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Scoping review: how do the properties of heated water influence the prescription of aquatic physical exercises to develop motor skills in people with Parkinson's disease?

review paper
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ABSTRACT
Purpose. Aquatic intervention seems to influence the motor skills of people with Parkinson's disease (PD). However, little is known about the transference of these motor skills to the land environment, as well as the use of the therapeutic properties of water. The study aim was to identify the aquatic intervention strategies considering the properties of water for the development of motor skills in PD.
Methods. With the PRISMA and Cochrane checklist, a systematic review was conducted involving 7 databases with randomized and nonrandomized studies from 2010 to July 2020. The prescription and description of aquatic physical exercise data were extracted and summarized, and the use of physical and thermal properties of heated water was analysed.
Results. Overall, 13 studies involving 307 participants (Hoehn and Yahr scale 1–4) met the inclusion criteria. In accordance with the Jadad scale, 7 studies were classified as low-quality (score 0–2), whereas 6 were categorized as high-quality (score 3). All the selected studies concentrated on aquatic physical exercise programs developed by the researchers who focused on transferring motor skills – such as mobility and functional reach, balance, motor aspects, activities of daily living, quality of life, and gait – to the land environment.
Conclusions. Aquatic intervention strategies can be adequately prescribed as beneficial to motor skill training in PD. The analysis of the physical and thermal properties of heated water is useful to systematize prescription parameters depending on the characteristics of the PD patient and the heated aquatic environment.
Key words: Parkinson's disease, hydrotherapy, motor skills, exercise, scoping review

Introduction

Physical exercise performed in an aquatic environment with a mean temperature of 32–33°C increases the activation of sensory and motor areas of the brain cortex. This is due to physiological responses, adaptation mechanisms, and postural adjustments, situations that can benefit the active and functional execution of motor behaviours [1]. These benefits result from intervention strategies with aquatic physical exercises, as well as from the action of the physical, mechanic, and thermal properties of water, such as Archimedes' principle (buoyancy), Pascal's principle (hydrostatic pressure), and water resistance (turbulence, viscosity). The properties of water work in combination; however, in certain physical exercises, they can have a directed action with isolated function – e.g., buoyancy as a support, making it either easier or more difficult to make movements. Hence, the adequate use of water in combination with aquatic physical exercises commands in a heated pool provided cognitive and sensory-motor stimuli for the acquisition or training of motor skills [2]. Studies with land physical exercise for motor skill training are more consolidated; however, there is a scarcity of studies approaching such training in the aquatic environment, as well as the possibility of transferring acquisitions from one environment to the other [3, 4]. In addition, disease progression is assessed with the Hoehn and Yahr scale, describing the patient's general condition. The scale is divided into 5 stages,

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which are: 1 – unilateral disease, 1.5 – unilateral and axial involvement, 2 – bilateral disease without balance deficit, 2.5 – mild bilateral disease with recovery in the push test, 3 – mild to moderate bilateral disease, with some postural instability and ability to live independently, 4 – severe disability, maintained ability to walk or stand without help, 5 – confinement to bed or wheelchair if not aided [3].

Motor skills are the qualitative parameter of motor behaviour – i.e., the motor gesture itself – which is skilfully and automatically performed after learning a motor function. These acquisitions relate to processes associated with the practice and experience of people with Parkinson's disease (PD), potentially leading to a relatively permanent change by means of the retention mechanisms [5]. In PD, which is a progressive neurologic disease, the process of acquiring and retaining motor skills is impaired [5] because of the dopaminergic reduction in the nigrostriatal pathway and degeneration of the basal ganglia. Thus, motor cortex activation becomes reduced as the disease progresses, which has negative consequences to the patients' motor control [3, 6–8] Hence, the 4 cardinal signs – bradykinesia, tremor at rest, postural instability, and muscle stiffness – stand out. To diagnose PD, at least 2 of these signs need to be present, one of them being bradykinesia [3, 8].

Motor gestures that used to be automatic in their repertoire, such as gait and activities of daily living, become a problem that hinders the patients' functioning (the third health indicator) and quality of life, making them less physically active [9–12]. Therefore, it is necessary to study and develop strategies to promote improvements in the functional motor performance of people with PD, allowing them to maintain more independent.

There seems to be a gap in the literature regarding the use of the physical, mechanic, and thermal properties of heated water in the physical exercise programs and motor skill acquisition. Despite this environment's influence on motor learning, studies do not clearly present how the properties of water can affect these processes or how the skills trained in the aquatic environment are transferred to land in people with PD.

Thus, the main objective of this study was to furnish current evidence of and specialists' opinion about aquatic intervention strategies used to develop motor skills in people with PD, with the consideration of the properties of water. The research questions in this article were as follows:

1. What aquatic interventions in a heated pool are used to enhance motor aspects, activities of daily living, balance, mobility, functional reach, gait, and quality of life in people with PD?
2. What are the frequency, duration, and intensity of the aquatic intervention in a heated pool proposed for this population?
3. How do the properties of water influence the aquatic intervention in a heated pool?
4. How is the transference of motor skills influenced by aquatic intervention in a heated pool?

Material and methods

Eligibility criteria

This study was based on the PRISMA checklist and Cochrane method [13–15]. The publications included were pilot studies, as well as randomized and nonrandomized clinical trials describing the use of aquatic physical exercises in specific programs, protocols, and/or methods performed in a heated pool. The population comprised individuals with PD, and the following outcomes were evaluated: Unified Parkinson's Disease Rating Scale, Parkinson's Disease Questionnaire 39, Timed Up and Go Test, Five-Times-Sit-to-Stand Test, Barthel Index, Berg Balance Scale, visual analogue scale, Tinetti test, Yesavage Geriatric Depression Scale, SF-36 Health Survey, Functional Reach Test.

The exclusion criteria were: (1) retrospective study, (2) systematic or literature review, (3) not approaching aquatic physical exercises or PD, (4) full text not found, (5) studies in languages other than Portuguese, Spanish, or English.

Search and selection strategy

Duplicated search was independently conducted in the MEDLINE, BIREME, PubMed, LILACS, PEDro, ScienceDirect, and SciELO databases. All articles written in Portuguese, Spanish, and English published in the previous 10 years were considered.

After consulting the Health Sciences Descriptors, the following keywords were used: Parkinson's disease; hydrotherapy; aquatic; exercise; and aquatic environment. On the basis of these, the searches were grouped and conducted.

All the titles and abstracts were selected by 2 independent researchers (JS and BG) in duplicate. If an abstract that did not furnish enough information on the inclusion and exclusion criteria, the article was

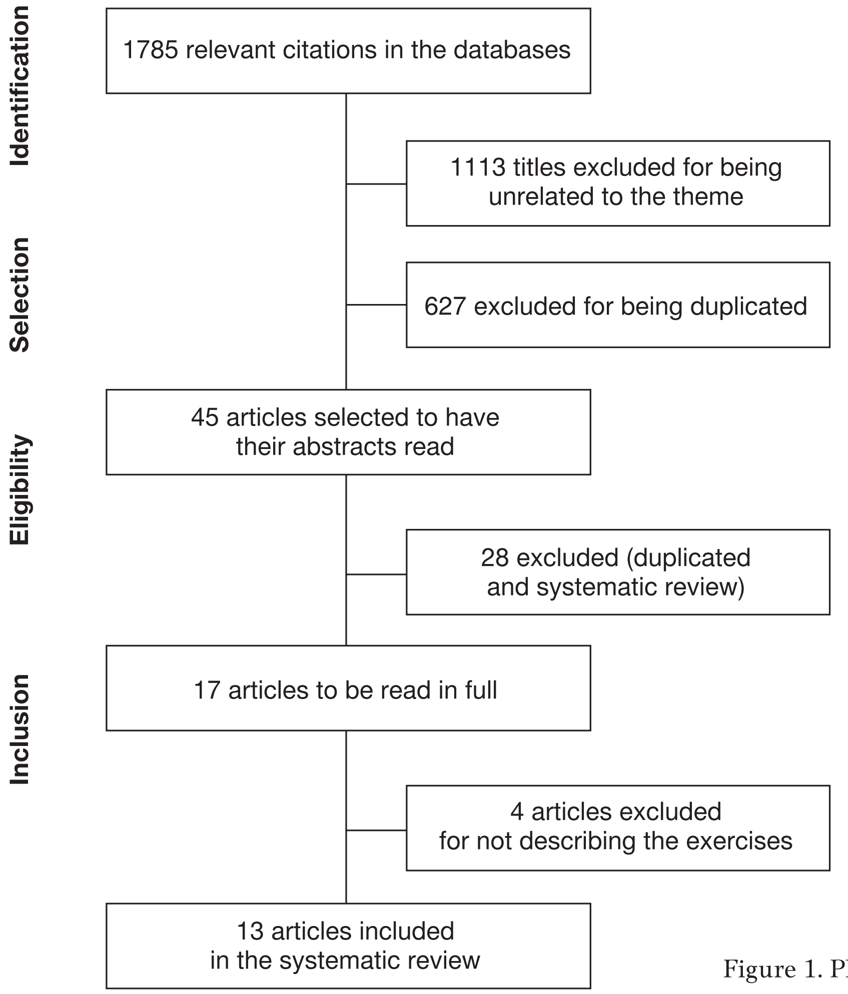

Figure 1. PRISMA flowchart of the study

selected to be evaluated in full. In the second phase, the same reviewers independently evaluated the articles' full texts and selected them in accordance with the eligibility criteria. The differences between the reviewers were solved by consensus.

Firstly, the total publications available in the selected databases were searched with the consideration of each descriptor. In the second phase, only the titles were selected. After excluding all the articles that did not meet the criteria for this study, a new investigation was carried out based on the abstracts of the selected articles. Both researchers compared the identified articles and by consensus defined those which would be read in full. When there was no consensus, a third person (LHP) was consulted (Figure 1).

Data extraction

The 2 reviewers independently conducted the data extraction regarding the methodological characteristics, interventions, and results of the studies. The results that were of interest for this review were the prescription and description of aquatic physical exercises, analysis of physical and thermal properties of heated water, and the results transferred to land.

Quality analysis: assessment of the risk of bias

Two researchers (JS and BG) independently assessed the quality of the studies with the Jadad scale [16]. When there was no consensus, a third researcher (LHP) was consulted.

The validated Jadad scale defines whether the study has been adequately described. Its score ranges from 1 to 5, with the following items: (1) description of the randomization; (2) description of the double-blinded randomization; (3) double-blinding; (4) description of the double-blinding; (5) description of the losses. Studies scoring 0–2 are classified as low-quality, while those scoring 3–5 are characterized as high-quality [16].

According to Verhagen et al. [17], PEDro is one of the various databases with good coverage of physical therapy intervention randomized trials. As PEDro only indexes randomized trials, systematic reviews, and clinical practice guidelines related to physical therapy interventions, it allows for a more directed search. Hence, it is more efficient for physical therapists who want to know about the effects of a given intervention. The PEDro scale was used in the present review. It has 11 items to be scored: (1) eligibility criteria were specified; (2) subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received); (3) allocation was concealed; (4) the groups were similar at baseline regarding the most important prognostic indicators; (5) there was blinding of all subjects; (6) there was blinding of all therapists who administered the therapy; (7) there was blinding of all assessors who measured at least one key outcome; (8) measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to the groups; (9) all subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome were analysed by 'intention to treat'; (10) the results of between-group statistical comparisons are reported for at least one key outcome; (11) the study provides both point measures and measures of variability for at least one key outcome. Each evaluated item is given 1 point for a 'yes' answer and 0 for a 'no' answer. If an item is not clear in the description of the study, it is not given any score, and the total score is referred to the number of items actually given a score.

Ethical approval

The conducted research is not related to either human or animal use.

Results

Description of the studies

Of the 1785 studies found, 13 (9 clinical trials and 4 pilot studies published between 2012 and 2019) met the inclusion criteria for this review. Altogether, 307 individuals with a clinical diagnosis of PD, classified as stages 1–4 in the Hoehn and Yahr scale, participated in the selected studies, as presented in Table 1.

Risk of bias

In accordance with the Jadad scale, 7 studies [18–24] were classified as low-quality (score 0–2), whereas 6 papers [3, 25–29] were categorized as high-quality (score 3). The main limitation found in all the studies was not having double-blinding. On the other hand, 8 of them [3, 20, 24–29] had carried out randomizations.

Frequency, duration, session

The duration of the sessions ranged from 30 to 60 minutes, and the programs were conducted 2–5 times a week; overall, the treatment lasted for 4–12 weeks. All the studies divided the sessions into the warm-up, main training, and cool-down.

Ten protocols [3, 18–24, 27, 29] comprised stretch, relaxation, specific exercises (functional, strengthening, balance, dual-task), and gait, whereas 2 [26, 28] were based on the Ai Chi method.

The research aimed to identify the aquatic intervention strategies considering the properties of water for the development of land motor skills in people with PD. In Table 2, on the basis of the analysis of the included articles and the practical knowledge of the authors, an association was established between the aquatic exercise developed in the pieces of research, the property of water involved, and the land motor skills acquired by the person with PD.

All the selected studies concentrated on aquatic physical exercise programs developed by the researchers who focused on transferring the motor skills – such as mobility and functional reach, balance, motor aspects, activities of daily living, quality of life, and gait – to the land environment. These are summarized in Figure 2.

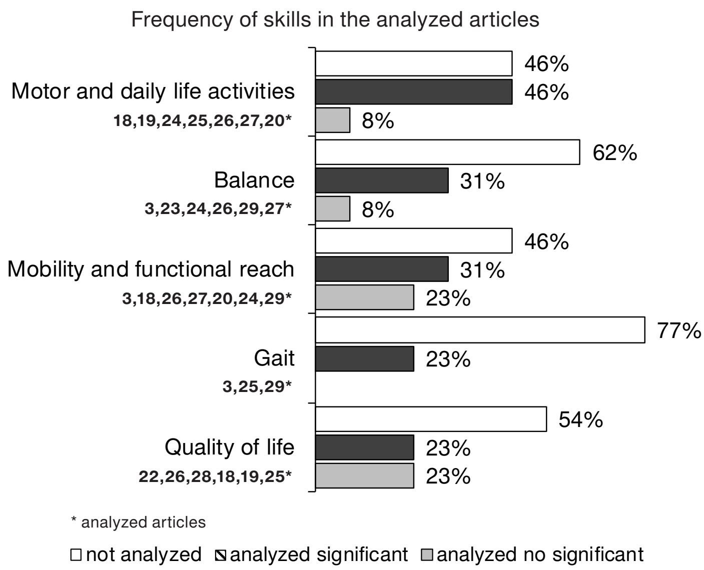

Figure 2. Motor skills of people with Parkinson's disease influenced by aquatic intervention in the 13 analysed articles, classified by significance

Table 1. Methodological characteristics of the reviewed studies

Author, year	Design	Sample size	Intervention		Duration	Scales	Results	Quality of the study	
			Experimental	Control				Jadad	PEDro
Ayán and Cancela, 2012 [19]	Controlled pilot study	n = 20 Individuals in stages 1–3 in Hoehn and Yahr scale, with stabilized medication Experimental: 6 W, 4 M Control: 5 W, 5 M	Low-intensity aquatic exercise program	Muscle strength exercises based only on water resistance	12 weeks, 2 nonconsecutive 1-hour sessions a week for both groups	FTSTS, UPDRS (III), PDQ-39, Barthel Index	↑ Functional mobility and motor symptoms (UPDRS); effect ↑ in group 2	1 (low)	6/11
Ayán and Cancela, 2012 [18]	Preliminary study	n = 13 Individuals in stages 1–3 in Hoehn and Yahr scale, with stabilized medication 10 W, 3 M	Aquatic exercises	–	12 weeks, 2 nonconsecutive 55-minute sessions a week	Fullerton Fitness Test, UPDRS (I–IV), PDQ-39	↑ Functional capacity and ability to perform activities of daily living	1 (low)	6/11
Carroll et al., 2017 [25]	Single-blind controlled randomized study	n = 21 Individuals in stages 1–3 in Hoehn and Yahr scale Experimental: n = 11 Control: n = 10 The participants were blinded in relation to the group	Aquatic physical therapy	Habitual care	6 weeks, two 45-minute sessions a week	PDQ-39, UPDRS, FOGQ, motion capture system	↓ Step length and time variability in treatment group; ↑ UPDRS	3 (high)	8/11
Clerici et al., 2019 [20]	Controlled randomized study	n = 60 All stages in Hoehn and Yahr scale MIRT: n = 30 MIRT + aquatic therapy: n = 30	Land rehabilitation protocol: MIRT	MIRT + aquatic therapy	4 weeks, 1-hour sessions	FOGQ, UPDRS (II and III), BBS, TUG, 6MWT	No difference between groups; after treatment, a difference in time in both groups	2 (low)	9/11
Crizzle and Newhouse, 2012 [21]	Applied pilot study	n = 4 All stages in Hoehn and Yahr scale	Aquatic intervention focused on group participation	–	6 weeks	Structured questionnaire	↑ Physical function	0 (low)	7/11
Da Silva et al., 2013 [22]	Longitudinal intervention study	n = 13 6 M, 7 W	Aquatic intervention	–	16 one-hour sessions twice a week for 2 months	PDQ-39	↑ QoL	1 (low)	7/11

Kurt et al., 2018 [26]	Controlled randomized clinical trial	*n* = 14 Individuals in stages 2–3 in Hoehn and Yahr scale	Ai Chi-16 + aquatic intervention	Land exercises	5 weeks, 5 times a week, 60-minute sessions (total: 25 sessions)	BBS, Biodex 3,1, TUG, PDQ-39, UPDRS (III)	↑ Balance, mobility, motor capacity, and QoL; ↑ more effective than land exercise	3 (high)	9/11
Palamara et al., 2017 [27]	Controlled randomized study	*n* = 34 Moderate stage of the disease MIRT: *n* = 17 MIRT + aquatic therapy: *n* = 17	Land rehabilitation protocol: MIRT	MIRT + aquatic therapy	4 weeks, 1-hour sessions	BBS, UPDRS (II and III), TUG	↑ Balance; ↑ UPDRS (II and III) and TUG (both groups)	3 (high)	7/11
Pérez-de la Cruz, 2018 [28]	Randomized clinical trial	*n* = 30 Experimental: *n* = 15 Control: *n* = 15	Ai Chi + aquatic exercises	Land exercises	10 weeks, two 45-minute sessions a week, totalling 20 sessions	SF-36 Health Survey, Geriatric Depression Scale (Yesavage), VAS	↓ Pain, depression; ↑ QoL in experimental group	3 (high)	6/11
Da Silva and Israel, 2019 [3]	Randomized clinical trial with 3-month follow-up	*n* = 25 Individuals in stages 1–4 in Hoehn and Yahr scale Experimental: *n* = 14 Control: *n* = 11	Dual-task aquatic exercise program	Instructed to keep their current activities	10 weeks, 2 sessions a week, totalling 20 one-hour sessions	TUG, FTSTS, BBS, Dynamic Gait Index	↑ Functional mobility, balance, and gait; dual task	3 (high)	7/11
Tonial et al., 2019 [23]	Quantitative experimental study	*n* = 13 5 M, 8 W	Aquatic program	–	20 one-hour sessions twice a week	AAHPERD flexibility test, FRT	↑ Flexibility test in the AAHPERD battery and FRT after aquatic physical therapy	0 (low)	8/11
Vivas et al., 2011 [24]	Controlled randomized pilot trial	*n* = 11 Individuals in stages 2–3 in Hoehn and Yahr scale	Aquatic therapy	Land therapy	4 weeks, two 45-minute sessions twice a week	FRT, BBS, UPDRS, 5-meter walk test, TUG	↑ FRT in both groups; ↑ BBS and UPDRS in aquatic therapy group	2 (low)	5/11
Zhu et al., 2018 [29]	Controlled randomized trial	*n* = 46 Individuals in stages 2–3 in Hoehn and Yahr scale 23 in each group	Aquatic therapy + Halliwick	Aquatic therapy with obstacles	5 sessions a week, 6 weeks, totalling 30 sessions	FOGQ, FRT, TUG, BBS	↑ Gait and balance in obstacle aquatic therapy group	3 (high)	10/11

AAHPERD – American Alliance for Health, Physical Education, Recreation and Dance, BBS – Berg Balance Scale, FOGQ – Freezing of Gait Questionnaire, FRT – Functional Reach Test, FTSTS – Five-Times-Sit-to-Stand Test, M – men, MIRT – multidisciplinary intensive rehabilitation treatment, PDQ-39 – Parkinson's Disease Questionnaire 39, QoL – quality of life, TUG – Timed Up and Go Test, UPDRS – Unified Parkinson's Disease Rating Scale, VAS – visual analogue scale, W – women, 6MWT – 6-minute walk test
↑ – increase, ↓ – decrease

Table 2. Relationship between aquatic exercise, property of water, and transferred land motor skills in people with PD

Aquatic exercise	Property of water involved									Land motor skills
	Viscosity	Buoyancy	Hydrostatic pressure	Drag force	Turbulent flow	Laminar flow	Surface tension, floatability	Thermal principles of water	Refraction	
Gait	X	X	X	X	X	X	X	X		Walking; dual-task walking in combination with holding an object or talking with someone; walking in irregular terrains; walking in higher speed; turning and returning or changing gait direction; turning safely to respond to a call; pelvic and scapular girdle dissociation, allowing for daily living activities such as rolling in bed or personal hygiene; walking around an obstacle or avoiding it; bypassing or transposing an obstacle; sitting up from lying down; getting up out of bed; maintaining orthostatic posture; using hand fine motor skills; going up steps and stairs; carrying objects
Stretch, relaxation		X	X					X		Decreasing muscle and joint stiffness; diminishing the anteriorized trunk pattern; promoting pelvic and scapular girdle dissociation; improving functional reach; picking an object from a high place or the floor; improving motion flexibility and amplitude, which enables motor skills to be better performed; commonly used as cool-down and/or return to calm
Specific exercises, central part (functional, strengthening, balance, dual-task...)	X	X	X	X	X	X			X	Strengthening of the trunk, lower limb, and upper limb muscles; improving and maintaining balance in different situations; sitting down and getting up – especially in a controlled manner; going up and down steps and stairs; safely transferring body weight, making some aspects easier, such as gait or recovering balance after an instability; walking holding an object or talking to someone; improving gait, including adverse situations, such as walking in irregular terrains
Ai Chi method	X	X	X		X		X			Maintaining postural and respiratory control; strengthening of the inspiratory muscles; turning when standing or seated; reacting/recovering when the trunk is destabilized (preventing falls); improved rolling in bed, sitting, picking an object from the floor

Motor and daily living aspects

The Unified Parkinson's Disease Rating Scale was used mostly with a focus on parts II and III, referring to motor aspects and experiences of daily living, and motor assessment, respectively. Seven studies [18–20, 24–27] applied the Unified Parkinson's Disease Rating Scale and found satisfactory results, except for one [20]. Hence, there is evidence of improvements in activities such as gait and balance, sitting, standing, dressing, rolling in bed, and hand movements. This was the investigation variable that most interested the authors, present in 54% of the articles, besides being the variable with the highest percentage of significance.

Considerations on the motor and daily living aspects in the aquatic environment:

1. Through the functional, strengthening, and balance physical exercises, da Silva et al. [22] point to the benefits of reducing the action of gravity in the aquatic environment, enabling tridimensional exercises without the risk of falls, as well as performing exercises with 2 lower and upper limbs at the same time.

2. The floatability and hydrostatic pressure offered by water provide the patient extra support to perform the proposed exercises and reduce the speed of falls [18, 19], as the body weight is transferred at a slower speed [26], allowing more time to execute compensatory movements [24].

Postural balance

The balance outcome was assessed with the Berg Balance Scale in 5 studies [3, 24, 26, 27, 29], one [27] of which obtained no significance in its findings. These results are important for the activities of daily living and the prevention of falls, as greater complications, such as fractures or hospitalizations, can be avoided. Three studies [23, 24, 29] verified the functional reach, though only one [24] obtained significant improvement; this reflects improved postural balance and control. It is observed that balance was little explored in these studies, although it has an expressive significance rate.

Considerations on the postural balance and functional reach in the aquatic environment:

1. The viscosity of water induces resistance to the movements and requires postural adjustments necessary to limit body fluctuation [27].

2. Floatability reduces the effects of gravity and the aquatic environment can be considered a microgravity environment. Training in and exposure to this environment seem to stimulate static and dynamic changes in postural control [26].

3. Providing a greater possibility of postural reactions and adjustments, floatability and buoyancy are essential to train balance, given its deficits in people with PD. Moreover, the aquatic environment can act on the sensory periphery, stimulating the proprioceptive system, crucial to control balance [27, 28].

4. Buoyancy is responsible for increasing the body adjustment and balance recovery time [30].

5. Contrary to gravity, the floatability of water reduces joint overload, improving mobility and contributing to dynamic flexibility.

6. The turbulent flow seems to make the learning process easier because of the need to maintain a rhythmic pattern and constant postural control to perform the tasks amid the flow [31].

7. The turbulent flow can also make more difficult the movements of weight shift, unipedal ones, or those with reduced support base, owing to the turbulence generated with water movement.

8. The turbulent flow allows for an increase in resistance and sensory stimuli, which requires greater neuromuscular effort to stabilize the body.

9. In accordance with Pascal's principle, hydrostatic pressure works on the stabilization of the trunk and body segments, besides activating and demanding more from the inspiratory muscles through the resistance exerted on the chest and diaphragm. However, for the same reason, exhalation becomes easier [30, 32].

Functional mobility and reach

Functional mobility was assessed in 2 studies [3, 18] which used the Five-Times-Sit-to-Stand Test, while 6 studies [3, 20, 24, 26, 27, 29] performed the Timed Up and Go Test. Besides verifying the functional mobility, these tests respectively analyse the strength and power of the lower limbs and their scores are predictors of falls. Four articles [3, 18, 26, 27] obtained positive results in these aspects. Although it was one of the most explored variables in the analysed articles, it had a little relevant significance rate.

Considerations on the functional mobility in the aquatic environment:

1. Heated water has a potential therapeutic effect on some motor symptoms, such as stiffness and postural instability, in people with PD [18, 19, 24, 28].

2. Heated water also helps improve and/or maintain the amplitude of joint movements, and ease muscle tension and pain [22].

3. The effort to improve functional mobility can be seen as complementary in the aquatic environment, in which water resistances, such as viscosity and turbulence, can provide gains in mobility [3].

4. Stretching and relaxation exercises are made easier by the water temperature. The aquatic resistances excite the Golgi tendon organs, muscle areas sensitive to tension, which furnishes dynamic stretch, since, when activated, they inhibit the contraction of the agonist musculature and excite the antagonist [23].

5. When there are changes in the centre of gravity and frontal recovery is necessary, the metacentre (balance between the forces of gravity and buoyancy) is changed. It also provides support to perform stretching exercises, especially concerning the maintenance of the segment in the desired position.

6. Buoyancy can facilitate movements toward the surface of the water or impede those toward the bottom of the pool. In the sit-to-stand training, for instance, when squatting or flexing the hip, it works as resistance, whereas when extending the hip, it works as a facilitator. The movements in which resistance equipment is used, such as floaters or aqua tubes, the resistance becomes even greater in exercises directed toward the bottom of the pool [32].

Gait

Gait was verified by 3 studies [3, 25, 29] with the Freezing of Gait Questionnaire [25, 29] and Dynamic Gait Index [3]. All of them presented progression in the aspects related to gait, a decrease in step length and time variability, as well as attenuation of gait freezing. The least explored variable in the studies included in this research was gait, with 23%, despite proving to be promising for the significance it obtained in all the studies.

Considerations on gait training in the aquatic environment:

1. Physical exercise in aquatic environment can increase the efficiency of gait in populations that suffer from gait disorders, especially due to neurological dysfunctions.

2. There is no consensus on the intensity, duration, and repetition of physical exercise performed in a heated pool to improve gait. The studies involved interventions lasting for 6–10 weeks, with 2–5 sessions a week and session duration of 45–60 minutes [3, 25, 29].

3. Hydrostatic pressure stabilizes the body in the sway phase in gait training [30, 32].

4. In accordance with Archimedes' principle, buoyancy reduces apparent weight and releases weight impact on the lower limbs, making the support and sway phases easier in gait training [25]. Also, it reduces the ground reaction force, decreasing the neuromuscular responses. Hence, it is a movement facilitator for participants with greater motor difficulties [32, 33].

5. Gait may be made easier by drag forces, as lower pressure areas are generated, besides the reduction in actual body weight due to floatation forces [25].

6. Viscosity can make gait training more difficult since it greatly activates the musculature as the speed increases (the body needs to overcome the resistance in order to displace) [33].

7. Viscosity also slows down the movements, allowing for postural control adjustments and longer reaction time – which consequently helps avoid falls, so common in PD, and stimulate the patient's confidence [30].

Quality of life

The quality of life was assessed by 6 studies [18, 19, 22, 25, 26, 28] with the Parkinson's Disease Questionnaire 39, Barthel Index, or SF-36 Health Survey. Only 3 of them [22, 26, 28] demonstrated differences after the aquatic physical exercise. Quality of life did not exhibit a significant difference in the analysed studies.

Muscle weakness and stiffness, pain, and psychological and sleep changes that appear or worsen as a result of PD can influence the motor learning process and restrict daily activities and participations, such as social life, leisure, and work [11, 34, 35].

Considerations on the quality of life after stimulations in the aquatic environment:

1. The evidence of the benefits of aquatic exercises points to them as an alternative to improve the patients' quality of life, especially regarding social interaction, exchange of information, and everyday contacts essential to mental health, particularly in a progressive and neurodegenerative disease [3, 12, 34, 35].

2. The proposal of using an environment rich in stimuli aims to apply all the hydrokinetic benefits associated with the maximal exploration of the person's potential.

Considerations on the transference of motor skills

Acquiring a motor skill, or even motor learning, depends on processes associated with the individual's practice and experiences, and can lead to a relatively permanent change [30]. Thus, the 3-fold relationship between the person (physical, cognitive, and individual aspects), task (action to be performed or stimulus), and environment (context in which the person is located) in the learning or relearning process is restated [5]. The acquisition of a motor skill is also dependent on the amount of practice and specificity, as motor performance can be improved with specific training and stimuli [32, 33].

Exploring the environment with active or passive motor activities, or only with observation [30], can interfere with the motor control and brain plasticity [31] to improve the motor performance, as well as aspects such as muscle strength, body balance, gait, and activities of daily living, consequently developing human functioning and increasing quality of life [12]. Moreover, aquatic physical exercise forces the person to adapt their movements, either by modifying them or by learning a new movement. All this has effects on motor learning, as patients need to overcome the restrictions imposed by this environment, which is different from the usual one [3].

Conclusions

The conclusion is that all the aquatic intervention strategies were based on the functional profile of individuals with PD or specific methods applied, such as Ai Chi.

There is no consensus yet regarding the prescription of interventions, with a wide range of variation in terms of duration, repetition, frequency, time, and intensity. Hence, further studies are necessary.

It is essential to analyse the physical and thermal properties of water to systematize prescription parameters depending on aspects of the PD patient and the aquatic environment in which they will be attended and treated. The aim is to promote prevention and rehabilitation by means of functional and therapeutic aquatic physical exercise programs. Issues such as the positioning of the patient, professional advice, direction of the movement, and speed and temperature of the water must be considered.

The interventions applied can be properly prescribed and beneficial to train motor skills in people with PD and therefore to improve the activities of daily living and diminish the restrictions to their participation in the society.

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Disclosure statement

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Conflict of interest

The authors state no conflict of interest.

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