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REVIEW ARTICLE

Aquatic training modalities in gait rehabilitation in Parkinson's Disease: Scoping review

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Abstract

Background: Parkinson's disease (PD) is characterized by the degeneration and progressive loss of dopaminergic neurons in the substantia nigra of the midbrain, leading to motor symptoms that affect the functional gait of individuals with this diagnosis. Among non-pharmacological treatment strategies, Aquatic Physical Therapy demonstrates several benefits for gait rehabilitation. However, its exercise prescription and effects on variables such as gait-related activities, speed, and freezing of gait remain poorly addressed in the literature. **Objectives:** The purpose of this study was to investigate the prescription, types, and modalities of aquatic training for PD and its effects on gait-related activities, speed, and freezing of gait in individuals with PD. **Methods:** This review was conducted by the PRISMA-ScR standard and registered on the Open Science Framework platform. Studies published in the last 10 years were selected from the following databases: PubMed, Web of Science, Science Direct, Scielo, and PEDro. The inclusion criteria were studies addressing the effectiveness of aquatic training on gait-related activities, speed, and freezing of gait in PD. Two reviewers independently selected and extracted data on the methodological characteristics, interventions, and outcomes of the studies. **Results:** A total of 182 articles were identified in the databases, of which 7 met the eligibility criteria and were included for analysis. The sample included in this review consisted of 205 individuals with PD between stages 1–4 of the Hoehn-Yahr scale. **Conclusions:** The most effective training modalities for the analyzed outcomes were multimodal training, obstacle training, and dual-task training in an aquatic environment. However, there is no standardized clinical prescription for aquatic training in gait management for PD.

Keywords: Parkinson's disease; aquatic therapy; hydrotherapy; gait; gait analysis.

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BACKGROUND

Parkinson's Disease (PD) is a pathology characterized by a disorder in the Central Nervous System (CNS), which results in the progressive decrease of neurotransmitters, mainly the dopaminergic pathway in the basal ganglia, present in the substantia nigra of the midbrain[1].

Resulting from these alterations in the CNS, the cardinal motor signs of PD consist of bradykinesia, muscle rigidity, and resting tremor[2], which directly influence the gait aspects of people with PD, as neurodegenerative diseases alter the mobility and efficiency of the muscular action of groups necessary for the execution of normal gait[3], leading to increased energy expenditure by the individual, reduced mobility, and compensatory conditions for the samep[4].

People with PD generally present changes in the continuous parameters of gait, such as a decrease in step length, a reduction in base of support, and body asymmetry, which contribute to the reduction in gait speed in this population[5]. Furthermore, typical patterns of motor alterations in the disease, such as trunk flexion and knee semiflexion, also limit joint range, affecting the spatiotemporal parameters[3]. In PD, these parameters include shorter strides, increased cadence, step asymmetry, slowness, increased double support, and increased ground contact time[6].

Among the episodic variables, freezing of gait (also called freezing of gait/FOG) manifests as a sensation of feet glued to the ground at the start of walking[7], just as festination is marked by short and rapid steps and hesitation when initiating movement[8]. These alterations compromise the ability to perform complex tasks, such as avoiding obstacles or executing dual tasks during locomotion, as well as resulting in changes to the planning and execution of daily life tasks for the person with PD[9].

Under certain clinical conditions, physical exercise (PE), prescribed by a physiotherapist, stands out as a non-pharmacological therapy for the treatment of motor dysfunctions in PD[10]. Physical exercise (PE) promotes significant benefits in maintaining the functionality of people with PD, especially thru gait training. Strategies such as rhythmic gait training, exercises with visual or auditory cues, and practices that emphasize stride length and movement symmetry can improve parameters such as speed, balance, and locomotion fluidity[11]. Furthermore, the inclusion of components such as lower limb strengthening, muscle power training, and dynamic balance exercises enhances the effects of physical exercise on motor changes, reducing falls and improving the individual's autonomy[12].

Among the modalities of PE, its insertion into the aquatic environment, thru Aquatic Physiotherapy (AP), promotes additional benefits to gait when compared to land rehabilitation methods, making it a safe modality by stimulating effective exercise, promoting quality of life[13] with high achievement of therapeutic objectives[14]. In this sense, aquatic exercises present numerous benefits when applied considering different contexts according to the guidelines: gait, mobility, and strength[15].

Aquatic exercise promotes modifications in the individual's walking and in the practice of physical exercise, thru immersion and the physical properties of water such as viscosity, surface tension, and turbulence, which offer resistance to the speed of movement, requiring greater muscular control of the trunk and lower limbs; thru buoyancy resulting from the Archimedes' Principle, which reduces the overload on the knee and ankle joints[16, 17]; thru the temperature above 32ºC, which is responsible for reducing stiffness and improving the fluidity of the components of the gait cycle[18]; and thru hydrostatic pressure, which promotes greater stabilization of the foot in the walking process[19].

However, there are gaps in the understanding of the prescriptions and modalities of aquatic training for gait rehabilitation in people with PD, as well as its effects on the continuous and episodic variables of PD and the ability to perform complex tasks involving gait. Therefore, this study aims to analyze the prescription methods, types, and modalities of aquatic training for PD and its effects on activities related to gait, speed, and freezing of gait in people with PD.

METHODS

Protocol and record

This scoping review was conducted based on the PICOS strategy (Population, Intervention, Comparison, Outcome, and Studies). The review protocol was registered on the Open Science Framework platform, with the identification DOI 10.17605/OSF.IO/TBUZR.

Eligibility Criteria

This study was based on the PICOS strategy, based on the following research question: "What are the most effective aquatic training modalities for reducing freezing, increasing speed, and improving activities involving gait in people with PD?" Clinical trials and case studies addressing the effectiveness of aquatic training on speed, freezing, and gait-related activities were included. The population consisted of people with PD. The exclusion criteria were based on (1) review articles, (2) duplicate titles, (3) titles, abstracts, or texts unrelated to the topic (those that did not address aquatic physical exercises in the variables of PD gait), (4) studies whose full text was not available, (5) studies published in a language other than English, and (6) studies outside the period from June 2015 to June 2025.

Search and selection strategy/information and research sources

After consulting the Health Sciences Descriptors (DeCS), the following keywords were used: Parkinson's Disease, Gait, Walking Speed, Aquatic Therapy, Hydrotherapy. Four combinations of descriptors were adopted for the search in all the mentioned databases, namely: (1) Parkinson's Disease AND Gait AND Aquatic Therapy; (2) Parkinson's Disease AND Gait AND Hydrotherapy; (3) Parkinson's Disease AND Walking Speed AND Aquatic Therapy; (4) Parkinson's Disease AND Walking Speed AND Hydrotherapy. The search was initiated on June 3, 2025, and conducted independently by two researchers (GS and MFH) in the databases PubMed, Web of Science, Science Direct, Scielo, and PEDro. All studies published in English in the last 10 years (2015-2025) were considered.

Selection of evidence sources

The searches were grouped and conducted based on the established descriptors. The research was conducted in the databases by two reviewers (GS and MFH). They independently evaluated the texts and full articles and selected them according to the eligibility criteria. A third reviewer (GCL) was contacted in cases of disagreements regarding the selection of studies.

Data mapping process

The two reviewers (GS and MFH) independently conducted data extraction on the methodological characteristics, interventions, and outcomes of the studies. The outcomes of interest in this review were the effects of Aquatic Physiotherapy and aquatic gait training on the variables of speed, freezing, and gait-related activities in people with PD.

The information was verified by the third reviewer (GCL). The extraction table included authorship, year of publication, study design, objectives, sample size, and main results related to the assessment instruments used in the study. In order to better understand the specifics of gait training, a second table was created with the prescription and modality of aquatic training.

Critical evaluation of individual sources of evidence

Two reviewers (GS and MFH) independently assessed the quality of the studies using the Jadad scale[20]. In the absence of consensus, a third reviewer (GCL) was consulted.

Such a scale determines whether the study was adequately described. The Jadad scale assigns a numerical score from 1 to 5, with scores of 0 to 2 indicating low quality and scores of 3 to 5 indicating high quality.

Evaluation of the analyzed outcomes

Aiming to understand the analysis of speed, freezing, and activities related to gait in PD, studies that used validated tests and questionnaires for specific outcomes were selected, as described below.

Gait Speed Test

For the assessment of gait speed, the 10-meter walk test (10 Meter Walk – 10MW) is used. It is performed in a flat corridor, pre-marked at 10 meters, with adhesive tape on the floor.

The evaluated person is instructed to walk the 10 meters. Two markings are made 2 meters from the start and 2 meters before the end of the 10-meter track (acceleration and deceleration spaces, respectively, excluded from the time count). The elapsed time is measured, with a stopwatch, to cover the 6 intermediate meters. The speed is then calculated in meters per second (m/s). The test is conducted three times, and the simple average of the three attempts is used to conclude the result[21, 22].

Freezing of Gait Scale

For the assessment of freezing of gait, the Freezing of Gait Questionnaire (FOG-Q) is used. The FOG-Q consists of a 6-question questionnaire, each focused on specific aspects of freezing of gait, such as frequency, severity, and factors influencing the freezing episode. Each question is answered on a scale from 0 to 4, with the total score ranging from 0 to 24, where a higher score indicates the severity or frequency of freezing episodes[23].

Dynamic Gait Index

The balance and gait of the human body in PD can be assessed thru the Dynamic Gait Index (DGI). Being a tool used to measure an individual's ability to perform walking tasks while dealing with different commands, the DGI is composed of 8 tasks, which are scored on a scale from 0 to 3, where 0 indicates the greatest difficulty and 3 indicates the proper execution of the task. The final score ranges from 0 to 24, with a score below 19 associated with a higher risk of falls[24].

Organization of the collected data

The organization of the data from the selected studies was carried out using the digital platform Google Sheets, as well as the arrangement of the information from each article, which was organized in a spreadsheet containing the data presented in Table 1 and Table 2.

RESULTS

Description of the studies

A total of 182 articles were identified in the databases, of which 7 met the criteria and were included in this review. Of these, four are randomized clinical trials, one is a comparative experimental clinical trial, one is an interventional clinical trial, and one is a non-randomized clinical trial, published between 2015 and 2025. A total of 205 people with PD, with Hoehn & Yahr (HY) between 1-4, were included in this review (Figure 1). The methodological characteristics of each study were presented in Table 1.

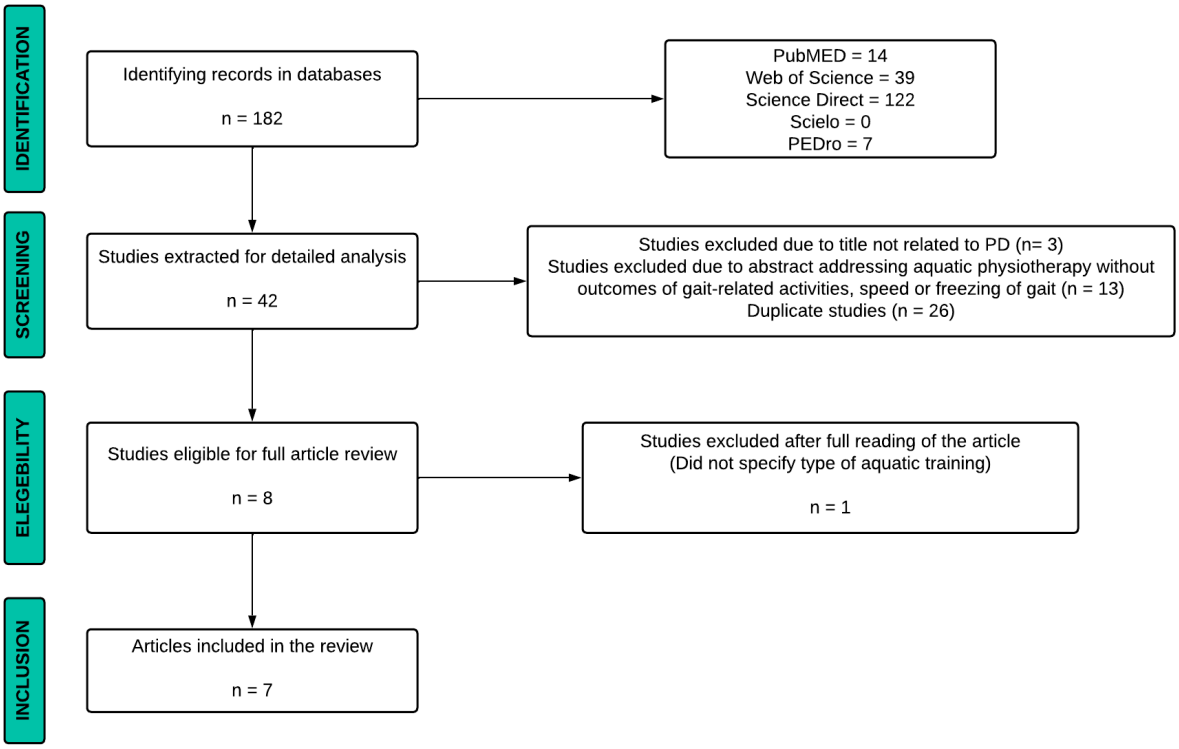


Figure 1. Flowchart of the search and selection process of studies as proposed by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses: Extension for Scoping Reviews (PRISMA-ScR)

Table 1. Methodological description of the selected studies

Author, year, country	Study design	Objective of the study	Sample	Assessment tools	Results	Study quality
Cancela et al.[25] 2015 Spain	Comparative experimental clinical trial	To compare the effects of an aquatic exercise program versus a combined program (aquatic + calisthenics) on postural control, functional independence, and the FOG phenomenon in patients with mild to moderate PD.	25 participants with PD (HY 1-3) (WB = 9) and (WC = 16) WB group = 67.44 ± 6.72 years. WC group = 70.62 ± 6.25 years.	FOG-Q SPPB UPDRS II	Significant improvement in freezing in the WC group (p=0.007) No significant changes in postural control and functional independence.	2 (Low Quality)

Carroll et al.[28] 2017 Ireland	Randomized controlled, single-blind clinical trial	To evaluate the effects of aquatic exercise therapy on gait variability and motor disability in people with PD, comparing it with usual care.	21 participants with PD (GI = 11) and (GC = 10) (HY 1-3); 14 men and 7 women with a mean age of 71.42 ± 4.9 years.	UPDRS III PDQ-39 FOG-Q.	There were no significant differences between the groups. However, the aquatic therapy group showed slight improvements in step length and time variability; Significant improvement in UPDRS III in the aquatic therapy group, with a moderate effect (p=0.01); No significant differences between the groups for quality of life and freezing of gait.	3 (High Quality)
Christinelli et al.[26] 2024 Brazil	Interventional clinical trial	To examine the effects of an aquatic physiotherapy program on gait speed and performance of complex gait-related activities in individuals with PD.	10 participants with PD (H&Y 1-3) 7 men and 3 women with a mean age of 65.8 ± 13.69 years.	10MWT DGI	Significant improvement in DGI score (p = 0.05), indicating better performance in complex tasks. Significant increase (p = 0.001) in average habitual speed (AHS) and non-significant increase in average speed (AS) (p= 0.0119).	2 (Low Quality)
Clerici et al.[29] 2019 Italy	Randomized, controlled, parallel-group, single-blind clinical trial	To investigate the effectiveness of MIRT treatment in improving FOG in people with PD and to assess whether the addition of MIRT-AT provides additional benefits compared to land-based rehabilitation.	60 hospitalized patients with Parkinson's disease and freezing of gait (HY 2-3); MIRT group = 30 participants; MIRT-AT group = 30 participants;	FOG-Q UPDRS II/III BBS TUG 6MWT	Both groups showed significant improvement in FOG-Q and secondary outcomes after treatment; There was no significant difference between the groups regarding the addition of aquatic therapy; The results suggest that MIRT is effective in reducing FOG, but the inclusion of aquatic therapy did not provide additional effects.	4 (High Quality)

Iucksch et al.[27] 2023 Brazil	Non-randomized clinical trial	To verify the influence of a sequential multimodal intervention program (aquatic and terrestrial) on balance, postural control, motor aspects, and ADLs in people with PD.	18 participants with idiopathic PD (HY 1-4); Mean age: 66.83 ± 11.74 66.7% represented by the male sex	BBS Mini-BesTest UPDRS II/III DGI QS	BBS: Aquatic Intervention (AI): Significant improvement in static balance after 12 weeks (p = 0.004) Complete Intervention (AI + LI): Benefits maintained after the combined program (p = 0.002) Mini-BESTest: Land Intervention (LI): Improvement in dynamic balance (p = 0.005) Complete Intervention: Large effect (p = 0.001) DGI: Ceiling effect achieved QS: No significant differences	2 (Low Quality)
Silva; Israel[30] 2019 Brazil	Randomized, single-blind clinical trial	To evaluate the effects of dual-task aquatic exercises on functional mobility, balance, and gait in people with PD.	25 participants with idiopathic PD (HY 1-4); Experimental group = 14 participants Control group = 11 participants Average age 63-64 years	UPDRS III TUG FTSST BBS DGI	Significant improvement in the experimental group (EG) compared to the control group (CG) in the Timed Up and Go (TUG) test (As2: p=0.03; As3: p=0.015) and in the Full Body Test for the Six Steps to the Middle Step (FTSST) test (Av2: p=0.001; Av3: p=0.004) Significant increase in the BBS score in the EG (As2 and As3: p=0.002) Significant improvement in the Distance Gaited Weight (DGI) in the EG (As2: p=0.001; As3: p=0.003) Follow-up: The benefits were maintained after 3 months of training.	4 (High Quality)

Zhu et al.[31] 2018 China	Randomized, controlled, single-blind clinical trial with two parallel groups.	To evaluate the effects of aquatic obstacle training compared to traditional aquatic therapy in patients with Parkinson's disease, focusing on balance parameters and freezing of gait.	46 patients with PD (HY 1-3); Traditional AP Group (n = 23); AP Group with Obstructions (n = 23).	FOG-Q BBS TUG FRT UPDRS II/III	The group with obstacles showed better performance on the FOG-Q (p=0.004 post-treatment; p=0.003 at follow-up) and on the TUG (p<0.001 at both time points) compared to the traditional group. Positive effects were maintained for 6 months.	4 (High Quality)

Note: Parkinson's disease (PD); Freezing of Gait (FOG); Water-Based (WB); Water-Based Plus Callisthenic Exercises (WC); Hoehn-Yahr (HY); Freezing of Gait Questionnaire (FOG-G); Short Physical Performance Battery (SPPB); Unified Parkinson's Disease Rating Scale Part II/III (UPDRS II/III); Intervention Group (IG); Control Group (CG); Parkinson's Disease Questionnaire (PDQ-39); 10 Meter Walk Test (10MWT); Dynamic Gait Index (DGI); Usual Average Speed (VMH); Maximum Average Speed (VMM); Multidisciplinary Intensive Rehabilitation Treatment (MIRT); Multidisciplinary Intensive Rehabilitation Treatment with Aquatic Therapy (MIRT-AT); Berg Balance Scale (BBS); Timed Up and Go Test (TUG); 6 Meter Walk Test (6MWT); Activities of Daily Living (ADLs); Mini Balance Evaluation Systems Test (MiniBESTest); Quiet Stance (QS); Five Times Sit-to-Stand Test (FTSST); Experimental Group (EG); Assessment (AS); Aquatic Physiotherapy (AP); Functional Reach Test (FRT).

Risk of bias

Based on the Jadad scale, three studies[25-27] were classified as low methodological quality studies (Score 2), while four studies[28-31] were classified as high methodological quality studies (Score 3-5). Regarding the quality criteria of the included studies, 4 out of the 7 studies used a control group with randomization among participants and blinding of the evaluators.

Modalities of aquatic walking training

The modalities of aquatic walking training varied according to the studies, but all 7 studies included walks with alternating directions in their training protocols. Six studies[25-30] mentioned the addition of floating devices to perform the progression of alternating walking exercises, aiming to increase the training's endurance. Two studies[28, 31] included the use of obstacles (submerged stairs) as part of the gait training.

Three studies[28-30] used tandem walking as part of the training protocols. One study[29] included walking in a straight line with plantar flexion. Only one study[31] included zigzag walking (using small objects fixed at the bottom of the pool) associated with the circumduction of the lower limbs around the objects.

This same study also included walking on steps of different heights (which changed as the training progressed), as well as walking in a straight line with a reduction in passage width (narrowing with each progression). The specific characteristics of each training session are outlined in TABLE 2.

Table 2. Characteristics of the prescription and specificities of aquatic walking training

Authors	Training Prescription	Aquatic training modality	Context of aquatic Training	Variables Analyzed
Cancela et al.[25]	50-60 minutes, once a week for 16 weeks.	Gentle walking in different directions; walking with support (heels on the balls of the feet); gait training (knee and heel raises/legs apart/crossed legs/arms in and out of the water); resistance walking (sinking a swimming board).	Heating up a specific aquatic intervention program	Freezing
Carroll et al.[28]	45-minute sessions, twice a week, for 6 weeks.	Gait training combined with walking in different directions, involving long strides; ascending/descending submerged steps; progression performed using ankle weights to generate resistance.	Specific aquatic exercise program aimed at gait rehabilitation.	Freezing
Christinelli et al.[26]	50-minute sessions, twice a week, for 12 weeks.	Forward and backward walking; side walking; walking with reference points; walking with dissociation of the shoulder and pelvic girdles; walking with obstacles; jogging; jumping; progression performed every 4 weeks.	Warm-up for Multicomponent Aquatic Training (MAT)	Speed Gait-related activities
Clereci et al.[29]	60-minute sessions, 3 times a week for 4 weeks.	Walking forward and backward; side walking; walking on tiptoes; lateral step crossing; walking in different directions; proprioceptive exercise with a floating board for ankle flexion/extension; progression performed using aquatic devices to generate resistance.	Specific aquatic exercise program included in the Multidisciplinary Intensive Rehabilitation Treatment with Aquatic Therapy (MIRT-AT)	Freezing Speed
Iucksch et al.[27]	60-minute sessions, twice a week for 12 weeks.	Walking in different directions and speeds; walking forward, backward, and sideways, with changes in pace; walking with the incorporation of turns, squats, and dissociation of the pelvic and scapular girdles; walking with floating equipment (boards) to increase instability; walking with obstacles.	Heating up the Multimodal Intervention Program (MIP)	Gait-related activities
Silva; Israel[30]	60-minute sessions, twice a week for 10 weeks.	Walking while moving the upper limbs (flexion/extension and abduction/adduction up to water level); walking while naming fruits or colors; walking while holding a submerged board in front of the body; tandem walking forward and backward; walking with aquatic dumbbells on the upper limbs; tandem walking with dumbbells submerged and parallel to the body; tandem walking with dumbbells, responding to sound stimuli (whistles to direct the gaze or stop); walking with dumbbells and crossing platforms (climbing, walking on them and descending).	Specific aquatic exercise program aimed at cognitive-motor rehabilitation in PD.	Gait-related activities
Zhu et al.[31]	40-minute sessions, 5 times a week for 6 weeks.	Zigzag walking (weaving between small fixed objects on the bottom of the pool); obstacle course walking (walking towards an object on the bottom of the pool and circling around it); walking on steps of varying heights (0.2 m, 0.3 m and 0.4 m); straight line walking through a narrow passage.	Specific aquatic exercise program aimed at gait rehabilitation.	Freezing

Frequency of the analyzed outcomes

The selected studies comprehensively evaluated the effects of aquatic gait training involving outcomes such as speed, freezing, and gait-related activities in PD. Three studies[26, 27, 30] analyzed gait-related activities using the DGI. Four studies[25, 28, 29, 31] analyzed gait freezing using the FOG-Q. Only two studies[26, 29] analyzed gait speed using the 10MWT and 6MWT, respectively.

DISCUSSION

This present review aimed to investigate the prescription methods, types, and modalities of aquatic training for PD and its effects on the analyzed outcomes. A limited number of studies addressing aquatic gait training were found, making it one of the limitations of this review.

Of the 7 studies, only three addressed gait rehabilitation in isolation, with an exclusive focus on aquatic gait exercises, often with additional challenges such as obstacles or the use of resistance[28,30,31]. In contrast, three studies included gait training as a warm-up, associated with other training modalities, included in exercise programs or multimodal training for PD[25-27]. A single study[29] included gait training both as a warm-up and as the main part of an aquatic rehabilitation program.

This division reflects the difference in the approach of the studies and the possible effects on the outcomes of interest, as some use walking as part of a broader protocol, while others investigate and use it as a primary intervention. The prescription of training protocols also followed the training pattern commonly reported in the literature, with a duration of 8 to 12 weeks, a frequency of 2 to 3 times per week, with sessions lasting 30 to 60 minutes each[32, 15].

The studies also relied on standard protocols for prescribing gait rehabilitation training in PD, primarily including multidimensional training (balance and gait) for 3 days/week, 30-60 min/day, and resistance training for 2-3 days/week, with progressive load increases throughout the interventions, a necessary factor for adapting to physical exercise and its evolution in gait rehabilitation in PD[33]. However, this prescription proved to be heterogeneous in the studies, varying between protocols and training programs, revealing discrepancies and presenting a lack of standardization in the clinical prescription of aquatic physiotherapeutic exercise in the context of gait rehabilitation.

Activities related to gait

The analyzed studies consistently found that aquatic training promotes significant improvements in gait and related complex activities in people with PD, as assessed by the DGI. In the intervention proposed by Christinelli et al.[26], which used gait training as a warm-up for a multicomponent program, a significant increase in the DGI score was observed after 12 weeks of aquatic intervention ($p = 0.05$), indicating a greater ability to adapt gait to challenging tasks, such as avoiding obstacles and changing speeds.

Similarly, Silva and Israel[30] reported improvements in the DGI after a dual-task aquatic exercise program, with effects maintained even three months after the end of the intervention period ($p = 0.003$).

The data from Iucksch et al.[27] corroborate these findings, highlighting that the sequential multimodal intervention (aquatic and terrestrial) also resulted in functional gains, although the DGI showed a ceiling effect in the full intervention group.

The results found are justified by the action of immersion in water on the body of the person with PD, as physical properties, such as buoyancy, are responsible for reducing joint impact and the risk of falls, allowing the immersed individual to perform movements with greater safety and range[16]. Thus, the practice of multidirectional exercises, such as walking with turns and changes of direction, which are essential for improving the adaptability of the gait cycle, is facilitated by the aquatic environment[34]. In this sense, the prescription of aquatic exercises addresses the individual's particular need to adapt to a different environment, which stimulates the formation of new neural networks thru neuroplasticity, improving the coordination and sensorimotor integration of the CNS[35]. This fact is particularly relevant for complex DGI tasks, such as walking associated with head movements, for example[27].

Furthermore, the association of aquatic gait training with dual-tasking is another aspect that benefits from immersion in a heated pool, as exercises like gait combined with cognitive activities reinforce the connection between cognitive and motor processes of the CNS, a crucial factor for the execution of daily life activities for individuals with PD[36].

Finally, the prescription of training such as tandem walking[30] proves to be positive as it works on balance training within walking, promoting muscle activation, increased proprioceptive sensitivity, and adaptability of the CNS for the individual, as well as reducing the risk of falls, which strengthens the compensatory mechanisms of the nervous system. Meanwhile, walking training applies these gains to locomotion, generating greater dynamic stability and increased synchronization between balance and movement in the gait cycle in PD[37].

Freezing of the march

Studies have shown that aquatic and multimodal interventions can be beneficial in the outcome of freezing of gait in people with PD. The article by Zhu et al.[31] compared traditional aquatic training with a protocol that included obstacles in a heated pool. The results demonstrated that the group subjected to obstacle training showed improvements in the applied questionnaires (FOG-Q and TUG), presenting lasting benefits.

The authors highlight that the aquatic environment offers unique advantages, such as the reduction of muscle stiffness and the sensory stimulation provided by the physical and thermal properties of water[38], which can contribute to the rehabilitation and re-education of the gait pattern of these patients[18]. Moreover, the study suggests that repeated exposure to situations that trigger freezing, such as changes in direction and narrow passages, contributes to the development of adaptive motor strategies in the neural network of people with PD[39, 40].

The clinical trial by Clerici et al.[29] analyzed the efficacy of an intensive and multidisciplinary training based on motor-cognitive strategies (MIRT), which was compared with the protocol of motor-cognitive strategies with the addition of aquatic therapy (MIRT-AT).

The results demonstrated that both groups showed improvements in the administered questionnaire (FOG-Q) and in secondary outcomes of the UPDRS and TUG scales. However, there were no significant differences between the groups. The authors highlight that MIRT, due to its intensive approach focused on motor-cognitive engagement, was effective in reducing freezing episodes, possibly due to the stimulation of cortical and subcortical networks involved in motor control and sensory integration[41].

The study by Cancela et al.[25] analyzed the effects of two groups, one with aquatic therapy (WB) and the other combining calisthenic exercises with aquatic sessions (WC), on the outcome of gait freezing in patients with PD. The results demonstrated that the combination of modalities (WC) significantly reduced freezing episodes compared to isolated aquatic therapy (WB), possibly due to the additional motor and cognitive stimuli[40]. The study reinforces that multimodal interventions, combined with the facilitating properties of the aquatic environment, can be promising strategies in managing gait freezing in PD.

Walking speed

The findings of Christinelli et al.[26] corroborate the effectiveness of AP in improving the habitual gait speed in people with PD, attributed to the physical properties of water and the multicomponent approach[42].

The participants underwent aquatic exercise sessions, with assessments conducted using the 10MWT. In the results, a statistically significant increase in habitual speed (1.09 ± 0.23 m/s; p = 0.001) is observed, suggesting that aquatic intervention may improve daily mobility. However, although an increase in maximum speed (1.57 ± 0.30 m/s) was observed, this difference did not reach statistical significance (p=0.119), possibly due to the small sample size or the complex nature of the task, which reaches a higher cortical demand[43, 44].

The authors attributed the benefits of AP to the physical properties of water, which facilitate the execution of broad and safe movements, in addition to promoting muscle strengthening[19]. The multicomponent protocol, which included gait exercises, lower limb strengthening, and balance training, was able to stimulate motor adaptation and neural plasticity, reflecting in the improvement of the DGI score. These findings highlight the potential of AP as a complementary intervention for the analyzed outcome[26].

Additionally, the study by Clereci et al.[29] also used gait speed (measured solely by the total distance covered) as a global indicator of functional improvement, but it was not analyzed in terms of gait speed per se. The increase in the distance covered in the 6MWT is not a direct factor involved in the reduction of freezing episodes, but a consequence of the same underlying mechanisms that were addressed during rehabilitation[45].

The MIRT protocol was able to stimulate an increase in stride length and the coordination and rhythm involved in speed, enhancing walking confidence and reducing the anticipatory neural reactions that cause freezing[46], translating this clinical improvement into a practical and measurable ability for the person with PD to move more effectively and for longer periods[45, 47].

However, the authors discuss that the addition of aquatic therapy did not bring relevant clinical benefits either in freezing or in speed when compared to the group that did not undergo it.

Study limitations

The low number of studies found in the databases was one of the limiting factors of this review. The heterogeneity of the studies and the similarities and discrepancies in the prescriptions, which often contrasted with the guidelines[15], also proved to be notable limitations, as they denote a comprehensive and divergent literature on aquatic training in gait rehabilitation in PD.

CONCLUSION

It was possible to conclude that aquatic gait training is beneficial for increasing the ability to perform complex gait-related tasks in PD, reducing freezing, and improving gait speed. Modalities such as multimodal training, obstacle training, and dual-task training in an aquatic environment stand out as types of programs with greater gains and benefits associated with the outcomes analyzed in this review. However, there is no standardized prescription for the observed training programs, necessitating that future studies address this standardization in their protocols involving gait and AP in PD.

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