Suppl. Table 1. Search strategy

Database	Search terms
Medline (06.02.2025)	(((((((((((Idiopathic Parkinson's Disease[Title/Abstract]) OR (Lewy Body Parkinson's Disease[Title/Abstract])) OR (Parkinson's Disease, Idiopathic[Title/Abstract])) OR (Parkinson's Disease, Lewy Body[Title/Abstract])) OR (Parkinson Disease, Idiopathic[Title/Abstract])) OR (Parkinson's Disease[Title/Abstract])) OR (Idiopathic Parkinson Disease[Title/Abstract])) OR (Lewy Body Parkinson Disease[Title/Abstract])) OR (Primary Parkinsonism[Title/Abstract])) OR (Parkinsonism, Primary[Title/Abstract])))))))))) AND ((((((((((Physiotherapy) OR (Rehabilitation)) OR (Rehabilitation[MeSH Terms]))) OR (Exercise[MeSH Terms])) OR (Exercise*)) OR (training)) OR (treatment*)) OR (“Exercise therap*”)) OR ("Exercise Therapy"[MeSH Terms])) OR (“Physical Therapy Modalities”[MeSH Terms])) AND ((((((Equilibrium[Title/Abstract]) OR (Balance[Title/Abstract])) OR (“Postural stability”[Title/Abstract])) OR (“Stability”[Title/Abstract])) OR (“Postural balance”[Title/Abstract])) OR (“Postural balance” [Mesh])) AND (random* OR control*)
Web of Science (06.02.2025)	TS= (("Parkinson's disease" OR PD)) AND TS= ((Physiotherapy OR Rehabilitation OR exercise* OR "Physical therap*" OR Training OR Treatment* OR "Exercise therap*")) AND TS= ((Equilibrium OR Balance OR "Postural stability” OR Stability OR "Postural balance")) AND TS= ((random* OR control*))
Embase (06.02.2025)	('parkinsons disease':ti,ab,kw OR PD:ti,ab,kw) AND (physiotherapy OR rehabilitation OR exercise* OR 'physical therap*' OR training OR treatment* OR 'exercise therap*') AND (equilibrium:ti,ab,kw OR balance:ti,ab,kw OR 'postural stability':ti,ab,kw OR stability:ti,ab,kw OR 'postural balance':ti,ab,kw) AND [randomized controlled trial]/lim

Abbreviations: ti: title; ab: abstract; kw: keyword.

Suppl. Table 2. Classification and definition of balance intervention considered.

Type	Definition
Aerobic training (walking/cycling)	Exercise intensity was monitored to maintain a heart rate consistent with 50–80% of max VO2. The exercise modalities included walking, recycling, and physical fitness.
Aquatic exercise	Exercise performed in the water.
Balance training	Balance exercises comprising static and dynamic balance exercises aimed at improving the control of the center of mass under different sensory conditions
Crossover training	Crossover is a device that simulates the movement of a skater, broadening the support base and improving the functionality of paravertebral muscles.
Exergaming and Virtual reality	Balance exercise performed by video games.
Multiple/Traditional exercises	The intervention included two or more specific types of exercise, like boxing, walking, balance, stretching, and upper limb exercise.
Resistance training	Resistance training, namely isometric training and isokinetic training, is a kind of muscle strength training method to maintain a constant speed of movement.
Rhythmical auditory exercise	Exercises equipped with rhythmic auditory stimulation to improve physical functions for Parkinson's disease by harnessing the innate internal timing process through external cues.
Control	The control group included wait-list control (no intervention provided) and active control (usual care or rehabilitation training).

Suppl. Table 3. Contents of rehabilitation

First Author [Ref], Year	*Balance intervention type of Experimental Group*	*Rehabilitation contents*	*Rehabilitation description*	*Progression*
Albrecht, 2021 (Albrecht et al., 2021)	Balance training	Balance	Balance and gait exercises using HiBalance program.	The level of difficulty and intensity was adjusted for each participant individually by experienced physiotherapists.
Arfa-Fatollahkhani, 2019 (Arfa-Fatollahkhani et al., 2020)	Aerobic training	Endurance	Treadmill training with moderate intensity defined by the 60% of HRR calculated as the difference between resting HR and maximum HR, and RPE ranged between 11 and 13 on a scale of 6–20.	NA
Ashburn, 2007 (Ashburn et al., 2007)	Multiple exercise	Balance-Resistance-Endurance	The exercise program was designed with six levels of exercise progression and comprised muscle strengthening (knee and hip extensors, hip abductors), range of movement (ankle, pelvic tilt, trunk and head), balance training (static, dynamic and functional) and walking (inside and outside).	The progression consisted in increasing the number of repetitions. For example, standing from sitting was progressed by increasing practice repetition, lowering the height of the chair and progressing to stepping up.
Ashburn, 2019 (Ashburn et al., 2019)	Multiple exercise	Balance-Resistance-Endurance	Warm-up activities, mobility and functional strength training, static and dynamic balance exercises, dual-task activities, gait training, and strategies to manage freezing of gait. Examples of exercises include sit-to-stand repetitions, tandem standing and walking, obstacle negotiation, weight shifting and reaching, stepping in different directions, and walking while turning the head or carrying objects.	the PDSAFE protocol includes progression through six increasing levels of difficulty. Exercises are individually adapted and progressed by the physiotherapist based on the participant's abilities and improvements over time.
Cabrera-Martos, 2020 (Cabrera-Martos et al., 2020)	Balance training	Balance-Resistance	The core stability program followed the principles of motor relearning and skills acquisition: activation of deep muscles, integration of deep and superficial systems, and tailored functional exercises in varying	The progression consisted in increasing the number of repetitions, and in changing the positions of the exercises (from

			environments and contexts to ensure the transfer to functional activity.	supine position to sitting and standing position).
Capato, 2019 (Capato et al., 2019)	Rhythmical auditory exercise	Balance-Resistance	Warm-up, main part and cool-down. The main part consisted in 360-degree turns on the spot, step forward and lateral step from a stationary position returning to the starting point, single-leg stance with eyes closed, normal walking, tandem walking, slalom walking, bending down to pick up an object from the floor, upper limb flexion against elastic resistance, and sit-to-stand with upper limb flexion, all performed with a metronome in the background. The auditory rhythmical cues were delivered in an open-loop fashion by a metronome at 50, 80, 100, 120, or 140 BPM, according to the exercises.	To promote progression the aim was to increase or decrease the speed throughout the parts of the training.
	Balance training	Balance-Resistance	Warm-up, main part and cool-down. The main part consisted in 360-degree turns on the spot, step forward and lateral step from a stationary position returning to the starting point, single-leg stance with eyes closed, normal walking, tandem walking, slalom walking, bending down to pick up an object from the floor, upper limb flexion against elastic resistance, and sit-to-stand with upper limb flexion.	To promote progression the aim was to increase or decrease the speed throughout the parts of the training.
Cheng, 2021 (Chen et al., 2021)	Resistance training	Resistance	Activation of postural muscles, especially trunk muscles, that play a role in maintaining balance during motor performance. Lower-limb muscles were also recruited for stability in performing the exercises.	The workload was progressively increased by 5 to 10% if the subject did not feel muscle fatigue or nit was increased using dumbbells, elastic bands and ankle weights
Cheng, 2016 (Cheng et al., 2016)	Multiple exercise	Balance-Resistance	Static balance exercises consisting of ground composed of different materials and bases of support. Dynamic balance training consisting in catching/throwing a ball, the ring toss game, and forward reaching in different directions. The strengthening training focused on the hip extensors, abductors, and knee extensors. Training intensity started at 50% of MVC for 10 repetitions. Moreover,	The progressions in balance training depended on individual's abilities and included decreases in support base and increases in movement range or movement speed. Regarding strength training, exercises intensity

			participants performed squat, stepping up/down in the standing position, and bridging and hip circle activities in the supine position.	increased progressively to 75%-80% of MVC.
	Aerobic training	Endurance	Participants used a rotational treadmill with a small radius (0.8 m), forcing them to turn instead of walk straight. They trained in both directions, with one leg as the inner limb for 15 minutes and the other as the outer limb for another 15 minutes. Safety harnesses were worn to prevent falls, and handrails could be used for balance but were discouraged.	The treadmill started at 80% of the participant's comfortable turning speed on flat ground and increased by 0.05 m/s every 5 minutes if tolerated. Speed was increased based on two criteria: maintaining an upright posture and keeping perceived exertion below a Borg rating of 13.
Cheng, 2018 (Cheng et al., 2018)	Multiple exercise	Balance-Resistance	Static balance exercises consisting on ground composed of different materials and bases of support. Dynamic balance training consisting in catching/throwing a ball, the ring toss game, and forward reaching in different directions. The strengthening training focused on the hip extensors, abductors, and knee extensors. Training intensity started at 50% of MVC 10 repetitions. Moreover, participants performed squat, stepping up/down in the standing position, and bridging and hip circle activities in the supine position.	The progressions in balance training depended on individual's abilities and included decreases in support base and increases in movement range or movement speed. Regarding strength training, exercises intensity increased progressively to 75%-80% of MVC.
	Aerobic training	Endurance	Participants used a rotational treadmill with a small radius (0.8 m), forcing them to turn instead of walking straight. They trained in both directions, with one leg as the inner limb for 15 minutes and the other as the outer limb for another 15 minutes. Safety harnesses were worn to prevent falls, and handrails could be used for balance but were discouraged.	The treadmill started at 80% of the participant's comfortable turning speed on flat ground and increased by 0.05 m/s every 5 minutes if tolerated. Speed was increased based on two criteria: maintaining an upright posture and keeping perceived exertion below a Borg rating of 13.
Conradsson, 2015 (Conradsson et al., 2012)	Balance training	Balance	There were considered the following balance components to set up the balance training: sensory integration (walking tasks on varying surfaces with or without visual constraints), anticipatory postural adjustments (voluntary leg/arm/trunk movements	Training was divided into three progressive blocks (A, B, C) to gradually increase complexity. Block A focused on single-component exercises to build

			focusing on movement velocity and amplitude, and postural transitions), motor agility (whole-body coordination during varying gait conditions and quick shifts of movement characteristics during predictable and unpredictable conditions), stability limits (voluntary leaning tasks in standing with varying base of support-stimulating weight shifts in multiple directions through arm and trunk movements).	familiarity. In Block B, variation increased through changes in posture, base of support, and movement features. Block C integrated components and dual-task challenges. Difficulty was individually adjusted to ensure progressive overload while maintaining safety.
De Moraes, 2020 (Filho et al., s.d.)	Resistance training	Resistance	Chest press, knee extension, hamstring curl, leg press, and seated row using weight machines (2 sets of 10-12 repetitions until fatigue).	NA
Frazzitta, 2012 (Frazzitta et al., 2012)	Multiple exercise	Balance-Endurance	Relaxation exercises, muscle stretching (scapular, hip flexors, hamstring, and gastrocnemius muscles), exercises to improve the range of motion of spinal, pelvic, and scapular joints, and exercises to improve the functionality of abdominal muscles and postural changes in supine position. Balance exercises using stabilometric platform with a visual cue and treadmill training associated with auditory and visual cues (treadmill plus). Moreover, occupational therapy exercises as transfers from sitting to standing, rolling from supine to sitting and from sitting to supine were performed.	NA
Freidle, 2022 (Freidle et al., 2022)	Balance training	Balance	Balance and gait exercises using HiBalance program with sensory integration, APAs, motor agility, and stability limits components.	Complexity increased through task variation, by combining exercises from all four core components, and by integrating simultaneous cognitive and motor tasks.
Landers, 2016 (Landers et al., 2016)	Balance training	Balance-Endurance	Treadmill training, obstacles course, and balance training on a compliant surface in a harness (tandem stance, narrow support stance, single leg stance, eyes	NA

			closed and predictable and unpredictable external perturbations).	
Liu, 2022 (Liu et al., 2022)	Balance training	Balance	Square-stepping exercise: participants were instructed to perform a sequence of different steps on a thin mat (250 cm) with 40 squares and to complete the stepping pattern smoothly. The exercise session enabled subjects to practice weight-shifting in different directions using different step distances and challenged their postural stability.	NA
Mak, 2021 (Mak & Wong-Yu, 2021)	Multiple exercise	Balance-Endurance	Balance exercises included postural re-education and dynamic balance training with musical cues and rhythms, involving tasks such as reaching forward and sideways while standing, shifting body weight in multiple directions, leaning and stepping in multiple planes, one-legged standing, turning the body with hands touching opposite knees, walking forward and backward along a line, and walking with large arm and trunk movements, all aimed at improving posture and maintaining upright symmetry during daily activities. Endurance training consisted of brisk walking with long strides and heel strikes, coordinating limbs in an alternating symmetrical pattern, and progressing to 150 minutes per week of moderate intensity through both supervised and self-directed sessions.	The brisk walking gradually increasing to 150 minutes per week.
Mak, 2024 (Mak et al., 2024)	Multiple exercise	Balance-Endurance	Music-based balance exercises targeting posture, symmetrical gait, dual-task ability, and balance confidence, along with brisk walking focused on increasing stride length and arm swing amplitude at a moderate intensity. Participants trained up to 30 minutes per week of balance and 150 minutes of brisk walking, using smartwatches for real-time heart rate monitoring.	From week 7, motor or cognitive tasks were added to walking to increase complexity, and therapists provided biweekly feedback based on exercise data.

Morris, 2017 (Morris et al., 2017)	Multiple exercise	Balance-Resistance	Training included progressive resistance strength exercises (e.g., step-ups, sit-to-stand, hip abduction, trunk rotations) targeting key muscle groups for gait and balance, movement strategy training using visual, auditory, and proprioceptive cues to improve daily activity execution, and falls prevention education.	Exercise intensity and progression were monitored through activity logs and perceived exertion scales.
Picelli, 2013 (Picelli et al., 2013)	Aerobic training	Endurance	Gait training using the Gait-Trainer GT1, a device with motorized footplates and body-weight support to simulate walking. Each session included two 15-minute blocks (with a 10-minute rest), progressing from 20% to 10% body-weight support and from 1.3 to 1.6 km/h.	NA
Schenkman, 2012 (Schenkman et al., 2012)	Balance training	Balance	Balance training combining flexibility, balance, and functional exercises.	NA
	Aerobic training	Endurance	30 minutes of exercise at 65–80% HRmax, and 5–10 minutes of cool-down. Most participants used a treadmill, though cycling and elliptical training were also allowed.	NA
Sedaghati, 2016 (Sedaghati et al., 2016)	Balance training	Balance	The sessions included a 5-minute warm-up focusing on lower extremity stretches and posture control, followed by 50 minutes of balance exercises. Balance exercises targeted muscle groups to prevent lower limb collapse and included standing with a reduced base of support, leg raises, sit-to-stand, step-ups, squats, heel raises, and graded reaching activities. The gait training activities involved various stepping and walking patterns, marching, and tandem walking.	Exercises were performed with progressive difficulty, including different balance pad sizes after 4 weeks.
Seymour, 2019 (Seymour et al., 2019)	Balance training	Balance-Resistance	The PDSAFE program focused on home-based exercises to prevent falls, including balance training with reduced support area, strength training using body weight or weighted vests, and functional exercises like sit-to-stand. Fall avoidance strategies	The progression of the exercises was monitored over the months.

			involved practicing transfers and turning in complex environments.	
Silva-Batista, 2016 (Silva-Batista et al., 2016) and Silva-Batista, 2018 (Silva-Batista et al., 2018)	Resistance training	Resistance	Each session began with a 10-minute warm-up on a cycle ergometer, followed by five resistance exercises (leg press, lat pulldown, ankle plantarflexion, chest press, half squat).	The training used linear periodization, progressing from low-intensity, high-volume to high-intensity, low-volume over 12 weeks. One experimental group group focused on increasing load over time, while the other group also added instability by using progressively unstable devices like balance pads and BOSU balls. This instability was adjusted based on the patient’s ability to maintain balance and force production.
Smania, 2010 (Smania et al., 2010)	Balance training	Balance	Balance training consisted of exercises to improve feedforward and feedback postural reactions. The tasks were divided into three groups: the first involved self-destabilization of the body (e.g., weight shifting and ball bouncing), the second focused on external destabilization (e.g., exercises on unstable surfaces or therapist-induced perturbations), and the third emphasized coordination between leg and arm movements during walking.	Each session included 10 exercises with increasing difficulty, therapist assistance, and variable repetitions.
Tollàr, 2018 (Tollár et al., 2018)	Exergaming training	Balance	Participants engaged in 45 minutes of Xbox Kinect-based training using three visual-feedback video game modules: Reflex Ridge (reactive responses), Space Pop (spatial orientation through full-body reaching), and Just Dance (sequencing rhythmic movements). This intervention aimed to enhance postural control, gait mobility and stability, turning ability, and both dynamic and static balance, leveraging real-time visual feedback to guide performance.	NA

	Aerobic training	Endurance	Participants took part in a spinning class using a bicycle ergometer, pedaling to music at a target heart rate of 110–140 BPM, with perceived exertion monitored. The session included 5-minute cycling intervals interspersed with 1-minute rest periods. This program lacked visual feedback and focused primarily on improving cardiovascular fitness with minimal direct stimulation of gait or balance skills.	NA
Tollàr, 2019 (Tollár et al., 2019)	Exergaming training	Balance-Resistance	The program focused on high-intensity sensorimotor and visuomotor agility training. Each session included a warm-up, sensorimotor training, virtual reality exergaming (Xbox Kinect), and cool-down. Exergaming consisted in improving postural instability, proprioception, somatosensory integration, interlimb, coordination, movement timing, and bradykinesia. The exercises included trunk and limb movements with corrected posture, strength training with or without added weights, and motor tasks guided by visual and auditory cues. Activities were performed on stable and unstable surfaces and involved walking, running, jumping, stepping over obstacles, and using agility ladders and blocks. Patients responded to predictable and unpredictable stimuli and executed rhythmic, asymmetrical, and complex whole-body movements.	The exercises covered gait, coordination, balance, and posture training with varying difficulty, utilizing visual and auditory feedback from the exergames.
Wallén, 2018 (Wallén et al., 2018)	Balance training	Balance	HiBalance program is based on motor learning principles—specificity, progressive overload, and variation—and is tailored to individual abilities without a fixed set of exercises. To target cognitive impairments, DT exercises were gradually integrated into the program by adding concurrent cognitive (eg, counting, remembering items) and/or motor tasks (eg, carrying and/or manipulating objects) to the balance	The HiBalance program includes a clear progression of exercises throughout the 10-week training. In the first two weeks, participants focus on single-task exercises targeting individual balance components, with an emphasis on movement quality and exercise

			exercises. These exercises were not the same tasks as those used during pre- and posttest. Moreover, 4 balance components specific to PD impairments were emphasized: (*a*) *sensory integration* (walking tasks on varying surfaces with or without visual constraints); (*b*) *anticipatory postural adjustments* (voluntary arm/leg/trunk movements, postural transitions, and multidirectional stepping, emphasizing movement velocity and amplitude); (*c*) *motor agility* (interlimb coordination under varying gait conditions and quick shifts of movement characteristic during predictable and unpredictable conditions); and (*d*) *stability limits* (controlled leaning tasks performed while standing with varying bases of support, stimulating weight shifts in multiple directions).	objectives. From weeks three to five, dual-task exercises are introduced, making up about 40% of each session, and the difficulty of the balance exercises is increased. In the final phase, from weeks six to ten, the complexity and variety of the exercises are further enhanced by combining multiple balance components and increasing the proportion of dual-task training to approximately 60% of each session. This progression is designed to gradually increase challenge and promote motor learning.
Wong-Yu, 2015 (Wong-Yu & Mak, 2015)	Balance training	Balance	The program was divided into two phases. In the first phase exercises focused on postural re-education, flexibility, strength training with functional tasks, and specialized activities such as Balance Dance (music-based movement for postural control), modified Wing Chun (martial arts movements adapted for balance and stepping), and Square Stepping Exercises (progressive step patterns for multi-directional balance). In the second phase, participants trained outdoors in parks and community settings, repeating prior exercises on uneven terrain and performing advanced balance activities, including perturbation training and fall-prone tasks (e.g., navigating escalators). DT training was also emphasized by combining walking with everyday activities like turning the head, talking, or carrying objects.	Progression was ensured by increasing complexity, movement speed, and reducing base of support.
	Exergaming training		This group performed balance exercises using a dynamic balance board in a virtual environment.	The training encouraged use of ankle strategies and progressed in

Yen, 2011 (Yen et al., 2011)			Participants shifted their weight to control a simulated platform, navigating through indoor and outdoor virtual tasks and a 3D ball game.	complexity, with therapists adjusting difficulty by modifying sensitivity and movement direction, making the exercises more challenging over time.
	Balance training	Balance	This group completed conventional balance training focused on static stance, dynamic weight shifting, and external perturbations. Exercises included standing on foam with varied support, catching a ball while stepping and squatting, and reacting to a tiltboard to improve postural responses.	NA

PD: Parkinson Disease; RPE: Rate of Perceived Exertion; HRR: Heart Rate Reserve; HR: Heart Rate; DT: Dual-Task; NA: Not Applicable; MVC: Maximal Voluntary Contraction; BPM: Beats Per Minute; APAs: Anticipatory Postural Adjustments. Studies represented more than once included multiple intervention arms featuring distinct combinations of training contents.

Suppl. Fig. 1. Summary of risk of bias assessment across all included RCTs.

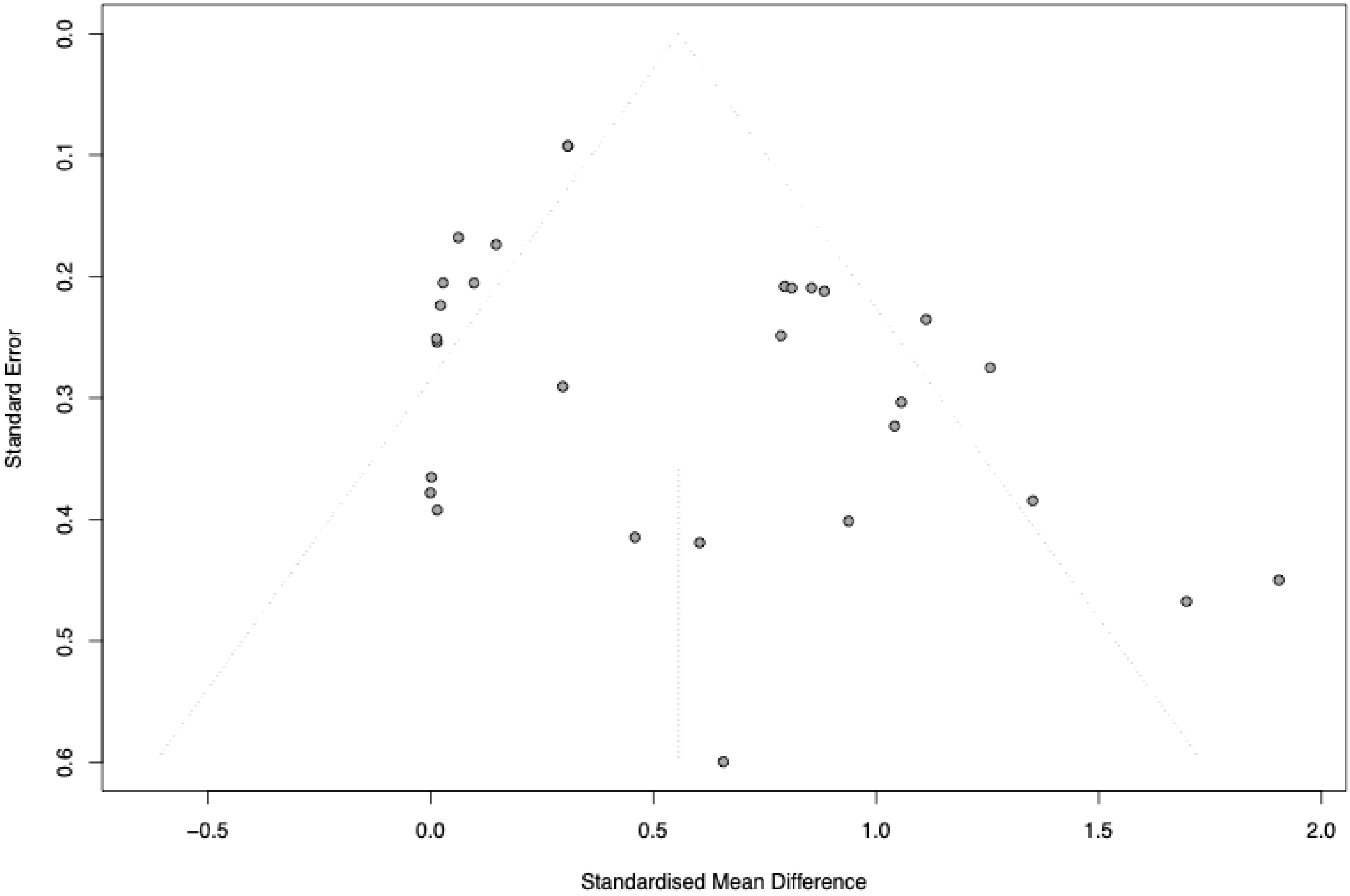
Risk of bias domains

Study	D1	D2	D3	D4	D5	Overall
Albrecht 2021	+	+	+	+	-	-
Arfa-Fatollahkhani 2019	+	X	X	+	+	X
Ashburn, 2007	+	+	+	+	-	-
Ashburn, 2019	+	-	+	+	+	-
Cabrera-Martos, 2020	+	+	+	+	+	+
Capato 2020	+	+	+	+	+	+
Chen, 2020	+	+	+	+	+	+
Cheng 2016	+	+	+	+	+	+
Cheng 2018	+	+	+	+	+	+
Conradsson, 2015	+	+	+	+	+	+
De Moraes, 2020	+	-	+	+	-	-
Frazzitta, 2012	+	+	+	+	-	-
Freidle, 2022	+	+	+	+	+	+
Landers. 2016	+	+	+	+	-	-
Liu, 2022	+	+	+	+	+	+
Mak, 2021	+	+	+	+	+	+
Mak, 2024	+	+	+	+	+	+
Morris M. E., 2017	+	+	+	+	-	-
Picelli A., 2012	+	+	+	+	-	-
Schenkman M, 2012	+	+	+	+	+	+
Sedaghati P, 2016	-	X	X	+	+	X
Seymour KC, 2019	+	+	+	+	-	-
Silva-Batista C, 2017	+	+	+	+	+	+
Silva-Batista C, 2016	+	+	+	+	+	+
Smania N, 2010	+	+	+	+	-	-
Tollar, 2019	+	+	+	+	+	+
Tollàr J, 2018	-	X	+	-	-	X
Wallèn M.B., 2018	+	+	+	+	+	+
Wong-Yu I.S.K., 2015	+	+	+	+	+	+
Yen C.Y., 2011	+	+	+	+	+	+

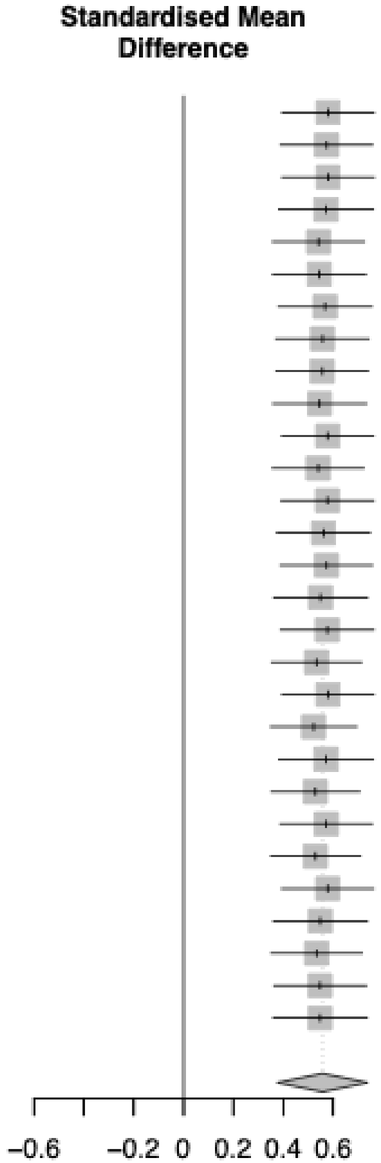
Domains:
D1: Bias arising from the randomization process.
D2: Bias due to deviations from intended intervention.
D3: Bias due to missing outcome data.
D4: Bias in measurement of the outcome.
D5: Bias in selection of the reported result.

Judgement
X High
- Some concerns
+ Low

Suppl. Fig.2. Funnel plot with pseudo 95% confidence limits for the meta-analysis.



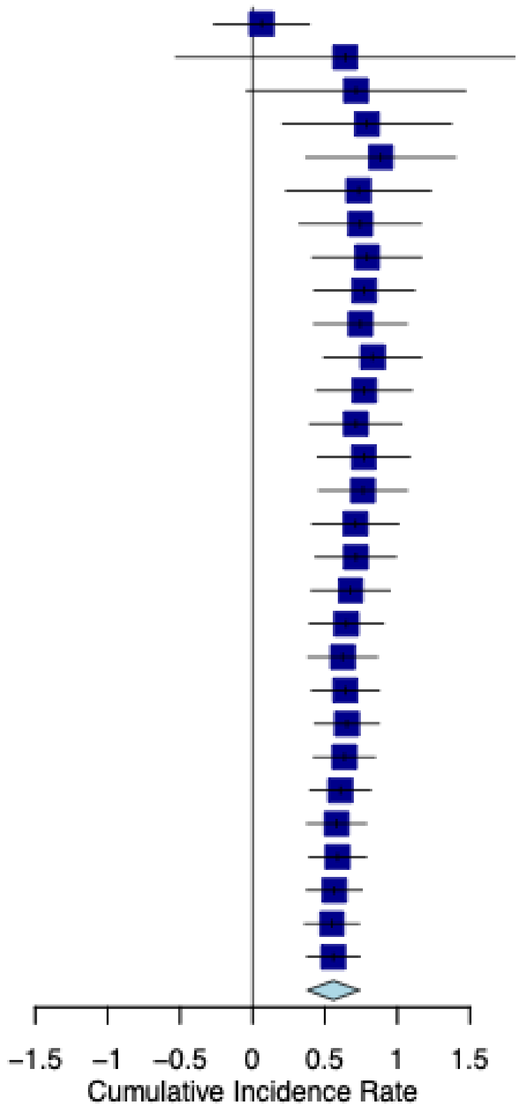
Suppl. Fig.3. Influential analysis plot of included studies.



Study	SMD	95%−CI	P−value	Tau2	Tau	I2
Omitting Albrecht 2021	0.58	[0.39; 0.76]	< 0.0001	0.1658	0.4072	71.3%
Omitting Arfa−Fatollahkhani 2019	0.57	[0.39; 0.76]	< 0.0001	0.1696	0.4119	72.1%
Omitting Ashburn 2007	0.58	[0.39; 0.76]	< 0.0001	0.1664	0.4080	71.0%
Omitting Ashburn 2019	0.57	[0.38; 0.76]	< 0.0001	0.1784	0.4224	71.9%
Omitting Cabrera−Martos 2020	0.54	[0.36; 0.73]	< 0.0001	0.1679	0.4098	71.5%
Omitting Capato 2020	0.54	[0.36; 0.73]	< 0.0001	0.1727	0.4156	71.2%
Omitting Chen 2020	0.57	[0.38; 0.76]	< 0.0001	0.1765	0.4201	72.5%
Omitting Cheng 2016	0.56	[0.37; 0.74]	< 0.0001	0.1756	0.4191	72.5%
Omitting Cheng 2018	0.56	[0.37; 0.74]	< 0.0001	0.1730	0.4159	72.5%
Omitting Conradsson 2015	0.55	[0.36; 0.73]	< 0.0001	0.1739	0.4170	71.3%
Omitting De Moraes 2020	0.58	[0.39; 0.76]	< 0.0001	0.1670	0.4087	71.7%
Omitting Frazzitta 2012	0.54	[0.36; 0.72]	< 0.0001	0.1668	0.4084	71.3%
Omitting Freidle 2022	0.58	[0.39; 0.76]	< 0.0001	0.1696	0.4119	71.7%
Omitting Landers 2016	0.56	[0.37; 0.75]	< 0.0001	0.1759	0.4194	72.5%
Omitting Liu 2022	0.57	[0.39; 0.76]	< 0.0001	0.1698	0.4121	72.2%
Omitting Mak 2021	0.55	[0.36; 0.74]	< 0.0001	0.1760	0.4195	71.9%
Omitting Morris 2017	0.58	[0.39; 0.76]	< 0.0001	0.1715	0.4141	71.7%
Omitting Picelli 2012	0.53	[0.35; 0.71]	< 0.0001	0.1582	0.3977	70.8%
Omitting Schenkman 2012	0.58	[0.39; 0.76]	< 0.0001	0.1662	0.4077	71.5%
Omitting Sedaghati 2016	0.52	[0.35; 0.69]	< 0.0001	0.1409	0.3754	69.2%
Omitting Seymour 2019	0.57	[0.38; 0.76]	< 0.0001	0.1784	0.4224	71.9%
Omitting Silva−Batista 2017	0.53	[0.35; 0.71]	< 0.0001	0.1514	0.3891	70.3%
Omitting Silva−Batista 2016	0.57	[0.39; 0.76]	< 0.0001	0.1704	0.4128	72.2%
Omitting Smania 2010	0.53	[0.35; 0.71]	< 0.0001	0.1544	0.3929	69.7%
Omitting Tollar 2018	0.58	[0.39; 0.76]	< 0.0001	0.1669	0.4085	71.7%
Omitting Wallen 2018	0.55	[0.36; 0.74]	< 0.0001	0.1761	0.4196	71.6%
Omitting Wong−Yu 2015	0.53	[0.35; 0.72]	< 0.0001	0.1610	0.4012	69.9%
Omitting Yen 2011	0.55	[0.36; 0.73]	< 0.0001	0.1717	0.4143	72.1%
Omitting Mak 2024	0.55	[0.36; 0.74]	< 0.0001	0.1755	0.4189	71.6%
Random effects model	**0.56**	**[0.38; 0.74]**	**< 0.0001**	**0.1684**	**0.4103**	**71.5%**

Suppl. Fig.4. Cumulative analysis plot of included studies, according to the year of publication.

Source	P–value	Tau2	Tau	I2	SMD (95% CI)
Adding Ashburn 2007 (k=1)	.71	.	.	.	0.06 [–0.27; 0.39]
Adding Smania 2010 (k=2)	.28	0.6609	0.8130	92.7%	0.64 [–0.53; 1.81]
Adding Yen 2011 (k=3)	.06	0.3649	0.6041	87.0%	0.71 [–0.04; 1.47]
Adding Frazzitta 2012 (k=4)	.008	0.2695	0.5192	84.0%	0.79 [0.21; 1.37]
Adding Picelli 2012 (k=5)	< .001	0.2527	0.5027	82.4%	0.88 [0.37; 1.40]
Adding Schenkman 2012 (k=6)	.004	0.3035	0.5509	82.4%	0.73 [0.23; 1.23]
Adding Conradsson 2015 (k=7)	< .001	0.2439	0.4939	80.5%	0.74 [0.32; 1.16]
Adding Wong–Yu 2015 (k=8)	< .001	0.2219	0.4711	80.2%	0.79 [0.41; 1.17]
Adding Cheng 2016 (k=9)	< .001	0.1970	0.4439	77.4%	0.77 [0.43; 1.12]
Adding Landers 2016 (k=10)	< .001	0.1796	0.4237	74.7%	0.74 [0.42; 1.07]
Adding Sedaghati 2016 (k=11)	< .001	0.2260	0.4754	76.9%	0.83 [0.49; 1.17]
Adding Silva–Batista 2016 (k=12)	< .001	0.2360	0.4858	76.1%	0.77 [0.44; 1.10]
Adding Morris 2017 (k=13)	< .001	0.2428	0.4928	77.3%	0.71 [0.40; 1.03]
Adding Silva–Batista 2017 (k=14)	< .001	0.2671	0.5168	77.8%	0.77 [0.45; 1.09]
Adding Cheng 2018 (k=15)	< .001	0.2509	0.5009	76.1%	0.76 [0.46; 1.07]
Adding Tollar 2018 (k=16)	< .001	0.2630	0.5128	76.4%	0.71 [0.41; 1.01]
Adding Wallen 2018 (k=17)	< .001	0.2373	0.4871	75.3%	0.71 [0.43; 0.99]
Adding Arfa–Fatollahkhani 2019 (k=18)	< .001	0.2391	0.4890	74.7%	0.68 [0.40; 0.95]
Adding Ashburn 2019 (k=19)	< .001	0.2241	0.4734	74.9%	0.65 [0.39; 0.90]
Adding Seymour 2019 (k=20)	< .001	0.2089	0.4570	74.4%	0.62 [0.38; 0.86]
Adding Cabrera–Martos 2020 (k=21)	< .001	0.2040	0.4517	74.2%	0.64 [0.41; 0.87]
Adding Capato 2020 (k=22)	< .001	0.1923	0.4385	74.3%	0.65 [0.43; 0.87]
Adding Chen 2020 (k=23)	< .001	0.1828	0.4276	73.2%	0.63 [0.42; 0.85]
Adding De Moraes 2020 (k=24)	< .001	0.1864	0.4317	73.0%	0.61 [0.40; 0.82]
Adding Albrecht 2021 (k=25)	< .001	0.1892	0.4350	73.0%	0.58 [0.37; 0.78]
Adding Mak 2021 (k=26)	< .001	0.1794	0.4236	72.5%	0.59 [0.39; 0.78]
Adding Freidle 2022 (k=27)	< .001	0.1776	0.4214	72.2%	0.56 [0.37; 0.76]
Adding Liu 2022 (k=28)	< .001	0.1755	0.4189	71.6%	0.55 [0.36; 0.74]
Adding Mak 2024 (k=29)	< .001	0.1684	0.4103	71.5%	0.56 [0.38; 0.74]
Total	< .001	0.1684	0.4103	71.5%	0.56 [0.38; 0.74]



Suppl. Table 4. Linear metaregression analysis assessing potential sources of heterogeneity and predictors of response in studies using a passive control group.

Potential sources of heterogeneity	Estimate	SE	Z-val	P-value	95% CI	
					Lower	Upper
Age of participants (years)	-0.070	0.04	-1.62	0.106	-0.1554	0.0148
Proportion of males	0.004	0.02	0.24	0.811	-0.0958	0.1615
Hoehn and Yahr	1.123	1.14	0.98	0.326	-1.1174	3.3642
UPDRS III	-0.005	0.03	-0.20	0.845	-0.0447	0.0133
LEDD	0.001	0.002	0.67	0.503	-0.0023	0.0047
Duration of PD	0.041	0.10	0.42	0.675	-0.1504	0.2322
Intensity (min per session) (log)	-1.979	1.80	-1.10	0.271	-5.4989	1.5412
Frequency (days per week)(log)	-0.204	1.90	-0.11	0.915	-3.9321	3.5237
Duration (# of weeks)(log)	0.078	0.90	0.09	0.931	-1.6879	1.8436
Total dose (minutes)(log)	0.020	0.96	0.02	0.983	-1.8573	1.8972

Suppl. Table 5. Linear metaregression analysis assessing potential sources of heterogeneity and predictors of response in studies using an active control group.

Potential sources of heterogeneity	**Estimate**	**SE**	**Z-val**	**P-value**	**95% CI**	
					Lower	**Upper**
Age of participants (years)	0.0046	0.0251	0.1820	0.8556	-0.0447	0.0538
Proportion of males	-0.0144	0.0089	-1.6127	0.1068	-0.0318	0.0031
Hoehn and Yahr	0.4446	0.2489	1.7867	0.0740	-0.0431	0.9324
UPDRS III	0.0103	0.0147	0.7019	0.4827	-0.0185	0.0392
LEDD	-0.0011	0.0005	-2.1952	0.0581	-0.0021	-0.0001
Duration of PD	-0.0016	0.0762	-0.0206	0.9836	-0.1509	0.1478
Intensity (min per session) (log)	0.8275	0.6915	1.1966	0.2315	-0.5279	2.1829
Frequency (days per week)(log)	0.8809	0.6764	1.3024	0.1928	-0.4448	2.2066
Duration (# of weeks)(log)	-0.3525	0.6033	-0.5842	0.5591	-1.5350	0.8300
Total dose (minutes)(log)	0.2518	0.4270	0.5897	0.5554	-0.2849	1.3497

Suppl. Table 6. Grades of Recommendation, Assessment, Development, and Evaluation of the trials included (GRADE)

OUTCOME MEASURE	CERTAINTY ASSESSMENT							SUMMARY OF RESULTS			
								N. OF PATIENTS		EFFECT	CERTAINTY
	N. OF STUDIES	STUDY DESIGN	RISK OF BIAS	INCONSISTENCY	INDIRECTNESS	IMPRECISION	OTHER CONSIDERATIONS	CONTROL	CIRCUIT	ABSOLUTE (95% CI)	
BBS	7	Randomised trials	Serious[a,b,c,e]	Serious[f]	Not serious	Not serious	None	220	220	MD 4.40 higher (1.9 higher to 6.9 higher)	⨁⨁◯◯ Low
Mini-BESTest	13	Randomised trials	Serious[b,e]	Serious[f]	Not serious	Not serious	None	872	864	MD 2.52 higher (1.41 higher to 3.64 higher)	⨁⨁◯◯ Low
TUG	9	Randomised trials	Serious[a,b,c,d,e]	Serious[f]	Not serious	Serious[g]	None	198	194	MD 2.25 lower (4.13 lower to 0.36 lower)	⨁◯◯◯ Very low
SOT	4	Randomised trials	Not serious[e]	Serious[f]	Not serious	Serious[g]	None	44	44	MD 4.43 higher (1.74 higher to 7.12 higher)	⨁⨁◯◯ Low
UPDRS-III	4	Randomised trials	Not serious[e]	Serious[f]	Not serious	Serious[g]	None	154	157	MD 2.92 lower (6.15 lower to 0.3 higher)	⨁⨁◯◯ Low

CI: Confidence Interval; **MD:** Mean Difference; **OIS**: Optimal Information Size.

Explanations:

a) Bias arising from the randomization process;
b) Bias due to deviations from intended intervention;
c) Bias due to missing outcome data;
d) Bias in measurement of the outcome;
e) Bias in selection of the reported result;
f) Bias due to overlap of CI;
g) OIS not met.

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