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Physiotherapy For Functional Mobility In Parkinson's Disease: Recent Outlook

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Abstract
Parkinson's disease is a common neurodegenerative disorder for which only symptomatic treatments are available. One of the most prominent challenges in Parkinson's disease is gait and balance disturbances, which significantly contribute to increased disability and a reduced health-related quality of life. Unfortunately, balance and gait deficits in Parkinson's disease are notoriously difficult to treat and are not substantially improved by pharmacological or surgical treatments. However, recent advances in research have highlighted the potential for neurochemical and neuroplastic changes following exercise, which offers hope for improving motor and nonmotor symptoms.An increasing body of high-quality studies has documented improvements in various aspects of mobility, such as gait, balance, and strength, following exercise interventions. Additionally, exercise has been shown to positively impact nonmotor symptoms, including depression, anxietyand fatigue, further improving overall well-being in Parkinson's disease patients. This review article focuses on the latest advancements in enhancing functional mobility, while underscoring the importance of targeted exercise interventions. Interventions like musically queued gait training, Pilates, Dual task group training, rhythmic auditory stimulation etc can help maximize benefits, ultimately leading to improved quality of life for individuals with Parkinson's disease.
Keywords: functional mobility, Parkinson's Disease, review study

Introduction

Parkinson's disease (PD) is a neurodegenerative disorder typically occurring in late adulthood. It is characterized by cardinal signs such as rigidity, bradykinesia, tremors, and postural instability. According to the Global Burden of Disease study (2018), the global prevalence of PD has more than doubled over the past two decades, increasing from 2.5 million cases in 1990 to 6.1 million cases in 2016. In India, approximately 0.58 million people were estimated to be living with PD in 2016. While 5–10% of PD cases are monogenic and inherited in an autosomal dominant or recessive manner, the majority of cases are sporadic.[1] According to Forhan and Gill in a review on obesity, functional mobility refers to the physiological ability of individuals to move independently and safely across various environments to perform functional activities or tasks and participate in activities of daily living (ADL) at home, work, and in the community. Functional mobility encompasses movements such as standing, bending, walking, and climbing, which are fundamental to ADL and crucial for independent living and overall health. Impaired functional mobility is linked to an increased risk of falls, loss of independence and institutionalization.

Functional mobility relies on dynamic neural control to adapt locomotion, balance, and postural transitions effectively and efficiently to changing environments and task demands. This requires sensorimotor agility, involving:

1. Coordination of complex movement sequences.
2. Continuous assessment of environmental cues and contexts.
3. The ability to quickly switch motor programs in response to environmental changes.

Due to the heterogeneity of Parkinson's disease, patients' experience mobility impairments and their coping strategies are highly individualized.[2]

Activities of daily living (ADL) impairment is a criterion for diagnosing dementia and can be categorized into basic and instrumental activities based on their complexity and functional demands. Instrumental ADL (IADL) are more complex, requiring higher cognitive control, and are therefore more sensitive indicators of cognitive decline. IADL impairments are also more prevalent than basic ADL impairments.For a diagnosis of Parkinson's disease dementia (PDD), ADL deficits that occur independently of motor or autonomic impairments are critical. To facilitate the early diagnosis of dementia in Parkinson's disease (PD), assessing IADL related to cognitive dysfunction in patients without dementia is essential.[3]

Parkinson's disease (PD) is characterized by two primary hallmarks:

1. Neuronal degeneration in the substantia nigra pars compacta (SNc): This leads to a significant loss of dopaminergic neurons, with motor symptoms manifesting after approximately 50–80% of these neurons have degenerated. This degeneration reduces dopamine release in the striatum, disrupting basal ganglia circuits responsible for movement control.
2. Presence of Lewy bodies (LBs) and Lewy neurites**:** These proteinaceous aggregates in neurons are another defining feature of PD.

Several factors influence PD risk, including environmental exposures such as mitochondrial toxins like MPTP (1-methyl-4-phenyl-1,2,3,6-tetrahydropyridine) and pesticides, as well as genetic variants ranging from common alleles with low penetrance to rare, highly penetrant alleles.[4]

The American College of Sports Medicine (ACSM) defines exercise as planned, structured, and repetitive physical activity aimed at improving or maintaining fitness components. Physical therapy incorporates exercise to enhance movement but also integrates cognitive strategies beyond traditional exercise.This review article synthesizes findings from randomized controlled trials over the last decade(search strategy detailed below). An overview of key studies (summarized in Table) shows evidence supporting the efficacy of balance training, gait training and strength and flexibility training in improving mobility in individuals with PD.[5]

Review

Methods

A systematic review of functional mobility in parkinsons patients was performed. This review was done through an electronic search of relevant articles using Google Scholar, PUBMED, Cumulated Index in Nursing and Allied Health Literature (CINAHL) from 2014 to December 2024 where in functional mobility, basic activities of daily living, instrumental activities of daily and mobility exercises in parkinsonswere used as the MeSH search terms. Articles were selected based on capability, self-awareness, and philosophical practice.

Search Strategy

Articles were searched from Google Scholar, PubMed,Sciencedirect,Researchgate and Cumulative Index to Nursing and Allied Health Literature (CINAHL) between November 2024 and December,2024. Reference lists for eligible articles were formed and authors were contacted for additional data, unpublished articles, and fulltext articles.

Inclusion Criteria

All relevant articles were published from January 2014 to January 2024 addressing the following criteria articles that included functional mobility exercises as an intervention, effect of mobility exercises in Parkinson's disease patients, effect of exercises on quality of life in Parkinson's disease patients.

Exclusion Criteria

All studies that were duplicates and studies that did not include UPDRS in the outcome measure, whose population were medically unstable and those who had altered psychological status were excluded. Hoehn and Yahr scores were less than

5.The detailed information on inclusion and exclusion criteria and the search strategy for the articles are illustrated in the figure.

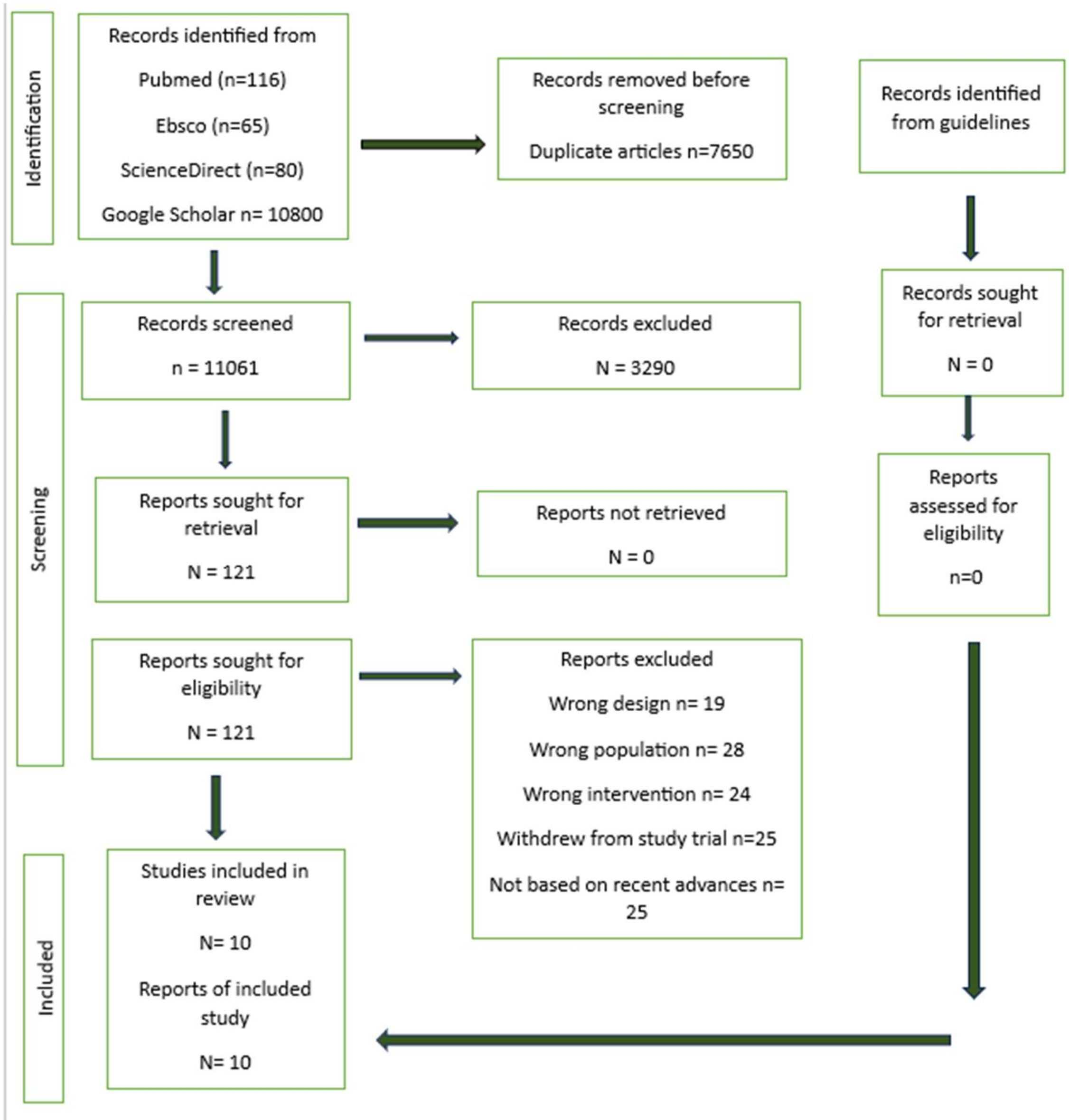

FIGURE no 1: PRISMA flow diagram of the literature search results.

Data collection and analysis

Data Extraction

One investigator selected the studies according to the inclusion criteria. The reviewer reviewed the titles and abstract of all the studies. Full texts of appropriate articles were reviewed and were selected if they were in line with the inclusion criteria. The following data was extracted from the related: study design, study population, physiotherapy intervention, physical impact, selected outcome, and key finding. Assessment of Study's Risk of Bias was also done. The methodological quantity of the chosen studies was reviewed by two investigators independently although studies which included a high-risk bias were also included.

Results

After searching several databases 11061 abstracts were extracted. The searches identified 10 appropriately significant studies which met the set inclusion criteria for further analysis.

Demographics

All studies included were of the same study design i.e. randomized controlled trial. Over 10 samples sizes population were included. These studies showed favourable effects of physiotherapy interventions in Parkinson's disease patients. Studies revealed that functional mobility exercises had a significant effect on the quality of life in Parkinson's disease patients. Table 1 contains a summary of included studies.

	D1	D2	D3	D4	D5	Overall
Coban 2021	Some concern	Low	Low	Low	Low	Some concern
Valenzuela 2020	Some concern	Low	Low	Low	Low	Some concern
Murgia 2018	Some concern	Low	Low	Low	Low	Some concern
Ferreira 2018	Some concern	Some concern	Low	Low	Low	Some concern
Kurt 2017	Some concern	Low	Low	Low	Low	Some concern
Ginis 2017	Low	Low	Low	Low	Low	Low
Icco 2015	Low	Low	Low	Low	Low	Low
Morris 2015	Low	Low	Low	Low	Low	Low
Capato 2015	Low	Some concern	High	Low	Low	High
Benoit 2014	High	High	Low	Low	Low	High

Table no 1 : Risk of Bias

D1: Bias arising from the randomization process

D2: Bias due to deviations from intended interventions

D3: Bias due to missing outcome data

D4: Bias in measurement of the outcome

D5: Bias in selection of the reported result

Sr No.	Title	Aim Of The Study	Study Design	Sample Size	Study Duration	Outcome Measures	Intervention
1	Effect of clinical Pilates training on balance and postural control in patients with	To evaluate and compare the effects of clinical Pilates exercises versus conventional physiotherapy	Randomized Control Trial	40 samples	8 weeks	BBS, Activities-Specific Balance Confidence Scale,	Each exercise session lasted 45 minutes, comprising a 5-minute warm-up, 30 minutes of core exercise performance, and a 10-minute cool-down. The intervention group performed clinical Pilates exercises, while the

	Parkinson's disease: a randomized controlled trial (2021) Fahriye Coban, et al.	exercises on balance, functional mobility, and fall risk in patients with Parkinson's disease (PD).				one-leg stance (OLS) test and tandem stance test (TST), functional reach test (FRT), 30-second chair-stand test (CST)	control group engaged in conventional physiotherapy exercises.
2	Effects of Dual-Task Group Training on Gait, Cognitive Executive Function, and Quality of Life in People With Parkinson Disease: Results of Randomized Controlled DUALGAIT Trial (2020) Constanza San Martı´n Valenzuela, et al.	This study aimed to evaluate the effects of a dual-task group program, compare them with a single-task group program, and examine the impact of functional secondary tasks.	Randomized Control Trial	40 samples	8 weeks	Parkinson's Disease Questionnaire-39, Frontal Assessment Battery and Trail Making Test (parts A and B)	Both interventions consisted of 20 one-hour sessions held twice weekly. Dual-task training incorporated walking exercises combined with cognitive or motor tasks, initially performed separately and later as a dual-task following a progressive protocol within the same session.
3	The Use of Footstep Sounds as rhythmic auditory Stimulation for Gait rehabilitation in Parkinson's Disease: a randomized Controlled	This study aimed to compare the effects of a rehabilitation program integrated with either ecological rhythmic auditory stimulation (RAS) or artificial RAS.	Randomized Control Trial	32 samples	5 weeks	(UPDRS), (FOGQ), Tinetti test, and timed up and go test (TUG), Geriatric depression scale (GDS), Short physical performance battery (SPPB), Functional independence	Each session included 20 minutes of specific gait training with RAS, during which participants walked while listening to their personalized soundtrack (ecological or artificial). Additionally, throughout the 5-week treatment period, participants were encouraged to train at home at least three times per week, performing a subset of the exercises practiced at the hospital,

	Trial (2018) Mauro Murgia, et al.					measure (FIM), Falls efficacy scale (FES), (PDQ-8), Activities specific balance confidence (ABC)	along with 30 minutes of gait training with RAS.
4	The effect of resistance training on the anxiety symptoms and quality of life in elderly people with Parkinson's disease: a randomized controlled trial (2018) Renilson Moraes Ferreira, et al.	To evaluate the effects of resistance training on anxiety symptoms and quality of life in patients with Parkinson's disease.	Randomized Control Trial	35 samples	24 weeks	Beck's Anxiety Inventory, Parkinson's Disease Questionnaire–39, UPDRS	The six-month exercise intervention included resistance training sessions of 30–40 minutes, conducted twice a week on nonconsecutive days. The program consisted of two sets of 8–12 submaximal repetitions for each exercise: bench press, deadlift, unilateral rowing, standing calf raise, and lower abdominal exercise.
5	Effects of Ai Chi on balance, quality of life, functional mobility, and motor impairment in patients with Parkinson's disease (2017) Emine Eda Kurt, et al.	This study aimed to investigate the effects of Ai Chi on balance, functional mobility, health-related quality of life, and motor impairment in patients with Parkinson's disease.	Randomized Control Trial	40 samples	5 weeks	Berg Balance Scale (BBS), Timed Up and Go (TUG) test. (PDQ-39), Unified Parkinson's Disease Rating Scale-III (UPDRS-III).	The Ai Chi group participated in 60-minute sessions, five times a week for 5 weeks (totaling 25 sessions). The Ai Chi program was conducted in a 1.2-meter-deep swimming pool at 32°C. Each session included a warm-up, Ai Chi exercises, and a cool-down. The 15-minute warm-up featured free extremity movements or activities with tools like pool noodles and kickboards. The Ai Chi program, lasting 30 minutes, involved 16 different movements performed in the following sequence: contemplating, floating, uplifting, folding, shooting, gathering, freeing, transferring, accepting, accepting with grace,

							rounding, flowing, relaxing, and sustaining. The control land-based exercise group participated in 60-minute group sessions, five times a week for 5 weeks (totaling 25 sessions). Their exercise program was designed based on existing exercise literature.
6	Prolonged Walking with a Wearable system Providing intelligent auditory input in People with Parkinson's Disease (2017) Pieter Ginis, et al.	The study aimed to compare the immediate effects of different cueing and feedback strategies (ConCue, IntCue, and IntFB) during a 30-minute walk in people with Parkinson's disease (PD). Additionally, the potential effects of these external input strategies on physical fatigue were assessed.	Randomized Control Trial	31 samples	6 weeks	(MDS-UPDRS III), Montreal Cognitive Assessment (MoCA), Multidimensional Fatigue Inventory (MFI) (22, 23), LASA Physical Activity Questionnaire (LAPAQ) (24), and Walk-12G	Participants completed four 30-minute walks over a 6-week period, with at least one week between each walk. All walks took place in the same hall at the same time and day of the week to minimize the influence of time and PD medication. After each walk, participants rested for 5 minutes and then self-assessed physical fatigue using a 10 cm visual analog scale, ranging from "No fatigue" to "Maximal fatigue." Participants started their walks either in a clockwise or counterclockwise direction, with the direction remaining consistent for each participant across the four sessions, but randomized between participants. Immediately after each walk, participants rated their physical fatigue and their perceived exertion using the 6–20 Borg scale.
7	Acute and Chronic Effect of Acoustic and Visual Cues on Gait Training in Parkinson's Disease: A Randomized, Controlled	The study aimed to compare and characterize the acute and chronic effects of visual and acoustic cues, used individually, in gait rehabilitation for individuals with	Randomized Control Trial	46 samples	4 weeks	UPDRS, FIM, MMSE	Patients in all three groups participated in 5 daily rehabilitation sessions per week for 4 consecutive weeks. Each session lasted 40 minutes and included passive muscle stretching, exercises for rigidity and joint mobility, specific motor exercises for hypokinesia, weight shifting, and balance training aimed at improving posture and movement

	Study (2105) Roberto De Icco, et al.	Parkinson's disease (PD).					strategies to prevent falls. In addition, patients underwent 5 daily sessions per week for 4 weeks dedicated to gait training. For the acoustic training group, cues were provided rhythmically using a digital metronome emitting a "beep" sound, with a frequency ranging between 60 and 120 Hz. In the visual cues group, colored stripes were placed on the floor perpendicularly to the walking direction.
8	A Randomized Controlled Trial to Reduce Falls in People With Parkinson’s Disease (2015) Meg E. Morris, et al.	The primary aim of the study was to determine the effects of Progressive Resistance Strength Training (PRST) or Movement Strategy Training (MST) compared with a Life Skills (LS) control group on the falls rate, recorded prospectively over a 12-month period in community-dwelling individuals with idiopathic Parkinson's disease (PD). Secondary aims included examining the effects of strength training or strategy training on	Randomized Control Trial	210 samples	8 weeks	Mini Mental State Examination (MMSE), UPDRS, TUG test, PDQ39, (VAS) of the Euroqol-5D, 6-m walk test	MST sessions focused on strategies to prevent falls and improve mobility and balance during functional tasks, such as transfers. The PRST group performed individualized functional resistance exercises, which were supervised by a registered physiotherapist. When participants' perceived exertion dropped below the required level (around 5 on the Modified Perceived Exertion scale), the exercises were progressively adjusted by increasing the repetitions (up to a maximum of 15), sets (up to a maximum of 3), or weights (by 2% of the person's body weight).

		mobility, disability, and quality of life.					
9	Randomized controlled trial protocol: balance training with rhythmical cues to improve and maintain balance control in Parkinson's disease (2015) Tamine Teixeira da Costa Capato, et al.	The aim of the study was to evaluate the effects of a motor program focused on improving balance, associated with rhythmic auditory cues.	Randomized Control Trial	150 samples	5 weeks	Berg Balance Scale (BBS) postural stress test (PST) [39], push and release test (PRT) [40] and Mini BESTest (MBESTest) (TUG) [42] and by the freezing of gait, using the Freezing of Gait Questionnaire (UPDRS) Falls Efficacy Scale-International (FES-I)	The program consists of two sessions per week, each lasting 45 minutes, and includes general physiotherapy exercises. Each session is divided into five minutes for warm-up, 30 minutes for the main exercises, and 10 minutes for cool-down. The exercises focus on improving balance.
10	Musically cued gait-training improves both perceptual and motor timing in Parkinson's disease (2014) Charles-Etienne Benoit, et al.	The aim of the study was to test whether a 1-month training program of gait using auditory cues enhances perceptual and motor timing.	Randomized Control Trial	15 samples	1 month	UnifiedParkinson'sDiseaseRating Scale(UPDRS), GeriatricDepressionScale	Patients with idiopathic Parkinson's disease (IPD) participated in an auditory cuing training program, where they were asked to walk while following a familiar German folksong. No explicit instructions were given to synchronize their footsteps with the beat of the music. The training consisted of three sessions per week for one month, with each session lasting 30 minutes and divided into three phases. In the first phase (10 minutes), the patient walked to the auditory rhythmic stimulus for 8 minutes, after which the stimulus was stopped and the patient continued walking for 2 minutes at the same speed. In the second phase (10 minutes), the patient performed stop-and-go trials, where the

							auditory stimulus was played for 30 seconds.

Table no. 2 : Clinical Characteristics and Management Strategies

Coban et al.[6] evaluated and compared the effects of clinical Pilates exercises versus conventional physiotherapy on balance and functional mobility in patients with Parkinson's disease. The study used the Berg Balance Scale and the 30-second Chair-Stand Test (CST) as outcome measures. The intervention group performed clinical Pilates exercises, while the control group engaged in conventional physiotherapy exercises.The results of the study showed that clinical Pilates exercises were as effective as conventional physiotherapy in improving balance and mobility. However, the clinical Pilates group demonstrated better improvements in dynamic balance. The findings suggest that clinical Pilates can be an effective rehabilitation strategy for improving balance in patients with Parkinson's disease, potentially offering additional benefits over conventional physiotherapy.

Valenzuela et al. [7]studied the effects of a dual-task training program compared to a single-task group program for individuals with Parkinson's disease (PD). The Parkinson's Disease Questionnaire-39, Frontal Assessment Battery, and Trail Making Test were used as outcome measures. Both interventions consisted of 20 one-hour sessions, held twice weekly. The dual-task training involved walking exercises combined with cognitive or motor tasks, initially performed separately and later integrated as dual-tasks, following a progressive protocol.The results revealed that the dual-task group showed improvements in velocity and stride length across all assessment conditions after the training. In contrast, the single-task group improved in these same outcomes only for the motor condition, but they did not experience improvements in perceived quality of life. These findings suggest that dual-task training may have broader benefits, improving both motor and cognitive functions in individuals with Parkinson's disease, while also enhancing aspects of gait performance and quality of life.

Murgia et al.[8]conducted an observer-blind, randomized controlled trial to compare the effects of a rehabilitation program integrated with either ecological or artificial rhythmic auditory stimulation (RAS) in individuals with Parkinson's disease (PD). Thirty-eight participants with PD were randomly assigned to one of two conditions: ecological RAS or artificial RAS. Thirty-two participants completed the study, which involved 5 weeks of supervised rehabilitation. Spatio-temporal gait parameters and clinical variables were assessed before the rehabilitation period, at its conclusion, and after a 3-month follow-up.The results showed that both groups improved in most biomechanical and clinical measures, regardless of the type of sound used. However, when separate group analyses were conducted, significant improvements in spatio-temporal gait parameters were observed only in the ecological RAS group. This suggests that ecological RAS may offer specific benefits for improving gait dynamics in individuals with Parkinson's disease.

Ferreira et al. [9]conducted a randomized controlled trial involving 35 elderly patients with Parkinson's disease, who were randomly divided into two groups: 17 patients in the control group and 18 in the intervention group. All participants continued their standard pharmacological treatment for Parkinson's disease. The intervention group participated in a 24-week resistance training program, while the control group received no additional intervention. Anxiety symptoms were assessed using the Beck's Anxiety Inventory, and quality of life was evaluated with the Parkinson's Disease Questionnaire-39 (PDQ-39). The intervention group showed a significant reduction in anxiety levels and an increase in quality of life after 24 weeks of resistance training. These findings suggest that resistance training may play a beneficial role in reducing anxiety and improving the overall quality of life for individuals with Parkinson's disease.

Kurt et al.[10] study was conducted as an open-label randomized controlled trial involving 40 patients with Parkinson's disease (PD), stages 2 to 3 according to the Hoehn and Yahr Scale. The patients were randomly allocated to one of two groups for a 5-week intervention: an Ai Chi exercise group or a land-based exercise control group.Outcome Measures were Biodex-3 and the Berg Balance Scale. Timed Up and Go (TUG) Test, Parkinson's Disease Questionnaire-39 (PDQ-

39) and the Unified Parkinson's Disease Rating Scale-III (UPDRS-III).Both groups showed significant improvement in all outcome variables.However, dynamic balance improvement was significantly greater in the Ai Chi group compared to the land-based exercise group.The findings suggest that Ai Chi, a form of aquatic exercise, might offer superior benefits for improving dynamic balance in PD patients compared to traditional land-based exercise programs, while both types of exercise led to improvements in overall mobility and quality of life.
Ginis et al.[11]investigated the immediate effects of different gait training modalities on Parkinson's Disease (PD) patients during a 30-minute walk, using performance-adapted (intelligent) auditory cueing and verbal feedback provided by a wearable sensor-based system, as alternatives to traditional cueing. Additionally, the study assessed the potential impact of these interventions on self-perceived fatigue.Twenty-eight individuals with PD and 13 age-matched healthy elderly (HE) participants performed four 30-minute walks, each with different conditions in a randomized order:Continuous auditory cueingIntelligent cueing (10 metronome beats triggered by a deviating walking rhythm)Intelligent feedback (verbal instructions triggered by a deviating walking rhythm). HE participants were able to maintain their cadence consistently throughout all conditions.PD participants, on the other hand, experienced a significant decline in cadence without any input.When given continuous cueing or intelligent feedback, PD participants were able to maintain their cadence better, but they reported more physical fatigue than HE participants.Cadence deviations were significantly greater in PD participants compared to HE participants.
Icco et al.[12]conducted a randomized controlled trial to analyze and compare the acute and chronic effects of visual and acoustic cues on gait performance in patients with Parkinson's Disease (PD). A total of 46 patients with idiopathic PD were randomly assigned to one of three modalities of gait training: (1) acoustic cues, (2) visual cues, or (3) overground training without cues. The study evaluated gait performance at baseline (T0), at the end of the 4-week rehabilitation program (T1), and 3 months later (T2) using kinematic analysis.Acoustic cues led to an increase in stride length and stride duration.Visual cues resulted in a reduction in the number of strides and normalized the stride/stance distribution, though gait speed was reduced.All three groups showed an improvement in gait speed by the end of the rehabilitation program.Visual cues also normalized the stance/swing ratio.Acoustic cues reduced the number of strides and increased stride length.Overground training improved stride length.
Morris et al.[13]evaluated two physical therapy interventions for reducing falls in Parkinson's disease (PD). The study randomized 210 participants with PD into three groups: progressive resistance strength training (PRST) combined with falls prevention education, movement strategy training (MST) with falls prevention education, and a control group that received life-skills information. All groups underwent 8 weeks of outpatient therapy once per week, with a structured home program.The outcome measures included the Mini Mental State Examination (MMSE), Unified Parkinson's Disease Rating Scale (UPDRS), Timed Up and Go (TUG) test, and the Parkinson's Disease Questionnaire (PDQ39). The MST sessions focused on strategies to prevent falls and improve mobility and balance during functional tasks like transfers. The PRST group performed individualized functional resistance exercises, supervised by a registered physiotherapist. The control group received life-skills information conducted by physiotherapists, occupational therapists, speech pathologists, or social workers.The results showed that both the MST and PRST groups experienced fewer falls compared to the control group, highlighting the effectiveness of strength and movement strategy training in reducing fall risk for people with PD.
Capato et al. [14] study involves 150 Parkinson's disease (PD) patients at Hoehn and Yahr stages II–III, who are asymptomatic for depression and dementia. The participants are enrolled in a single-blind randomized trial and assigned to one of three groups: the Balance and Rhythm Training (BRT) group, the Motor Training (MT) group, and the Control Group (CG). The balance and gait of participants are assessed before and after 10 training sessions, as well as 4 and 30 weeks after the training ends.The BRT group receives a motor program to improve balance with rhythmic auditory cues (RACs), while the MT group performs motor training with similar balance improvement goals but without RACs. The CG receives training focused on orientation without specific balance exercises. The exercise program for balance lasts 5

weeks, with two sessions per week, each lasting 45 minutes, and consists of general physiotherapy exercises.The study suggests that BRT may enhance attentional engagement with the tasks, and that external cue stimulation may improve sensory integration, compensating for deficits in the basal ganglia.

Benoit et al.[15] assessed perceptual and motor timing in 15 individuals with idiopathic Parkinson's Disease (IPD) before and after a 4-week music training program with rhythmical auditory cueing. Long-term effects were evaluated 1 month after the completion of the training. The outcome measures used were the Unified Parkinson's Disease Rating Scale (UPDRS) and the Geriatric Depression Scale. Prior to training, IPD patients exhibited impaired perceptual and motor timing. However, the training improved patients' performance in tasks requiring synchronization with isochronous sequences and enhanced their ability to adapt to duration changes in hand-tapping tasks.

Discussion

The analysis summarizes randomized controlled trials (RCTs) published over the past decade on physiotherapy management for functional mobility in Parkinson's Disease patients. RCTs provided the bulk of the evidence for this study. However, some discrepancies were observed in study criteria and results, which can be attributed to variations in the methodologies used to review the articles, differences in study designs, and the specific objectives emphasized in the studies.Google Scholar and PubMed were the primary databases used to source the majority of the articles, although additional databases were also explored to ensure comprehensive coverage.

Coban et al. [6]reported positive improvements in all measurements for both groups, but the Clinical Pilates (CLP) group demonstrated superior improvement in the Functional Reach Test (FRT), a dynamic balance measure. Two factors may explain this outcome.First, movement strategy and reduced spinal flexibility can influence functional reach distance. Clinical Pilates exercises promote trunk stabilization and enhance flexibility, which likely contributed to improved trunk mobility in the CLP group. Second, the improvement in dynamic balance may be attributed to enhanced flexibility and body awareness achieved through the CLP method.Notably, the FRT is a reliable indicator of fall risk, with a threshold score of 25 cm or below associated with increased risk.

Valenzuela et al.[7]conducted the first study comparing the effects of a dual-task (DT) group training program with standard group physiotherapy (ST) in patients with Parkinson's disease (PD). The motor improvements observed in the ST group may be attributed to the repetitive and rhythmic nature of the secondary task, which resembles arm swing movements.In contrast, the cognitive secondary tasks incorporated in the DT program likely imposed higher physical and attentional demands. This increased challenge may explain the greater improvements in velocity and stride length observed in the DT group compared to the ST group across various conditions and assessments post-rehabilitation. Murgia et al.[8] suggests that ecological rhythmic auditory stimulation (RAS) is as effective as artificial RAS, allowing patients to choose their preferred type of sound for gait training. This flexibility is important, as administering sounds perceived as annoying could reduce adherence to the training.Interestingly, several participants noted that the footstep sounds were meaningful and evoked memories of physical activities they had previously engaged in, such as a military march. These associations may stimulate motor imagery directly linked to walking, further enhancing the effectiveness of gait training.

Ferreira et al.[9] highlighted that excessive anxiety symptoms are associated with reduced activity of noradrenergic neurons in the locus coeruleus of the medulla oblongata, leading to decreased norepinephrine synthesis, increased expression of 5-hydroxytryptamine (5-HT), and reduced activity of 5-HT1A and 5-HT1B autoreceptors in serotonergic neurons of the dorsal raphe nucleus.Resistance exercise plays a key role in mitigating these effects by increasing central insulin-like growth factor (IGF1), which stimulates the IGF1 receptor and activates the Akt pathway. This pathway is essential for processes such as angiogenesis, cell growth, proliferation, and neural survival. Additionally, vigorous muscle contraction releases endocrine-related factors like brain-derived neurotrophic factor (BDNF), which can cross the blood-brain barrier and promote neuroplasticity, further contributing to anxiety reduction and improved neural function.Kurt et al.[10] emphasizes that both land- and water-based exercise consistently improve motor and non-motor symptoms in

Parkinson’s disease (PD). Exercise enhances synaptic strength and functional circuitry, which likely underpins behavioral improvements in PD patients. Neural plasticity serves as the fundamental mechanism driving rehabilitation outcomes in PD.Additionally, growing evidence suggests that physical exercise mitigates chronic oxidative stress by promoting mitochondrial biogenesis and upregulating autophagy. Exercise also stimulates the synthesis of neurotransmitters and trophic factors, both of which play a critical role in fostering neuroplasticity and contributing to the overall therapeutic effects of exercise in PD management.

Ginis et al.[11] explains that individualized responses to cueing in Parkinson’s disease (PD) can be attributed to the basal ganglia's role in rhythm perception. Recent studies suggest that predictive rhythmic stimulation facilitates interactions between the basal ganglia and the premotor cortex.Intelligently applied cueing proved most effective in maintaining gait stability, while intelligent feedback improved cadence toward the end of walking sessions. However, this also led to increased cadence variability and fatigue. Although continuous cueing reduced gait deviations, it caused greater fatigue in PD patients compared to healthy individuals (HE), highlighting the need to balance benefits with patient endurance.Icco et al. [12]report that cueing effectively improves various walking parameters in Parkinson’s disease (PD) patients. Auditory cueing shows greater efficacy in enhancing speed, cadence, and step length, while visual cues also improve these parameters but have distinct effects.Specifically, auditory cues positively impact stride duration and in-stride length. Conversely, patients exposed to visual cues experience a reduction in the number of strides and a decrease in gait speed. However, limited studies have examined the retention of these beneficial effects after rehabilitation ends, highlighting a gap in long-term outcomes research.Morris et al.[13]demonstrated that focusing on visual and auditory cues, as well as strategies that emphasize large-amplitude movements, allows individuals with Parkinson's disease (PD) to bypass the impaired basal ganglia and instead utilize frontal cortical mechanisms to control their movements. Additionally, progressive resistance strength training helps optimize peripheral motor control mechanisms, enhancing strength and power generation in people with PD.It is speculated that progressive strengthening may increase neural drive, reduce abnormal movements, and, as a result, decrease the risk of falls in individuals with PD.

Capatoet al.[14]suggests that auditory cues can facilitate anticipatory responses early enough to prevent loss of balance, similar to how they promote compensatory responses. Individuals with Parkinson's disease (PD) tend to prioritize voluntary tasks over postural control. Additionally, rhythmic cues may enhance attentional control, effectively serving as a form of dual-task training.The transfer of exercise benefits may involve the repair or consolidation of motor circuitry that overlaps between cognitive and automatic movement components. Many cognitive aspects associated with this process can help generalize and maintain the benefits of Balance and Rehabilitation Training (BRT), which can be applied to activities of daily living.Benoit et al. conducted a training program based on musically-paced gait over four weeks in patients with mild to moderate idiopathic Parkinson's disease (IPD). Their findings suggest that generalization of skills is mediated by a domain-general system that governs both perceptual and motor timing, extending beyond just gait.

Benoit et al.[15] studied that a training scheme relying on musically paced gait exercises conducted over four weeks in patients with mild to moderate idiopathic Parkinson’s disease (IPD) demonstrated beneficial effects on both perceptual and motor timing beyond gait improvements. This suggests that such interventions may activate neural networks responsible for coupling motor steps to auditory stimuli, offering insights into the functional and neuronal mechanisms underlying timing in both performance and perception.

Given that Parkinson’s disease increasingly affects not only movement but also cognitive function, interventions targeting cognitive aspects are critically needed. Training schemes that bridge motor performance and cognition may serve as essential components in developing effective strategies to delay cognitive decline in Parkinson’s disease. These approaches underscore the potential of integrated rehabilitation programs to address both motor and nonmotor challenges in patients.

Summary

A total of ten articles were included in the review. All the studies followed a consistent design, specifically randomized controlled trials. Among these, three studies had a duration of 5 weeks or less, while the remaining studies had durations ranging from 6 to 8 weeks. All of the studies incorporated components of functional mobility within their interventions.

Conclusions :

The articles reviewed provide a comprehensive summary of the impact of functional mobility exercises on the quality of life in individuals with Parkinson's Disease (PD). The studies demonstrated significant improvements in gait parameters, balance, and overall performance, particularly during the ON phase of medication. These findings underscore the importance of defining best practices for exercise interventions that address both motor and non-motor complications of PD.However, exercise strategies that target multiple physiological restrictions simultaneously or combine various exercises into a single 1-hour session appear to be a feasible approach. To ensure sustained participation in exercise, barriers should be minimized. Strategies such as offering group classes, facilitating home exercises, monitoring and managing comorbidities, setting personal goals, and exploring alternative methods to encourage long-term engagement in exercise are crucial for improving outcomes.

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