mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer name]
10. crossover procedure.sh.
11. Double-blind Procedure.sh.
12. Randomized Controlled Trial.sh.
13. Single-blind Procedure.sh.
14. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13
15. exp Parkinson Disease/
16. parkinson*.mp.
17. 15 or 16

18. exp physiotherapy/
19. physical therapy.mp.
20. exp Exercise/
21. exp Rehabilitation/
22. physiotherapy.mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer name]
23. exercise.mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer name]
24. rehabilitation.mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer name]
25. 18 or 19 or 20 or 21 or 22 or 23 or 24
26. 14 and 17 and 25
27. limit 26 to yr="2001 - Current"

CINAHL (EBSCO) (1982-2012).

S1. (MH "Random Assignment")
S2. (MH "Comparative Studies")
S3. (MH "Clinical Research+")
S4. (MH "Clinical Trials+")
S5. (MH "Evaluation Research+")
S6. TX ((control* or clinic* or prospective*) adj5 (trial* or study or studies))
S7. TX cross*over*
S8. TX (compar* adj5 (trial* or study* or studies))
S9. "random$"
S10. "placebo"
S11. "RCT"
S12. (S1 or S2 or S3 or S4 or S5 or S6 or S7 or S8 or S9 or S10 or S11)
S13. (MH "Parkinson Disease")
S14. "Parkinson*"
S15. "physiotherapy"
S16. (MH "Physical Therapy+")
S17. (MH "Exercise+")
S18. rehabilitation
S19. S13 or S14
S20. S15 or S16 or S17 or S18
S21. S12 and S19 and S20

ISI Web of Science: Science Citation Index Expanded (SCI-EXPANDED) (1981 to January 2012), ISI Web of Science: Conference Proceedings Citation Index-Science (CPCI-S) (1982 to January 2012).

#1. TS=clinical trial*
#2. TS=research design
#3. TS=comparative stud*
#4. TS=evaluation stud*
#5. TS=controlled trial*
#6. TS=follow-up stud*
#7. TS=prospective stud*
#8. TS=random*
#9. TS=placebo*
#10. TS=(single blind*)
#11. TS=(double blind*)
#12. #11 OR #10 OR #9 OR #8 OR #7 OR #6 OR #5 OR #4 OR #3 OR #2 OR #1
#13. TS=(parkinson disease)
#14. TS=parkinson*
#15. #13 OR #14
#16. TS=physiotherap*
#17. TS=(physical therap*)
#18. TS=exercise*
#19. TS=rehabilitation*

#20. #19 OR #18 OR #17 OR #16
#21. #20 AND #15 AND #12

AMED (EBSCO) (1985-2012).
S1. (MH "Random Assignment")
S2. (MH "Comparative Studies")
S3. (MH "Clinical Research+")
S4. (MH "Clinical Trials+")
S5. (MH "Evaluation Research+")
S6. TX ((control* or clinic* or prospective*) adj5 (trial* or study or studies))
S7. TX cross*over*
S8. TX (compar* adj5 (trial* or study* or studies))
S9. "random$"
S10. "placebo"
S11. "RCT"
S12. (S1 or S2 or S3 or S4 or S5 or S6 or S7 or S8 or S9 or S10 or S11)
S13. (MH "Parkinson Disease")
S14. "Parkinson*"
S15. "physiotherapy"
S16. (MH "Physical Therapy+")
S17. (MH "Exercise+")
S18. rehabilitation
S19. S13 or S14
S20. S15 or S16 or S17 or S18
S21. S12 and S19 and S20

REHABDATA (1995-2012). Searched using the term Parkinson*

REHADAT (1990 - 2012). Searched using the term Parkinson.

PEDro (1929-2012). Searched using the term Parkinson.

GEROLIT (1979-2012). Searched using the terms "parkinson*" AND "physi*", "parkinson*" AND "exercise*", "parkinson* AND rehabilitation*"

LILACS (Virtual Health Library) (1982-2012); MedCarib (Virtual Health Library) (17th Century-2012); IMEMR (1984-2012). Searched using the terms "Parkinson$" AND "physi$", "Parkinson$" AND "exercise$", "Parkinson$" AND "rehabilitat$", "Parkinson$" AND "physiotherap$".

The Cochrane Controlled Trials Register. See the Cochrane Library.

The CentreWatch Clinical Trials listing service. Screened all entries under the Medical Condition 'Parkinson's Disease'.

The metaRegister of Controlled Trial; NIDRR. Searched using the term Parkinson.

ClinicalTrials.gov. Searched using the terms "parkinson" AND "(physical therapy OR physiotherapy OR exercise OR rehabilitation)".

RePORT. Searched using the terms "Parkinson" and "Rehabilitation", "Parkinson" and "Exercise", "Parkinson" and "Physical Therapy", "Parkinson" and "Physiotherapy".

NRR. Searched using the terms "Parkinson" and "Exercise", "Parkinson" and "Exercising", "Parkinson" and "Physiotherapy", "Parkinson" and "Physiotherapies", "Parkinson" and "Physical", "Parkinson" and "rehabilitation", "Parkinson" and "Rehabilitating", "Parkinson" and "Rehabilitate".

Conference Proceedings Citation Index (1982-2012). See ISI Web of Science.

DISSABS (DISSertation ABStracts) (1999-2012). Search using the term "parkinson".

Conference Papers Index (ProQuest) (1982-2012); Index to Theses (1970-2012); ProQuest dissertations and theses databases (1861-2012).
Searched using the terms (all(Physical therapy*) OR all(physiotherap*) OR all(exercise) OR all(rehabilitation*)) AND all(parkinson*).

Electronic Theses Online Service (EThOS) (16^{th} Century-2012). Searched using the terms "parkinson" AND "physical therapy", "parkinson" AND "physiotherapy", "parkinson" AND "exercise", "parkinson" AND "rehabilitation".

WHAT'S NEW

Last assessed as up-to-date: 31 January 2012.

Date	Event	Description
13 May 2014	New citation required but conclusions have not changed	Conclusions not changed
13 May 2014	New search has been performed	Search updated to 31 January 2012 New studies added, conclusions unchanged

HISTORY

Protocol first published: Issue 4, 2000

Review first published: Issue 1, 2001

Date	Event	Description
29 November 2000	New citation required and conclusions have changed	Substantive amendment

CONTRIBUTIONS OF AUTHORS

Claire Tomlinson was involved in searching and selection of studies, data extraction, analysis and interpretation of the review.

Clare Herd was involved in searching and selection of studies, data extraction, analysis and interpretation of the review.

Smitaa Patel was involved in selection of studies, data extraction.

Charmaine Meek was involved in selection of studies, data extraction and provided expert physiotherapy input into the interpretation of the review.

Carl Clarke contributed to the design of the protocol and was involved in the interpretation of the review providing clinical input.

Rebecca Stowe contributed to the design of the protocol and was involved in searching and selection of studies and interpretation of the review.

Laila Shah was involved in searching and selection of studies for the review.

Catherine Sackley contributed to the design of the protocol and provided expert physiotherapy input into the interpretation of the review.

Katherine Deane undertook the 2001 Cochrane Review, and was involved in the interpretation of this review.

Keith Wheatley contributed to the design of the protocol and was involved in the interpretation of the review.

Natalie Ives contributed to the design of the protocol and was involved in the analysis and interpretation of the review.

DECLARATIONS OF INTEREST

Carl Clarke, Natalie Ives, Charmaine Meek, Smitaa Patel, Catherine Sackley and Keith Wheatley are either recruiting for or involved in the running of the UK PD REHAB trial.

SOURCES OF SUPPORT

Internal sources

- No sources of support supplied

External sources

- Parkinson's UK, UK.
- Department of Health, UK.

INDEX TERMS

Medical Subject Headings (MeSH)

*Physical Therapy Modalities; Parkinson Disease [*rehabilitation]; Randomized Controlled Trials as Topic

MeSH check words

Humans