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Complementary physical therapies for movement disorders in Parkinson's disease: a systematic review

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Background. **The growth and popularity of complementary physical therapies for Parkinson's disease (PD) attempt to fill the gap left by conventional exercises, which does not always directly target wellbeing, enjoyment and social participation.**
Aim. **To evaluate the effects of complementary physical therapies on motor performance, quality of life and falls in people living with PD.**
Design. **Systematic review with meta-analysis.**
Population. **Outpatients — adults diagnosed with idiopathic PD, male or female, modified Hoehn and Yahr scale I-IV, any duration of PD, any duration of physical treatment or exercise.**
Methods. **Randomized controlled trials, non-randomized controlled trials and case series studies were identified by systematic searching of health and rehabilitation electronic databases. A standardized form was used to extract key data from studies by two independent researchers.**
Results. **1210 participants from 20 randomized controlled trials, two non-randomized controlled trials and 13 case series studies were included. Most studies had moderately strong methodological quality. Dancing, water exercises and robotic gait training were an effective adjunct to medical management for some people living with PD. Virtual reality training, mental practice, aerobic training, boxing and Nordic walking training had a small amount of evidence supporting their use in PD.**
Conclusion. **On balance, alternative physical therapies are worthy of consideration when selecting treatment options for people with this common chronic disease.**
Clinical Rehabilitation Impact. **Complementary physical therapies such as dancing, hydrotherapy and robotic gait training appear to afford therapeutic benefits, increasing mobility and quality of life, in some people living with PD.**

KEY WORDS: Parkinson disease - Rehabilitation - Exercise therapy - Complementary therapies.

Parkinson's disease (PD) is a common neurodegenerative disorder, especially in older adults.[1] The worldwide prevalence per 100,000 is around 425 for people aged 65-74 years, and above 1900 for those older than age 80.[2] People with PD can experience a range of movement disorders such as slowness, reduced movement amplitude, difficulty walking and balance problems.[3, 4] These movement disorders can be associated with falls [5, 6] and reduced quality of life.[7] If not carefully managed, movement disorders can lead to considerable disability.[8]

Worldwide, there is a trend towards including exercise, physical activity and movement rehabilitation alongside medical and surgical management of PD.[9-12] Physical therapies and movement rehabilitation are frequently recommended for people with

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PD and is received by around 7% people with PD in the UK and around 60% in the Netherlands.[13] Physical therapy incorporates a variety of methods and techniques such as movement strategies,[14] cueing,[11] progressive resistance strength training,[15] gait and balance training[16] and falls prevention program.[5] There are now several large systematic reviews on the outcomes of conventional physiotherapy for PD showing improvements in gait speed, step length, walking and turning, balance and motor disabilities.[3, 15-21]

In recent years, some complementary physical activities have been proposed for people with PD with the goal of optimizing mobility whilst at the same time being enjoyable, and enhancing quality of life, social inclusion and wellbeing.[22] These include activities such as dancing, boxing, tai chi, virtual reality training, robotic gait training, whole body vibration and hydrotherapy.[23-28] The growth and popularity of complementary therapies attempt to fill the gap left by conventional exercise therapy, which does not always directly target wellbeing, enjoyment and social participation. This might be one reason why conventional physical therapies for PD are sometimes associated with poor adherence and compliance over the longer term.

The aim of this systematic review was to evaluate the effects of complementary physical therapies aimed at improving motor disabilities in people living with PD. We have focused our review of alternative therapies on dancing, tai chi and related activities, martial arts, hydrotherapy, whole body vibration, robotic gait training, virtual reality training and mental practice, given that these are the most frequent approaches used in recent literature.

Materials and methods

Published articles meeting the following criteria were included in this systematic review:

Design:

— randomized controlled trials (RCTs);

— non-randomized controlled trials (NRCTs);

— case series studies.

NRCTs and case series studies were included to increase the representability and generality of the findings.

Participants:

— people diagnosed with idiopathic PD;

— adults (>18 years old);

— male or female;

— modified Hoehn and Yahr Scale I-IV (H&Y);[29]

— any duration of PD;

— any duration of physical treatment or exercise.

Interventions:

— "alternative" physical therapy compared with no treatment;

— "alternative" physical therapy compared with conventional physical therapy (*e.g.* cueing, strength training, gait training, balance training, hand training, physiotherapy);

— "alternative" physical therapy compared with another "alternative" method of physical therapy.

Dependent variables:

— mobility (Timed up and Go, five times sit to stand, Functional Reach Test);

— balance (Berg Balance Scale, ABC Scale, MiniBest Test, Tinetti Balance Scale, Four Square Step Test);

— gait (walking speed, step length, stride length, cadence, 10m Walk Test, 6min Walk Test);

— falls (Fall calendar, Falls Efficacy Scale);

— activities of daily living (Barthel Index, UPDRS II, B'DS, Schwab and England);

— quality of life (PDQ-39, SF-36, PDQL, Nottingham's Scale);

— disease severity (UPDRS, UPDRS III, UPDRS I).

Exclusion criteria

Books, theses and conference abstracts were not included in this systematic review.

We excluded studies that used specific trainings such as strength, resistance, stretching, balance and gait training with cues because they have been used as a type of physical therapy for a long time, with good quality of evidence of their benefits.

Identification and selection of studies

A systematic search of the literature was conducted with retrieval of published articles indexed on health electronic databases from Medline, Embase, Cinahl, The Cochrane Library and Pedro. The search was limited to studies written in English, Spanish or Portuguese, because these languages were spoken by the authors. Each database had a different search strategy. Nevertheless, for all of them the key words

were: "*Parkinson's disease, rehabilitation, non-conventional physical therapies, alternative therapies, complementary physical therapies, exercise therapy, socio environmental therapy*". References for the identified studies were also hand searched by the first author.

After the initial search the titles and abstracts identified were screened by the first author. Full-texts were then evaluated and documented by two authors (PAR and CV). Disagreements were resolved through a consensus meeting. Figure 1 shows the details for the search process.

Assessment of study characteristics

A standardized data extraction form containing key information was constructed to identify and extract features of the included studies. This included the types of therapies and treatments, the aims of the study, the design, the number of participants, sex, mean age, inclusion criteria, exclusion criteria, the mean modified HY Score, the method of randomization, allocation concealment, blinding, number of patients randomized, number of drop outs, outcomes, assessment tools and period, type of each intervention, duration of the program (number of sessions), therapy duration (length of session), frequency (number of therapies per week), follow up, results of each outcome (mean and standard deviation), and any side effects that occurred during the trial. To be included, the studies needed to assess functional mobility, activities of daily living, gait, quality of life, balance or a combination of these.

Each of the studies was examined in relation to risk of bias by two reviewers (PAR, CV), according to a standardized form based on the Cochrane collaboration tool.[30] All items were judged to be either adequate (low risk of bias), inadequate (high risk of bias) or unclear (unclear). Methodological quality was assessed with two different tools. The PEDro scale was used to assess RCT and for NRCT and case series we used the Downs and Black check-list.[31] Both scales are valid, reliable and have strong internal and external validity.[31-33]

Data synthesis

Due to the heterogeneity of studies and different designs and variables used, descriptive analyses were conducted with the interventions and variables. A meta-analysis of RCTs was conducted when possible.

Results

Thirty-five studies met the inclusion criteria for this systematic review. There were 20 RCTs, two NRCT and 13 case series studies. All provided reasonably clear descriptions of the participants and interventions.

Thirteen studies carried out follow-up assessments[23-25, 34-43].

Participants

The number of participants ranged from 6-145, with 1210 participants in total. All studies recorded the mean age, which had a mean of 60.17±10.26 years [24] to 72.77±7.87 years.[44] Two reported means without standard deviation (SD).[40, 45] One study did not described stage of disease progression.[25] The mean duration of PD ranged from 2.4 years to 11.2 years. One study did not provide data about disease duration.[46]

Therapy frequency

The frequency of therapy was defined as number of sessions per week. Three studies had one session per week,[26, 47, 48] 19 had two sessions per week [24, 34-36, 39-41, 44, 46, 49-58], eight provided therapy three times per week [23, 37, 38, 42, 43, 45, 49, 59] and six had therapy five times per week.[27, 60-64] One study reported different numbers of sessions across the trial,[49] ranging from two occasions of service per week to three occasion of service per week.

Therapy intensity

The intensity of therapy was reported in some investigations. Typically, intensity was reported in relation to the amount of weight lifted during progressive resistance strength training. Others quantified intensity in relationship to the speed of movements during therapy. Six studies provided data about therapy intensity.[37, 38, 42, 43, 47, 64]

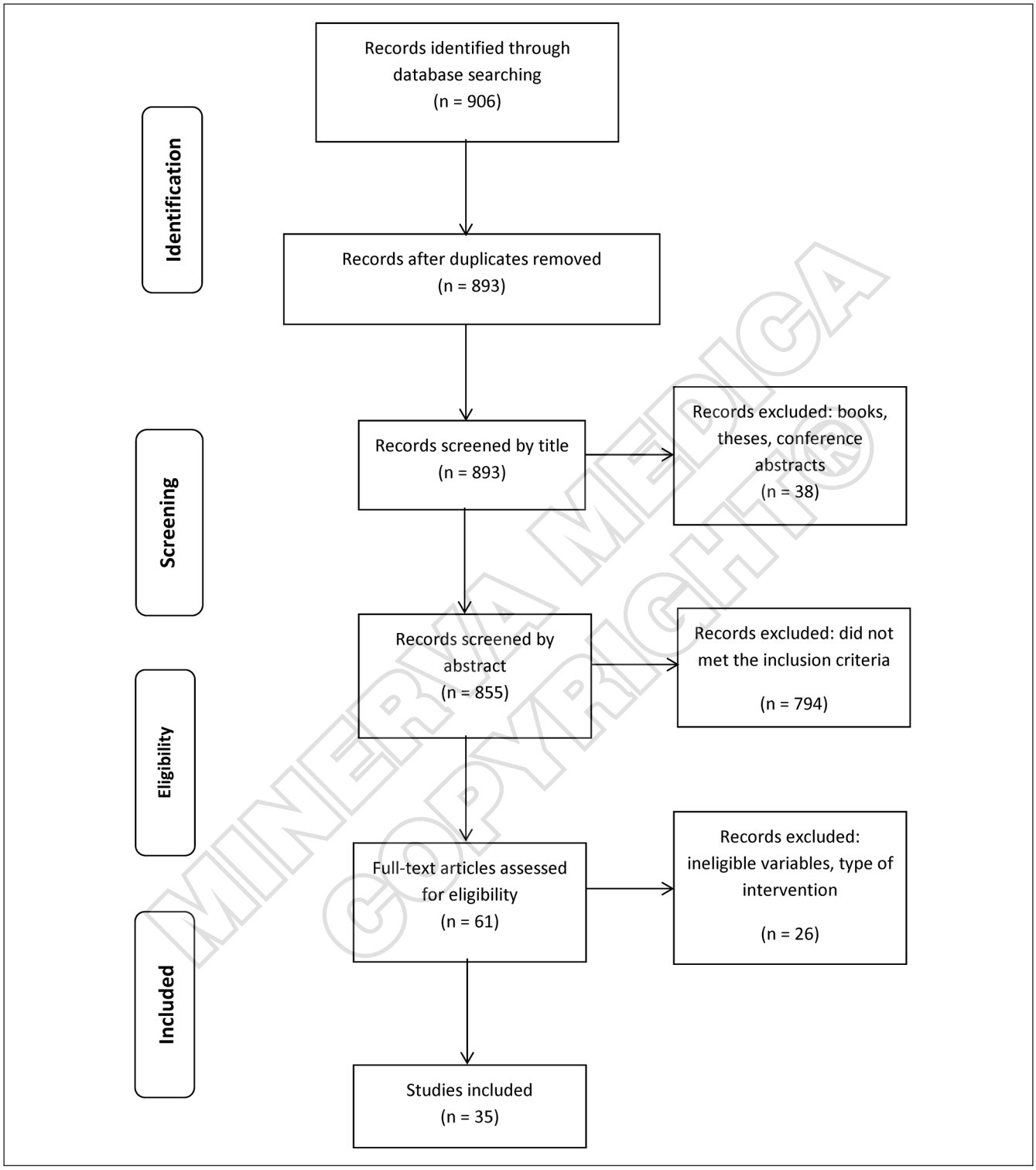

Figure 1.—Search Strategy Based on PRISMA Flow Diagram.

Therapy duration

The duration of each type of therapy was defined as the length of each session during the rehabilitation program. Six studies provided 90 minutes of therapy,[24, 26, 48, 61-63] 16 studies provided 60 minutes,[27, 34-36, 39, 40, 45, 49-53, 55-58] one provided 55 minutes,[44] one 50 minutes,[59] six provided 45 minutes,[37, 38, 41, 43, 47, 64] one study delivered 40 minute sessions[54], two implemented 30 minute sessions [23, 42] and one 20 minutes.[46] One study had session durations longer than 90 minutes.[25]

Type of therapy

Many of the alternative therapy studies were about dance therapy and hydrotherapy. The others were about tai chi, virtual reality therapy, mental practice, aerobic exercises, robotic gait training, boxing, whole body vibration and Nordic walking training. Table I lists the types of interventions used as well as studies design and measurement tools.

Feasibility and safety

Sixteen studies had no drop-outs during the sessions or over the follow up period.[26, 27, 37, 38, 40, 43-46, 49, 52, 54, 57, 62-64] Safety was determined by the number and severity of adverse effects during intervention. Twelve studies reported no adverse effects during therapy sessions.[23, 24, 27, 36, 38, 39, 43, 45, 46, 48, 50, 62] One study reported drop outs with participants reporting that "*the intervention causes too much effort and motor actions were too confronting*".[34] One study reported one fall during a therapy session.[26] The other studies did not mention adverse effects.

Methodological quality

Fourteen RCTs studies scored six to eight indicating good methodological quality,[23, 26, 27, 34, 36, 38, 39, 43, 49, 53, 57, 59, 61, 64] five of the studies scored four to five indicating fair quality [41, 42, 53, 55, 56, 58] and one scored three indicating relatively low quality [25] according to PEDro Scale.

One NRCT scored 17 indicating fair methodology quality.[44] One study scored 20 indicating good quality.[50] Most of the case series scored 16 to 19 indicating fair methodology quality.[24, 37, 40, 45-48, 51, 52, 61, 63] One scored less than 15 indicating poor quality [54] according to Downs and Black check-list.

Measurement tools

Table I shows the measurement tools used in each study. Mobility was the primary variable of interest for this systematic review and was reported in 19 studies using different measurement tools (Timed up and Go, five times sit to stand, Functional Reach Test). Gait was assessed in 24 studies, while balance was measured in 18 studies and falls just in two. Activities of daily living, quality of life and disease severity were measured in nine, 14 and 24 studies, respectively.

Therapy effects

TAI CHI (N.=2 RCT/1 CASE SERIES)

Studies that analyzed tai chi showed improvements for functional mobility, gait and disease severity.[36, 62] One RCT concluded that tai chi was not better than QiGong, with no significant differences between groups.[49] However this trial had a very small sample size (21 participants) compared to Li 2012 (195 participants).

WATER EXERCISES (N.=2NRCT, 2 CASE SERIES AND 2 RCT)

Some authors reported improvements in walking.[44, 51] Others showed that water exercises were associated with improved quality of life and falls.[27] The other studies did not show significant changes between groups.

ROBOTIC GAIT TRAINING (N.=4 RCT)

A small number of studies on robotic gait training demonstrated improvements in functional mobility,[2], balance [38] and disease severity.[64] All of them evidenced significant results on gait.

Robotic gait training had more optimal outcomes than physiotherapy for gait, balance and movement disorders. There were no differences between treadmill walking training and robotic gait training for gait and disease severity (Figures 2-4).

TABLE I.—*Study design, intervention and measurement tools.*

Intervention	Study	Measurement tools						
		Mobility	ADL	Gait	QoL	Balance	Falls	Disease severity
Tai Chi	Li 2007 (case series)[62]	●		●				
	Li 2012 (RCT)[36]	●		●			●	●
	Amano 2013 (RCT)[49]			●				●
Water Exercises	Ayan 2012a (NRCT)[50]	●			●			●
	Ayan 2012b (case series)[51]		●		●			●
	Ayan 2014 (NRCT)[44]			●				
	Vivas 2011 (RCT)[41]	●		●		●		●
	da Silva 2013 (case series)[52]				●			
	Volpe 2014 (RCT)[27]	●	●		●	●	●	●
Robotic Gait Training	Carda 2012 (RCT)[23]	●		●	●			●
	Picelli 2012 (RCT)[43]			●				●
	Picelli 2013 (RCT)[38]			●		●		●
	Sale 2013 (RCT)[64]			●				●
Dance	Volpe 2013 (RCT)[26]	●			●	●		●
	Hackney 2007 (RCT)[57]	●		●		●		●
	Hackney 2009a (RCT)[55]	●		●		●		●
	Hackney 2009b (RCT)[56]				●			●
	Hackney 2009c (case series)[61]	●		●		●		●
	Hackney 2010 (RCT)[35]	●		●		●		
	Duncan 2012 (RCT)[53]		●	●		●		●
	Marchant 2010 (case series)[63]	●		●	●	●		●
	Shanahan 2014 (case series)[48]			●	●			●
Virtual Reality	Goncalves 2014 (case series)[54]	●	●	●				●
	Pompeu 2012 (RCT)[39]		●			●		
	Mirelman 2011 (case series)[37]			●	●	●		●
	Mhatre 2013 (case series)[45]					●		
	Loureiro 2012 (case series)[46]	●			●	●		
Mental Practice	Braun 2011 (RCT)[34]	●		●				
	Tamir 2007 (RCT)[58]	●	●			●		●
Aerobic Training	Lauhoff 2013 (case series)[47]	●	●	●	●	●		●
	Burini 2006 (RCT)[59]		●	●	●			●
Boxing Training	Combs 2010 (case series)[24]	●	●	●	●	●		●
Whole Body Vibration	Ebersbach 2008 (RCT)[25]	●		●		●		●
Nordic and downhill walking training	van Eijkeren 2008 (case series)[40]	●		●	●			
	Yang 2010 (RCT)[42]			●				

DANCE (N.=6 RCT/2 CASE SERIES)

Several studies showed that dancing was associated with improvements in functional mobility,[26, 63] QoL,[48, 55] gait,[35, 56] balance [26, 35, 53, 56, 57, 61, 63] and disease severity.[26, 48, 53, 57, 61, 63]

Dance is more effective than no intervention for gait, balance and disease severity. Whether dance is more effective than physical therapy remains open question (Figures 2-4).

VIRTUAL REALITY (N.=4 CASE SERIES/1 RCT)

A small number of studies demonstrated improvements in functional mobility,[54] ADL,[39, 54] gait,[37, 54] QoL,[37] balance [37, 39, 45, 46] and movement

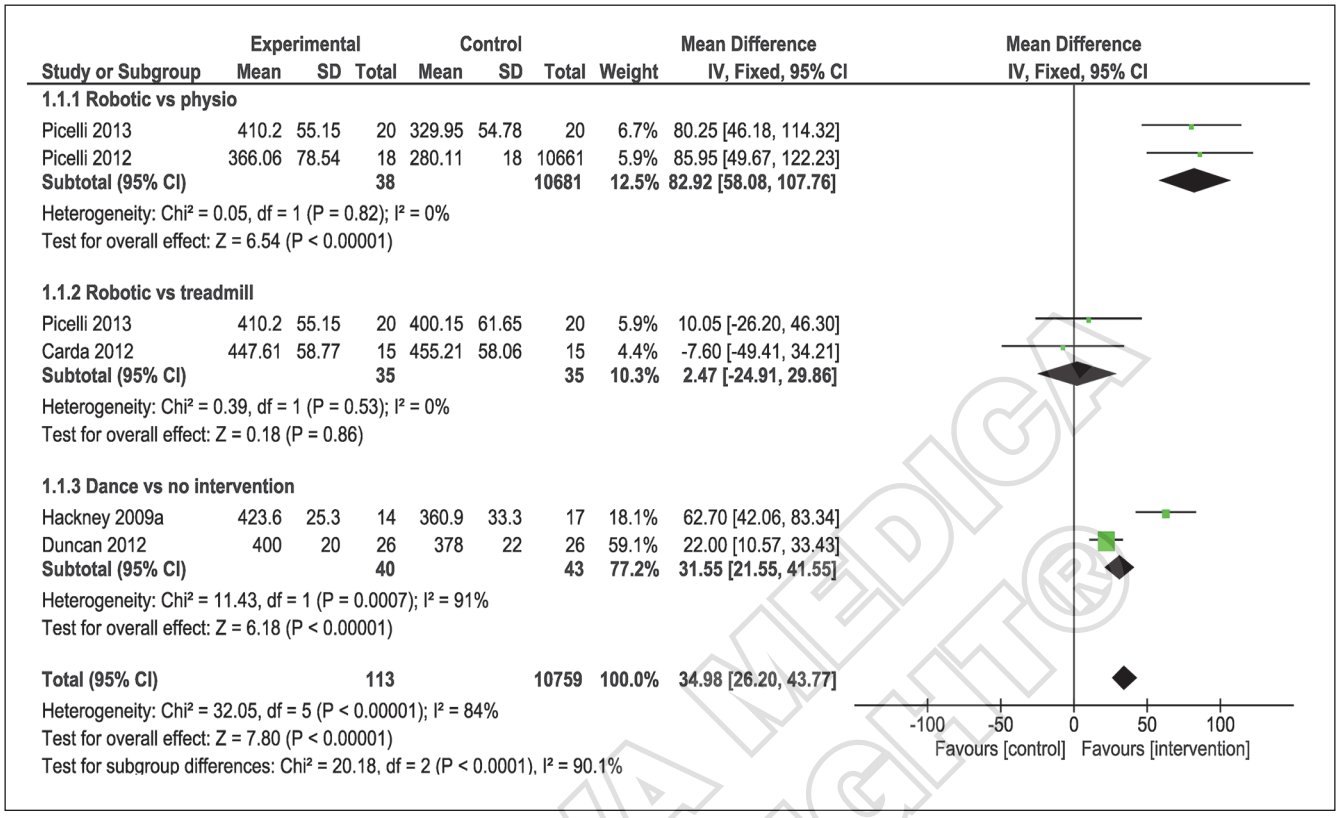

Figure 2.—Forest plot - 6mWT (m).

disorders.[37, 54] However, virtual reality therapy compared with physical therapy did not show better improvements on balance (Figure 3).

Mental practice (n.=2 RCT)

Two studies evaluated the benefits of mental practice.[34, 58] Braun *et al.* showed that mental practice was not better than relaxation therapy for people with PD. Tamir *et al.* reported select benefits of imagery training associated with physical practice on functional mobility and disease severity (Figure 4).

Aerobic training (n.=1 RCT/1 case series)

Two studies used cycle ergometer as aerobic training. One showed improvements in functional mobility, ADL, balance and disease severity.[47] The other demonstrated significant improvements in walking.[59]

Boxing training (n.=1 case series)

The author demonstrated that boxing therapy could improve functional mobility, ADL, gait and balance in some people with PD.[24]

Whole body vibration (n.=1 RCT)

Just one small study analyzed the effects of whole body vibration in people with PD reporting modest improvements in the short term for mobility, gait, balance and disease severity[25]. This has not since been replicated.

Nordic and downhill walking training (n.=1 RCT/1 case series)

One study used Nordic walking training as a treatment for PD participants and demonstrated significant benefits in functional mobility, gait and QoL.[40]

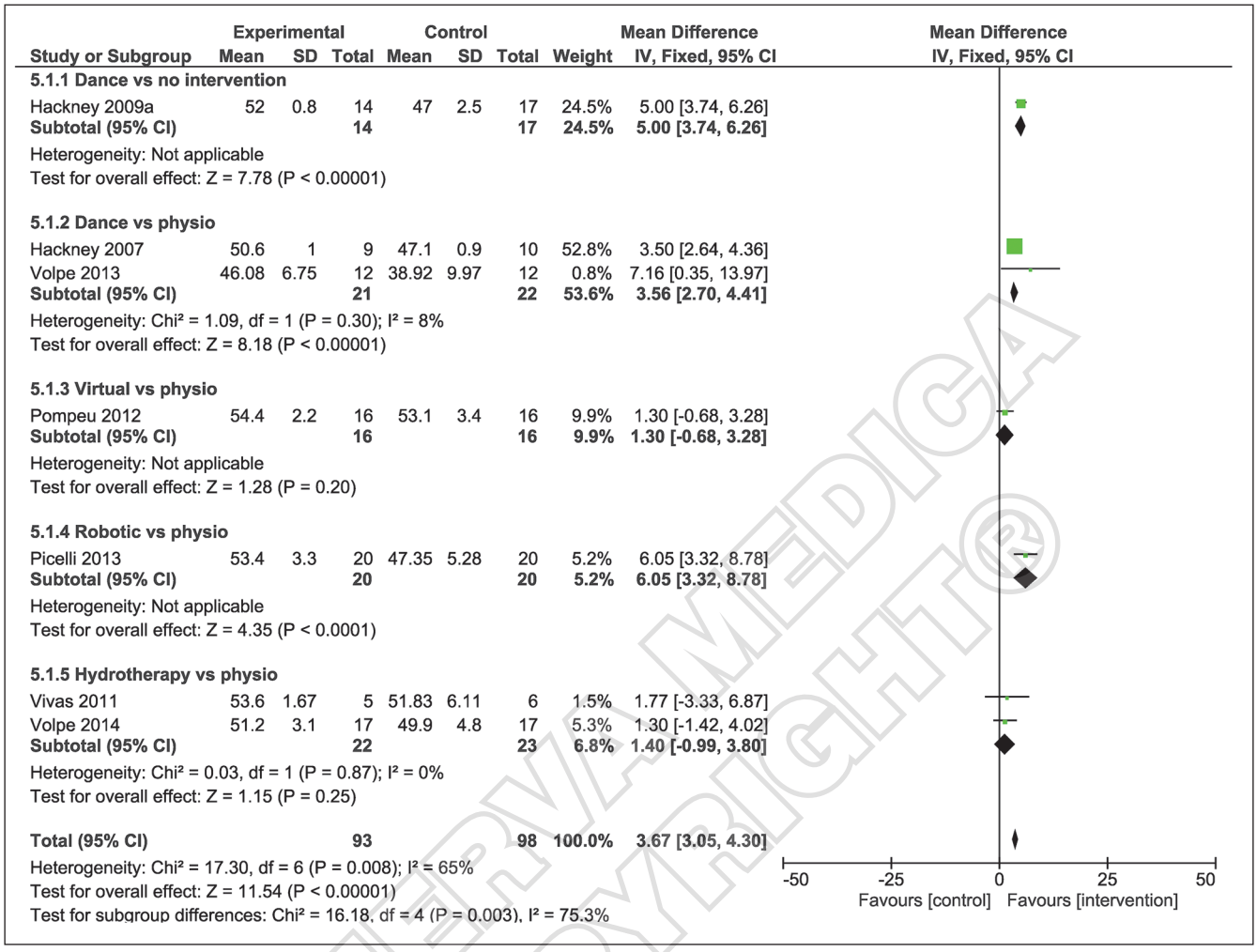

Figure 3.—Forest plot - BBS.

The other study analyzed the effect of downhill walking training, and showed significant improvements in walking.[42]

Discussion

This systematic review showed that a range of complementary physical therapies can assist with the rehabilitation of movement, balance, falls and functional ability in people living with Parkinson's. Overall, the literature on complementary therapies was of moderate strength from a methodological perspective. Nevertheless there was a consistent message that some physical therapies such as dancing, water exercises, virtual reality training and Nordic walking might enable some people with PD to move more easily and to enjoy greater health and wellbeing. These findings add to the existing body of evidence showing the beneficial effects of traditional physical therapies such as cueing, cognitive strategies, progressive resistance strength training, falls prevention education and gait training for people with PD.[3, 10, 11, 15, 19, 20, 65, 66]

The largest study on complementary physical therapy with a high level of evidence was from Li *et al.*, (2012) who studied tai chi. Consistent with other investigations [62, 67-70] Li *et al.* showed that tai

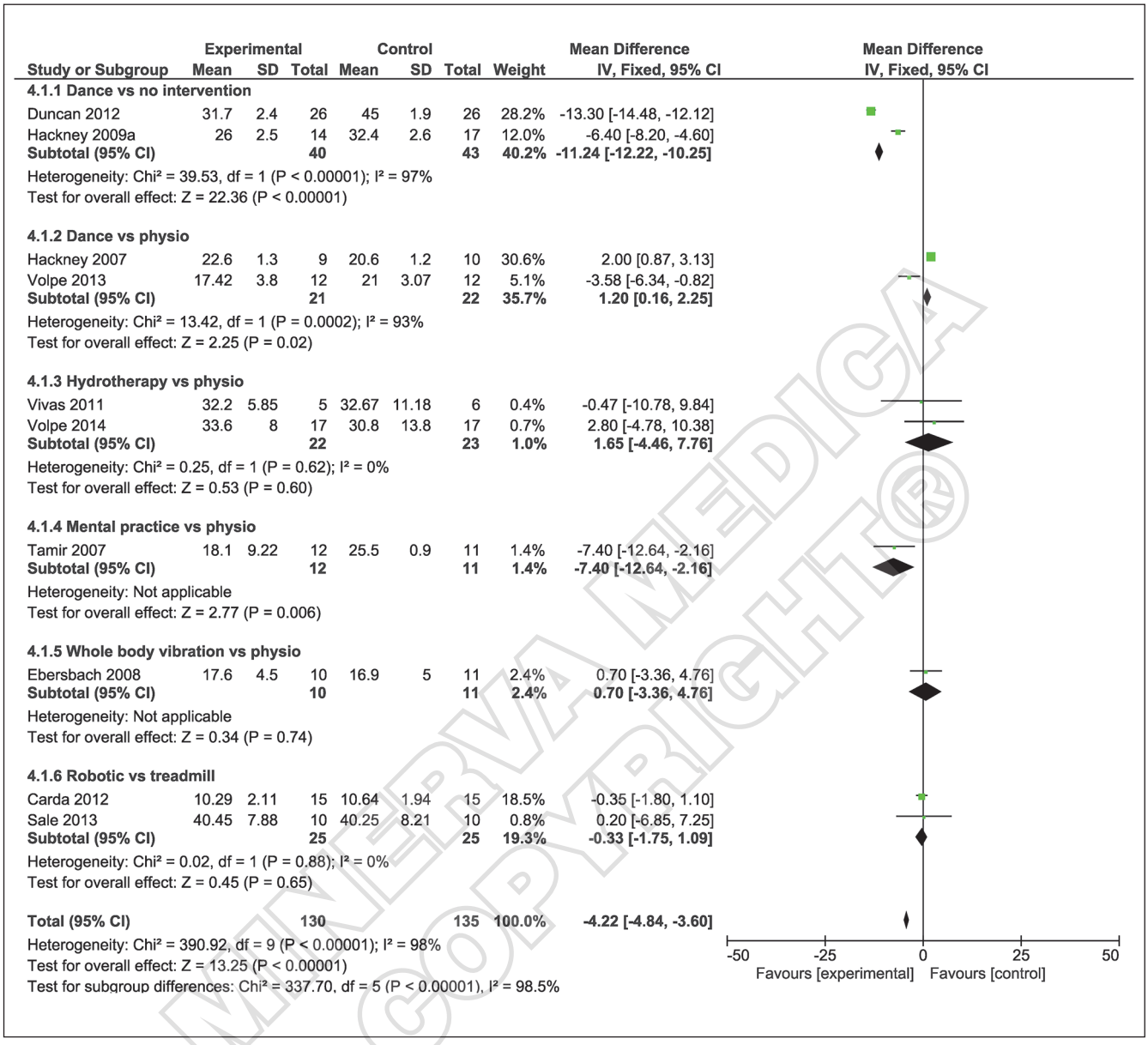

Figure 4.—Forest plot - Disease severity (UPDRS III)

chi improved postural stability and movement function, while also improve gait in people with mild-to-moderate PD. Gains were often maintained for 3 months, in agreement with other research on adults with PD aged over 70 years.[67]

Dancing was also shown to be of benefit for people with PD in a number of studies (Figures 2-4). Dancing is a complex motor skill involving elements such as postural stability, weight shifting, inter-limb coordination, single leg stance activities and trunk rotation. These elements have been the focus of some traditional exercise programs; although routine exercises are not always perceived to be interesting and enjoyable over long term. Volpe *et al*[26] reported that Irish dancing is an enjoyable adjunct to traditional therapy for PD with excellent adherence over long

periods of time such as six months. Gerontological literature has also shown that some elderly people enjoy dance more than traditional exercises, with accompanying increased adherence.[56, 71, 72] Each of the dance genres analyzed in this systematic review showed benefits not only for body function and disease severity, but also for quality of life, corroborating the findings of research on social dancers.[73, 74]

Water exercises and hydrotherapy have also been used to treat other disorders and have shown promising results for both mobility and quality of life.[75-77] Emerging evidence suggests improvements in gait, quality of life, and falls after hydrotherapy in people with PD. Such benefits have been attributed to the beneficial effects of buoyancy and hydrostatic pressure that might reduce the risk of falls.[78] The aquatic environment might enhance balance, reduce freezing of gait and fear of falling and increase movement amplitude and speed.[27, 79] It may well enable people to perform complex skills in a different context, using frontal lobe mediated neural networks that subserve attention to bypass the defective basal ganglia pathways.[80]

Virtual reality therapy and exercise gaming have been proposed as an effective method to complement exercise therapy for some neurological patients.[81, 82] Due to added cognitive and motor stimulation in a motivating environment, this alternative therapy may enhance movements and afford a greater amount of practice. The exact mechanism by which virtual reality therapy is effective remains uncertain.[37]

Studies that analyzed robotic gait training as a complementary physical therapy suggested important improvements on motor performance of PD. However, none of these showed that robotic gait training is better than traditional treadmill walking training, which is less expensive and easier to handle. For the remaining alternative therapies reviewed, there was relatively low level evidence of their effects on people with PD. It remains open to question whether robotic gait training, mental practice, aerobic training, boxing training, whole body vibration or Nordic walking produce long term benefits in people with PD.

Conclusions

The therapies described within this systematic review provide complementary treatment options for people living with PD. There was emerging evidence that some of the therapies may be a suitable adjunct to conventional physical therapy (Figures 2-4). Despite this, more robust studies designed with higher methodological quality are needed. It is recommended that future research compare complementary physical therapies, ranging in both duration and frequency, in an effort to clarify the associated risks and benefits to people with this chronic and progressive disease.

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