The efficacy and feasibility of aquatic physiotherapy for people with Parkinson's disease: a systematic review

Article *in* Disability and Rehabilitation · August 2017

DOI: 10.1080/09638288.2017.1362710

Fleur Terrens
Peninsula Health

Sze-Ee Soh
Monash University (Australia)

Disability and Rehabilitation

ISSN: 0963-8288 (Print) 1464-5165 (Online) Journal homepage: www.tandfonline.com/journals/idre20

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To cite this article: Aan Fleur Terrens, Sze-Ee Soh & Prue Elizabeth Morgan (2018) The efficacy and feasibility of aquatic physiotherapy for people with Parkinson's disease: a systematic review, Disability and Rehabilitation, 40:24, 2847-2856, DOI: 10.1080/09638288.2017.1362710

To link to this article: https://doi.org/10.1080/09638288.2017.1362710

DISABILITY AND REHABILITATION
2018, VOL. 40, NO. 24, 2847–2856
https://doi.org/10.1080/09638288.2017.1362710

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REVIEW

The efficacy and feasibility of aquatic physiotherapy for people with Parkinson's disease: a systematic review

Aan Fleur Terrens[a,b], Sze-Ee Soh[b,c] and Prue Elizabeth Morgan[b]

[a]Movement Disorder Program, Peninsula Health, Frankston, Australia; [b]Department of Physiotherapy, Monash University, Frankston, Australia; [c]Department of Epidemiology and Preventative Medicine, Monash University, Frankston, Australia

ABSTRACT

Purpose: To critically evaluate the literature regarding the efficacy and feasibility of aquatic physiotherapy in people with Parkinson's disease.

Method: Relevant studies were identified through searches in nine health-related databases. Two independent reviewers assessed study quality using either the PEDro scale or a customised tool for safety and feasibility.

Results: Database searches yielded 88 articles, of which 10 met the inclusion criteria. Studies varied greatly in methodology, quality, interventions and outcome measures. Study quality was generally low in items reporting on safety precautions, adverse events, attrition, and adherence. Results suggest that aquatic physiotherapy may have a positive effect on motor symptoms, quality of life and balance.

Conclusions: Aquatic physiotherapy may improve aspects of motor performance, quality of life and balance in people with Parkinson's disease, however, it remains unclear whether it is a safe and feasible treatment modality. The development of standardised outcome measures for people with Parkinson's disease (unified Parkinson's disease rating scale and Parkinson's disease questionnaire-39) would aid study comparability and validate study outcomes. As safety criteria was grossly underreported, guidelines for mandatory reporting of safety criteria are essential to make conclusions regarding the feasibility of aquatic physiotherapy for people with Parkinson's disease.

ARTICLE HISTORY
Received 16 September 2016
Revised 18 July 2017
Accepted 30 July 2017

KEYWORDS
Parkinson's disease; physical therapy; physiotherapy; aquatic; hydrotherapy

➤ IMPLICATIONS FOR REHABILITATION

- Aquatic physiotherapy may be a beneficial treatment modality for people with Parkinson's disease.
- A minimum data set that includes the unified Parkinson's disease rating scale and Parkinson's disease questionnaire 39 is required to aid future meta-analysis and to allow more definitive conclusions to be made regarding aquatic physiotherapy for people with Parkinson's disease.
- People with Parkinson's disease are a vulnerable population, where safety within an aquatic physiotherapy program needs to be well documented and addressed.

Introduction

Parkinson's disease (PD), is a progressive neurological disorder occurring when there has been a significant loss or degeneration of dopaminergic cells from the basal ganglia [1]. It is currently estimated that over 69,000 people in Australia live with PD with a total economic cost of approximately $9.9 billion [2]. The prevalence of PD in Australia is expected to rise to approximately 123,781 people by 2034 [2]. Similar figures have also been reported in Europe, North America and South America in individuals aged 80 and above, with Asia having the lowest prevalence rates geographically [3]. Given this expected increase in the number of people living with this debilitating condition, new and effective treatment strategies must be explored.

Typical motor symptoms that characterise PD include akinesia, hypokinesia and bradykinesia, rigidity, postural instability and tremor [1,4]. Other common motor symptoms include a flexed posture, festination and motor blocking, commonly referred to as freezing of gait [5,6]. As the disease progresses the incidence of falling also increases, and this is associated with a decrease in both static and dynamic balance and thus postural control [7]. Greater variability in kinematic parameters, often expressed as the coefficient of variation, has been associated with greater falls frequency [8].

Regular intensive exercise therapy has been shown to delay symptom progression and preserve executive functioning in people with PD [9]. However, the majority of physiotherapy treatments have been land based, focussing predominantly on movement strategy training with some studies investigating the impact of progressive resistance strength training and dual tasking [10–12]. Whilst these traditional forms of physiotherapy interventions have been shown to improve motor function, balance, gait and quality of life [13,14], there is a growing interest in whether alternative forms of therapy such as dancing, tai chi and aquatic physiotherapy may be effective in people with PD.

Aquatic physiotherapy, sometimes referred to as hydrotherapy was developed from combining the knowledge of human movement and the hydrostatic properties of water [15]. Previous studies have found that aquatic physiotherapy can improve pain, strength, flexibility and balance in a variety of conditions in older

CONTACT Aan Fleur Terrens fterrens@phcn.vic.gov.au Movement Disorder Program, Peninsula Health, Frankston, VIC, Australia
Supplemental data for this article can be accessed here.

adults including chronic low back pain and rheumatic conditions [15]. It has also been found to provide short-term therapeutic effects on pain and disability for people with hip and knee osteoarthritis [16]. Despite this, little is known about whether aquatic physiotherapy is beneficial in people with PD. Only 10 studies to date have examined the efficacy of aquatic physiotherapy in people with PD, but both were limited by small samples sizes [17–26].

There are risks associated with aquatic physiotherapy because it may compromise both the cardiac and respiratory systems [17]. Immersion, partial or complete, in water causes an increase in stroke volume and a decrease in diastolic blood pressure, which may cause dizziness and shortness of breath in participants, particularly those with a history of cardiac disease. There is also an increased risk of falls due to the physical environment when transferring out of the pool [27]. The Australian Physiotherapy Association aquatic guidelines [27] state that safety precautions, such as external pool assistants and thorough prescreening should be undertaken when treating clients in vulnerable population groups, of which PD is included. Safety criteria, for example, staffing expertise and monitoring of adverse reactions, as well as feasibility criteria such as adherence and attrition are therefore important factors to take into consideration when deciding whether aquatic physiotherapy is suitable for people with PD.

This systematic review aims to critically evaluate the literature regarding the efficacy and feasibility of aquatic physiotherapy in people with PD. Commonly used outcome measures and elements of the aquatic intervention will also be summarised, as well as the safety criteria reported.

Method

Search strategy

Relevant studies were identified through searches in the following health-related databases: AMED (from 1985), CINAHL plus (from 1982), Cochrane Library (from 1992), Embase (from 1980), MEDLINE via Ovid (from 1970), ProQuest central (from 1972), PsycINFO (from 1967), PubMed (from 1946), Scopus (from 1995) until May 2016.

A patient, intervention, comparison, outcome (PICO) framework search strategy using appropriate customised terms and Boolean operators was used when searching each database and included the following keywords: [all (aquatic physiotherapy) OR all (aquatic physical therapy) OR all (hydrotherapy) OR all (aquatherapy)] AND all (Parkinson$)). Additional articles were sourced via a targeted search of health-related databases for articles describing the use of Ai Chi[1]. A manual search was also undertaken of cited references from all studies obtained in full text. The search process adhered to PRISMA reporting guidelines [28] where possible.

The abstracts obtained from the database searches were screened for eligibility, with all duplicate and irrelevant abstracts discarded. Initial screening of article titles and abstracts was completed by the primary reviewer (AT). Any study design was accepted, other than single case design studies and systematic reviews.

Selection criteria

Potential articles for the review were obtained in full text and further screening was performed by two independent reviewers (AT and PM) for the following inclusion criteria: (1) all participants had idiopathic PD and not Parkinsonism disorders; (2) the intervention included any form of physiotherapy prescribed exercise delivered in a heated pool; (3) at least one outcome measure (impairment or activity limitation) was assessed pre- and post-treatment; (4) full papers published in English and (5) aquatic intervention was not combined with any other therapy, i.e., land based therapy.

Quality appraisal and data extraction

The methodological quality of randomised controlled trials (RCT's) was evaluated using the 11-point PEDro scale [29]. Items were scored either yes or no, with a score of 1 given to every 'yes' criterion. If a study obtained a high PEDro score, it is considered to be of high methodological quality. All other non-RCT study designs were evaluated using a tool adapted from Twyeround [30] because standardized checklists did not capture the specific aims and focus of this review (Figure S1). The customized quality appraisal tool was designed to include additional information such as aquatic therapy safety (water temperature, number of staff present) and feasibility (adherence to therapy, adverse events, attrition rates) which was relevant to the topic under investigation. This tool was piloted by the authors with a small set of representative studies prior to its use in order to ensure its utility and functionality. Scores were obtained by assigning yes, no or partial (1/0/0.5) to each quality criterion in the scale across 10 items. The maximum score possible is 10, with higher scores indicates better methodological quality. Any rating disagreements on quality criteria using either the PEDro scale or the customized tool were checked against the original article to ascertain scoring according to a pre-determined procedure in accordance with established and recommended protocols [28].

A standardized data extraction form was developed and used by the same two reviewers to obtain key information relevant to this review and piloted with a small subset of studies. The extracted study details focused on participant characteristics, aquatic intervention details, between and within group effects, outcome measures, and safety and feasibility outcomes. Outcome measures were further classified as measures of impairments in body structure and function activity limitations and participation restrictions based on the International Classification of Functioning (ICF) framework [31].

Evidence synthesis

When at least three studies utilized the same outcome measure, within group analyses were presented as a forest plot with a weighted mean difference (95% confidence interval [CI]). Where data was unable to be pooled due to heterogeneity of outcome measure selection, a qualitative or descriptive analysis was performed. Data analysis was performed using review manager 5.3.

Results

Search yield

The electronic search of the database and the manual search of reference lists yielded a total of 90 articles. Article abstracts were first screened for eligibility if it examined the use aquatic physiotherapy in people with PD, and subsequently 36 articles were excluded. 32 articles were then obtained in full text. Following the application of the pre-defined inclusion criteria, 10 studies were included in this review, with a total of 119 participants (Figure 1).

Quality appraisal of reviewed articles

Two studies were assessed using the PEDro scale [17,19]. The quality assessment was moderate, 6/10 [17] and 7/10 [19].

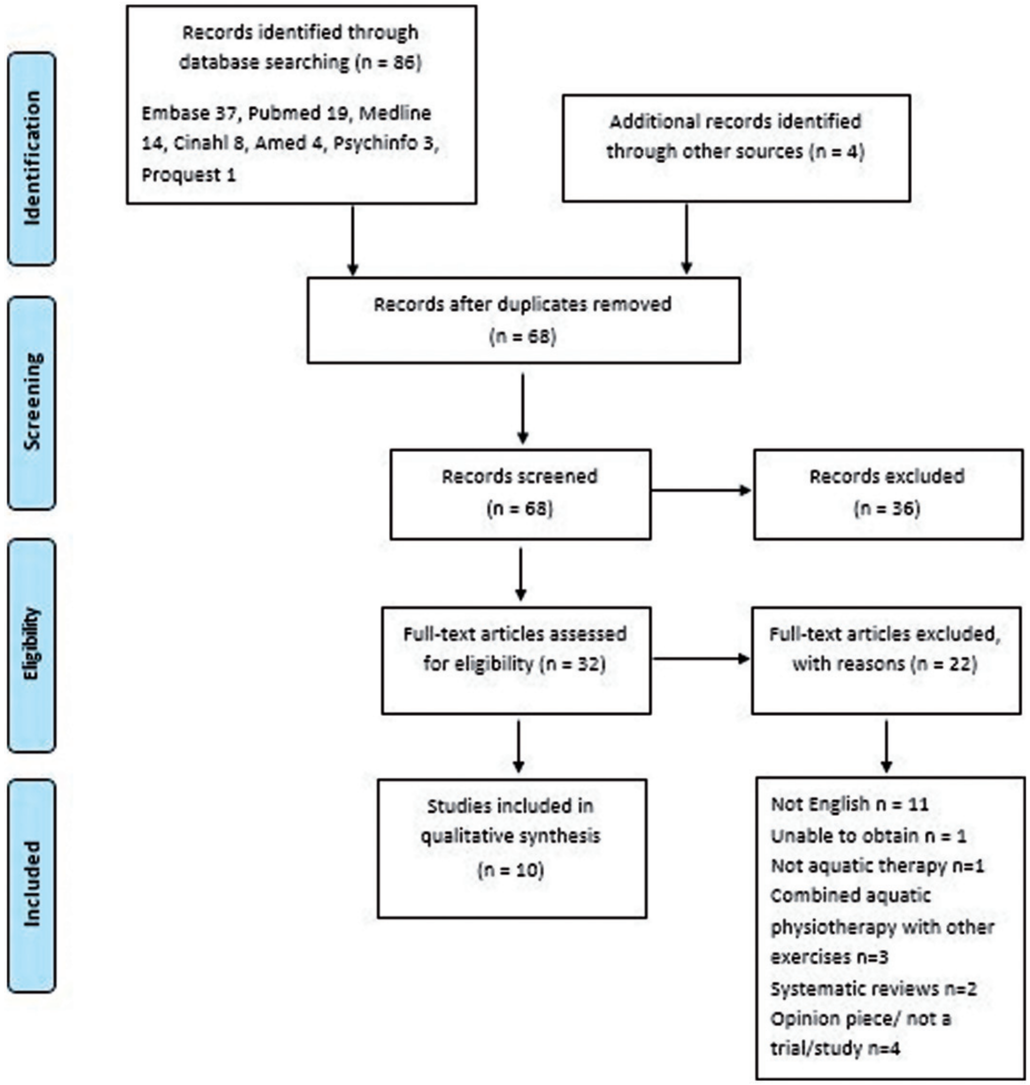

Figure 1. PRISMA flow diagram outlining the search and screening process.

As expected, no studies were able to blind therapist and participants regarding the intervention, and neither utilised blinded assessors, thus impacting on the overall quality score (Table S1).

The remaining eight studies were assessed using the customized tool adapted from Tyerould [18,20–26,30]. Methodological quality ranged from a low of 4/10 [26] to a high of 9.5/10 [20], with an average score of 6.5 (Table S2). Quality was particularly low in items on the customised tool for non-RCT's requiring reporting of safety precautions, adverse events, attrition, and adherence.

Study characteristics

Study design

Of the 10 studies included in the review, two were RCTs [17,19], seven were cohort studies [18,20–23,25,26] and one was a quasi-experimental study [24].

Sampling method

Samples were recruited predominantly from Spain [17,18,20,21] and Brazil [22,23,25,26], with a single cohort each from North America [24] and Italy [19]. Aquatic intervention sample sizes ranged from six [17] to 17 [19,23] participants. Total sample sizes including control or comparison groups ranged from seven [26] participants to 58 participants [24]. The largest study was of quasi-experimental design involving five different intervention groups [24]. Five studies recruited participants through local PD associations [17,18,20,21,25] and three studies recruited through neurological clinics or databases [22–24] as samples of convenience. The recruitment source was not reported in remaining studies.

Sampling characteristics

The mean age of participants ranged from 59.9 to 70.6 years. Where reported, studies included participants with mild to moderate PD (Hoehn and Yahr [HY] stages 1–3) with four studies stating that the intervention was performed when the patient was in the 'ON' stage of their medication cycle [17,18,20,21]. Disease duration ranged from 4.2 to 8.3 years. Eight studies recorded medication management of participants [17–22,24,26]. Six studies screened for medical comorbidities before commencement of intervention [19–23,25], and four screened for cognitive function [12,17,23,24]. Interestingly, only one study [19] reported the falls history of participants. The methodological characteristics and quality assessment of included studies are summarised in Table 1.

Type and target of intervention

There were a range of aquatic physiotherapy and comparison groups in the included studies: two studies [17,19] compared

Table 1. Methodological characteristics of reviewed articles.

Study ID		Population					Co-morbidities				
First named author, year	Study design	n	Gender (number of males)	Mean age, year (SD)	mean disease duration, year (SD)	Mean Hoehn & Yahr stage (range)	Medications recorded	Falls Hx	Medical co-morbidities screen	Cognition screen	Quality score
Ayan [18]	Cohort	I1: 10	4M	68.9 (9.6)	6.1 (3.1)	2.4 ± 0.7	Y	NR	NR	NR	8T
		I2: 10	5M	71.9 (5.1)	7.5 (5.5)	2.0 ± 0.7					
Ayan [20]	Cohort	I: 13	3M	65.3 (9.65)	5.8 (3.94)	1-3 NA	Y	NR	Y	NR	9.5T
		C: NA	NA	NA	NA						
Da Silva [22]	Cohort	I: 13	6M	NR	NR	NR	Y	NR	Y	NR	5T
		C: NA	NA	NA	NA	NA					
Perez-de la Cruz [21]	Cohort	I: 15	6M	65.9 (7.1)	Stated >6 months	NR	Y	NR	Y	NR	8T
		C: NA	NA	NA	NA	NA					
Pompeu [23]	Cohort	I: 17	NR	67.6 (8.6)	NR	2.2 (1.0)	NR	NR	Y	Y	6T
		C: NA	NA	NA	NA	NA					
Sage [24]	Quasi experimental study	I: 12	12M	63.1 (9.2)	7.7 (6.4)	NR	Y	NR	NR	Y	7T
		C1: 17	9M	65.8 (9.9)	3.8 (3.9)	NR					
		C2: 18	9M	68.7 (8.3)	5.7 (4.0)	NR					
		C3: 24	18M	68.0 (4.5)	5.1 (4.5)	NR					
		C4: 18	10M	68.6 (8.1)	3.2 (2.8)	NR					
Villegas [25]	Cohort	I: 8	NR	67.5 (11.0)	8.0 (4.6)	2.8 ± 1.1	NR	NR	Y	Y	7.5T
		C: 7	NR	70.5 (9.6)	6.9 (2.5)	2.6 ± 1.8					
Vivas [17]	RCT	I: 6	3M	65.7 (3.7)	4.2 (1.6)	2.7 ± 0.6	Y	NR	NR	Y	6P
		C: 6	4M	68.3 (6.9)	7.8 (3.9)	2.4 ± 0.6					
Volpe [19]	RCT	I: 17	NR	68 (7)	7.5 (5.1)	2.8 ± 0.3	Y	Y	Y	Y	7P
		C: 17	NR	66.8 (8)	7.6 (4.6)	2.7 ± 0.5					
Zotz [26]	Cohort	I: 7	NR	59.9 (7.9)	7.9 (3.8)	2-3	Y	NR	NR	NR	4T
		C: NA	NA	NA	NA	NA					

C: comparison group; C1: aerobic group; C2: strength group; C3; SAFEx group; C4: control group; Cohort: cohort study; H&Y: Hoehn and Yahr; I: intervention group; I1: low intensity group; I2: muscular resistance group; NA: not applicable; NR: not reported; P: PEDro scale; Qualitative: qualitative study; RCT: randomised controlled trial; T: Twyerould scale; Y: yes.

Table 2. Detail of specific components of the aquatic physiotherapy program.

		Intervention specifics																	
		Impairments					Activity limitations				Treatment approaches			Other					
First named author (year)		Lower limb[a]	Upper limb[a]	Strength[a]	Aerobic[a]	Co-ord/Rhythm	Walking	Balance	Trunk mobility	Postural stability	Halliwick Concept	Bad Ragaz	Ai Chi	Group games	Relaxation/ socialisation	Floating	Stretching	Warm up[a]	Cool Down[a]
Ayan [18]	I1:					✓	✓	✓						✓		✓	✓		
	I2:	✓	✓				✓										✓		
Ayan [20]						✓	✓	✓						✓		✓	✓		
Da Silva [22]		✓					✓								✓		✓		
Perez-de la Cruz [21]													✓	✓	✓				
Pompeu [23]						✓	✓				✓	✓	✓				✓		
Sage [24]				✓	✓			✓							✓		✓		
Villegas [25]													✓						
Vivas [17]									✓	✓	✓							✓	
Volpe [19]								✓									✓	✓	✓
Zotz [26]											✓								

[a]Unspecified; Bad Ragaz: an aquatic therapy method based on proprioceptive neuromuscular facilitation, Halliwick concept: A three stage, ten point program that teaches motor skills to encourage independence in the pool I1: Intervention 1-low intensity aquatic group, I2: intervention 2-muscular resistance aquatic group.

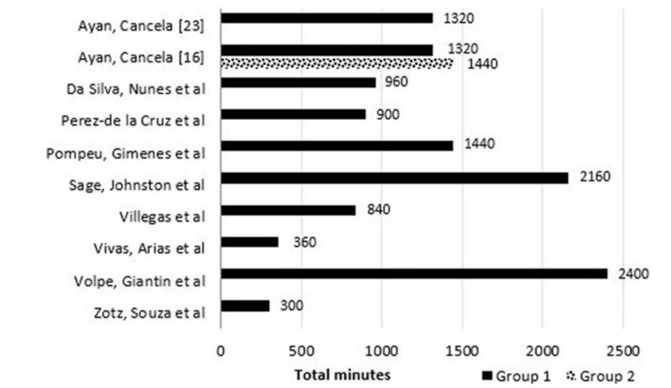

Figure 2. Total minutes of aquatic physiotherapy intervention.

aquatic to land based physiotherapy. Another study [18] compared two different aquatic physiotherapy exercise programs (low intensity and musculoskeletal resistance), whilst the study by Sage et al. [24] compared aquatic physiotherapy to aerobic exercises, strength exercises, and PD-SAFEx (sensory attention focussed exercise). Only one study by Villegas and Israel [25] compared Ai-Chi therapy to a control group that received no intervention. The remaining five studies did not include a comparison group [20–23,26]. Table 2 details the target and types of exercises delivered within the aquatic physiotherapy program.

Duration and dosage of intervention

The most common duration of intervention in minutes per session was 60 min. Figure 2 illustrates the total minutes of aquatic physiotherapy delivered for the duration of each study. There was considerable variation in the frequency of aquatic therapy sessions, ranging from once a week to five times a week. The length of intervention in weeks varied from 4 to 16 weeks, the most common being 12 weeks [18,20,23–25].

Outcome measures

The most widely used outcome measure utilized was the unified Parkinson's disease rating scale (UPDRS), with seven studies using some (either part I, II or III) or all parts [17–20,23–25]. Outcome measures that specifically addressed impairments of body structures and function included the motor examination (UPDRS-III) and motor complication (UPDRS-IV) subsections of the UPDRS. The visual analogue scale was utilized in one study [21] to rate physical pain levels, whilst another study measured kinematic and kinetic gait variables [17]. Villegas and Israel [25] also assessed posture using postural assessment software.

The non-motor (UPDRS-I) and activities of daily living (UPDRS-II) subsections of the UPDRS fall under the activity limitations domain. Other functional tools that assessed activity limitations included the five times sit to stand test [18], the Fullerton fitness test [20] and the Barthel index [20]. Only one study by Zotz et al. [26] used the scoring system of the Halliwick concept, a three stage, 10-point program in which the patient is sequentially moved through different exercises, specifically rotations, in order to gain independence in the pool [32]. This method utilises the principles of hydrodynamics and includes practising appropriate breath control, rotations through the sagittal, transverse and longitudinal axes, and then finally combined rotations through multiple axes. It also assesses the ability of patients to retain buoyancy throughout several changes in positions [32].

Balance, which was considered a component of activity limitations, was measured most commonly using the Berg balance scale [17,19,23] and the timed up and go test [17,19,21,23]. The Tinetti

Table 3. Intervention characteristics and outcome measures.

	Aquatic intervention				Outcome			
	Dosage/Duration					Measurement points		
Study ID First named author, year	Time	Yes/no/reason Frequency (days/week)	Intervention period	Adverse events	Outcome measures	Pre	Post	Follow up
Ayan [18]	I1: 55 min I2: 60 min	2 2	12 weeks 12 weeks	No	UPDRS part 3 FTSTS test PDQ-39	✓ 2–3 days	✓ 2–3 days	
Ayan [20]	55 min	2	12 weeks	Yes- allergy to chlorine, n = 1	UPDRS parts 1–3 FFT Barthel index PDQ-39 parts 1, 2 + 6	✓ 2–3 days	✓ 2–3 days	
Da Silva [22]	60 min	2	8 weeks	NR	PDQ-39	✓	✓	
Perez-de la Cruz [21]	45 min	2	10 weeks	No	VAS Tinetti-gait, balance and total Get up and go test	✓	✓	✓ 4 weeks post
Pompeu [23]	40 min	3	12 weeks	NR	UPDRS DGI BBS TUG	✓	✓	
Sage [24]	60 min	3	12 weeks	NR	UPDRS	✓	✓	✓ 6 weeks post
Villegas [25]	35 min	2	12 weeks	NR	UPDRS Posture[a] PDQ-39	✓	✓	
Vivas [17]	45 min	2	4 weeks	NR	UPDRS Gait kinematics FRT BBS TUG	✓	✓	✓ 17 days post
Volpe [19]	60 min	5	8 weeks	No	UPDRS parts 2 and 3 BBS TUG COP sway area ABCS FES Falls diary PDQ-39	✓	✓	✓ 7 days post
Zotz [26]	30 min	2	5 weeks	NR	Halliwick concept	✓	✓	

✓Intervention assessment completed but timeframe unknown.

[a]Posture assessed via Postural Assessment Software SAPO, ABCS: Activities-specific balance confidence scale, BBS: Berg balance scale, COP: Centre of pressure, DGI: Dynamic gait index, FES: Falls efficacy scale, FFT: Fullerton fitness test, FRT: Functional reach test, FTSTS test: five times sit to stand test, get up and go test: Timed with seconds, not ordinal scale therefore the same as the TUG test, Halliwick concept: a three stage, 10 point program that teaches motor skills to encourage independence in the pool, I1: low intensity aquatic group, I2: muscular resistance aquatic group, NR: not reported, PDQ-39: Parkinson's disease questionnaire, QOL: quality of life, TUG: timed up and go test, Tinetti: Tinetti gait and balance tool, UPDRS: unified Parkinson's disease rating scale, VAS: visual analogue scale.

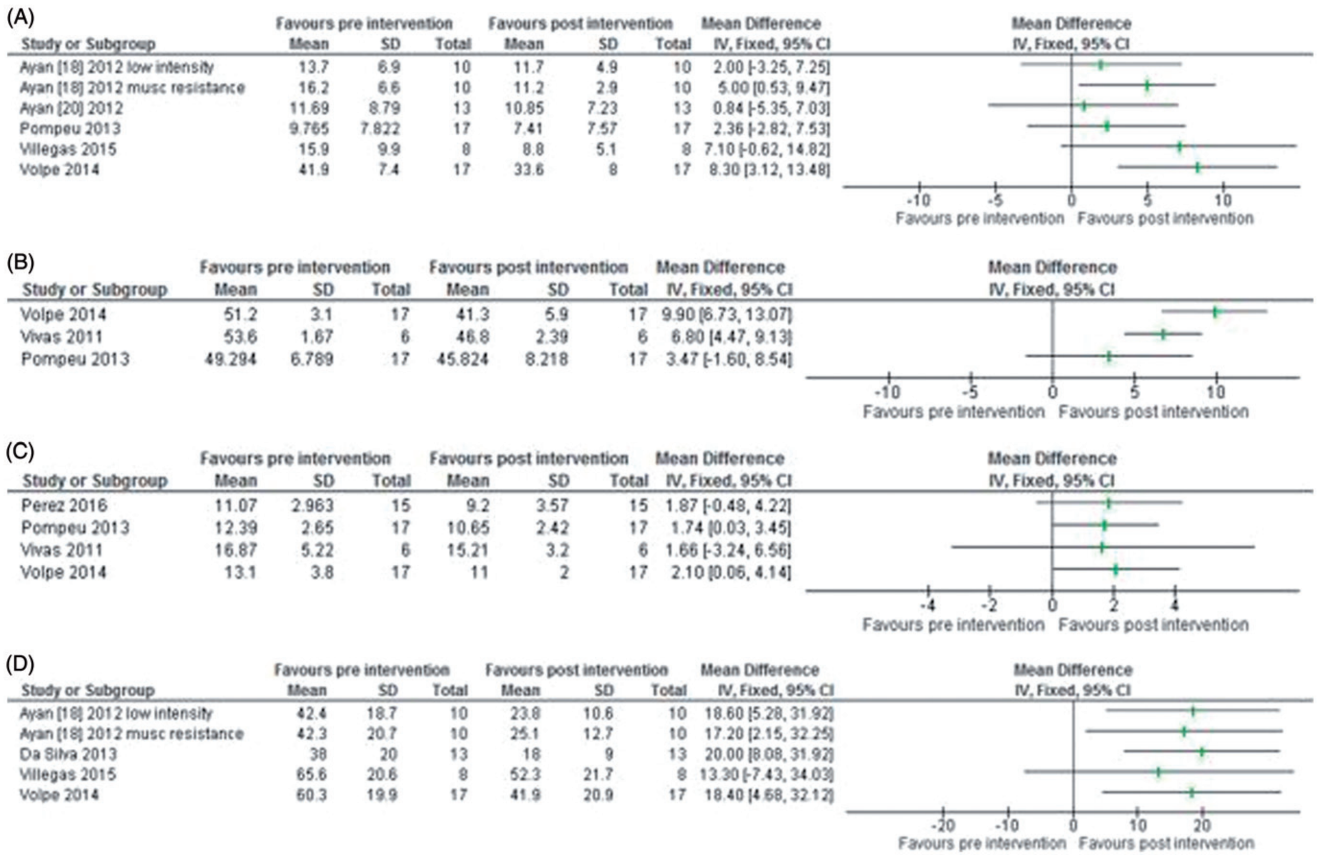

Figure 3. Forest plot illustrating within-group outcomes of interventions, with pre and post aquatic intervention comparisons according to first named author and year for (A) UPDRS-III; (B) Berg balance scale; (C) Timed up and go; and (D) Parkinson's disease questionnaire-39.

test was also used to assess the risk of falls amongst patients [33], whilst Volpe et al. [19] measured the centre of pressure sway area for balance. Other studies used the dynamic gait index [23] and the functional reach test [17], whereas patient subjective questionnaires such as the Activities-specific balance confidence scale, the falls efficacy scale and utilisation of falls diaries were used in the study by Volpe et al. [19].

Participation restriction was measured in some studies using the Parkinson's disease questionnaire-39 [18–20,22,25]. Only three studies reported the blinding of assessors for the collection of outcome measure data [18,19,24]. The intervention characteristics and outcome measures utilized by reviewed articles have been summarized in Table 3.

Descriptive analysis

Due to the variety of outcome measures used and study designs available, a qualitative synthesis was performed. Within each ICF domain, the results of statistical analyses were reported for within-group and between-group efficacy (where available) for all outcome measures in the reviewed studies. Where more than one intervention was examined within a study, both study arms are described.

Body structure and function impairments

In the study by Volpe et al. [19], significant within group and between group effects were found for centre of pressure sway area with eyes closed. One study found significant between group effects for the motor subsection of the UPDRS (UPDRS-III) [17]. Pérez-de la Cruz et al. [21] observed a significant decrease in the Visual Analogue Scale post aquatic intervention; immediately and at one month follow-up.

Activity limitations

Four studies reported within group significant effects for the various subsections of the UPDRS [18–20,23]. The study by Pompeu et al. [23] showed significant within group effects for UPDRS-I, which evaluates non-motor aspects of experiences of daily living while three studies found significant within group effects for UPDRS-II [20,23,25]. A single study by Ayan and Cancela [18] showed significant within group and between groups effects for UPDRS-III in the muscular resistance aquatic intervention group. Total UPDRS scores were shown to have within group improvements in two studies [23,25] and a single study by Vivas et al. [17] reported an improvement in total UPDRS score in the aquatic intervention group when compared to the land based exercise intervention.

The Berg balance scale was seen to have significant within group effects in three studies [17,19,23] and significant between group effects in the two studies that were able to make comparisons to another treatment group [17,19]. Pérez-de la Cruz et al. [21], Pompeu et al. [23] and Volpe et al. [19] also reported improvements within groups for the timed up and go test (recorded as the get up and go test by Pérez-de la Cruz et al. [21]). The study by Volpe et al. [19] found significant within and between group effects for both the activities-specific balance confidence scale and the falls efficacy scale. Balance, measured by the Tinetti test in the study by Pérez-de la Cruz et al. [21], was better after aquatic physiotherapy within the aquatic intervention group, and these gains were maintained one month post-intervention. Significant within group effects were reported for the Bartel Index, the five times sit to stand test and the Fullerton fitness test [18].

Participation restrictions

The Parkinson's disease questionnaire-39 was reported to have significant improvements within intervention groups for four studies [18–20,22] with two of these with comparison groups demonstrating significant improvements between groups [18,19]. Pérez-de la Cruz et al. [21] found no significant within group effects, but a significant between group effect in the Parkinson's disease questionnaire-39 scores.

Evidence synthesis

The greatest volume of evidence supported by statistical analysis was around the effect on UPDRS-III, Berg balance scale, timed up and go test and Parkinson's disease questionnaire-39. Where data were available, the within-group effects for these outcome measures (pre- and post-intervention) have been illustrated in a forest-plot (Figure 3). As shown in Figure 3(A, B), the forest plot suggests a trend towards enhancement of UPDRS-III and Berg balance scale as a result of the aquatic intervention. Figure 3(C, D) show a trend towards improvements in the timed up and go test and Parkinson's disease questionnaire-39 after aquatic intervention. Of note, the small sample sizes and wide confidence intervals indicate that caution is needed when interpreting the findings.

Safety and feasibility

Safety and feasibility data was poorly documented by all included studies. Data such as pool depth, pool temperature and intensity of exercise was intermittently documented amongst studies. Pool depth was documented in seven studies [17,18,20–23,25] whilst eight studies documented pool temperature [17,18,20–23,25,26]. None of the included studies documented exercise intensity as measured by exertional outcomes, for example the BORG scale, which is a rating of perceived exertion [34].

Only four studies detailed safety data in regards to how many instructors were present in and out of the pool, and expertise level [18,20,23,25], with one study stating that safety measures taken were 'similar to those for any aquatic activity' [[21], p. 178]. Four studies reported the presence or absence of adverse events (Table 3) [18–21], of which there was only one adverse event where a participant withdrew due to a chlorine allergy [20].

Attrition was reported in four studies, predominantly attributable to transportation challenges [17,18,20,24]. Three studies reported an attendance rate of above 80% [18,20,21] whereas the study by Volpe et al. [19] simply reported that there was 'good compliance'. All other studies failed to document attendance or attrition.

Discussion

This systematic review indicates that aquatic physiotherapy may be an effective treatment modality for people with PD. Results suggest that aquatic physiotherapy had a positive effect on motor performance and balance but it is not clear whether these effects are more widespread to other functional tasks due to significant variation in research methodology and quality. The evidence also suggests that aquatic physiotherapy was effective in improving health-related quality of life scores, as demonstrated by da Silva et al. [22] and Volpe et al. [19]. Aquatic physiotherapy interventions delivered varied widely, ranging from aerobic and muscular strengthening exercises to balance, stretching and the use of the Halliwick concept. This makes it challenging to determine which aspects of aquatic therapy may be most beneficial for people with PD.

Comparative studies have shown that aquatic physiotherapy improved scores in the timed up and go test in stroke survivors, community dwelling individuals and people with PD [21,23,35,36]. Other studies examining the effects of aquatic physiotherapy on balance in both healthy individuals and stroke survivors have also found significant improvements in balance as measured by the Berg balance scale after aquatic intervention [35,37], supporting the notion that aquatic physiotherapy is an effective treatment modality for balance across a range of health conditions.

Limited information was reported regarding feasibility elements of aquatic therapy, such as adherence and attrition, in the reviewed articles. Of the studies that did provide feasibility details, adherence was reported to be approximately 80% [18,20,21] with only one mild adverse reaction [19]. These results are similar to the study by Wang et al. [38] in which they found adherence of 81% and nil adverse reactions when examining the effects of aquatic physiotherapy on osteoarthritis of the hip and knee. It is expected that in non-trial conditions that adherence to any exercise program would not be 100%, as seen in a study by Simek et al. [39] that looked at adherence to home exercise programs. It is also expected that adverse reactions would be minimal due to the medical screening that patients have to have before commencing an aquatic physiotherapy program. Subsequently, the reporting of adherence and attrition is crucial to determine the feasibility and efficacy of aquatic physiotherapy for people with PD.

Safety information such as pool depth, pool temperature and exercise intensity were not well documented by the included studies. Pool temperature is a key factor that needs to be documented because it has important physiological effects on the body. For instance, it may result in an increase in heart size, stroke volume and a reduction in diastolic blood pressure [27]. These physiological changes can affect a patient's ability to exercise safely in water [27]. People with PD are more vulnerable to the hydrostatic properties of water as they have more than 50% risk of developing orthostatic hypotension [40]. Given this increased risk, it is important to record and report the temperature in which aquatic interventions are being delivered so as to minimize their risk of adverse reactions.

Pool depth indicates the percentage of weight bearing or load that the patient is experiencing when exercising [27]. As resistance increases linearly with pool depth, documenting pool depth can guide the level of difficulty of the exercises prescribed [27]. In addition, hydrostatic pressure of the pool increases as depth increases, causing a reduction in thoracic space due to diaphragm displacement [27]. As people with PD have decreased lung capacity and a tendency to become more short of breath [41], increasing depth of water can place these individuals at a higher risk of adverse events [38]. Only 6 articles in this review reported pool depth used [17,18,20–23], therefore it is recommended that pool depth should be a mandatory reported item when describing the efficacy of aquatic physiotherapy in people with PD.

No studies included in this review documented the level of exercise intensity [34]. This is consistent with a previous review, which found that the intensity of balance exercises was grossly underreported [42]. Exercise intensity is an important safety consideration because it provides a means for physiotherapist to monitor patient safety whilst undertaking an exercise program [43]. This is particularly relevant in the aquatic setting given the hydrostatic properties of water and its potential physiological effects. Thus, future studies examining the efficacy of aquatic therapy in people with PD should consider addressing and reporting exercise intensity using the Borg rating of perceived exertion scale [34] to guide exercise prescription for this vulnerable population.

Another marked omission by all included studies was reporting of the number of staff present and the safety precautions taken during treatment. Safety of intervention by providing sufficient staffing is critical considering people with PD are frequent fallers [7]. Only four studies documented the number of staff present and their level of training [18,20,23,25]. This makes it difficult to assess the safety of the aquatic programs delivered and the level of training that the therapists have, both of which are essential factors in determining the safety and feasibility of aquatic physiotherapy for people with PD.

Falls history was also under-reported by many studies in this review, which is of concern considering the high prevalence of falls amongst people with PD [19]. As per APA aquatic guidelines [27], a history of falls may preclude an individual from undertaking aquatic physiotherapy. Aquatic physiotherapy immersion has large physiological impacts on the body, which make the exit out of pool unsafe due to potential changes in blood pressure. Additionally, environmental factors such as wet floors may increase an individual's risk of falling. Documentation of falls history is therefore essential to determine the suitability of aquatic physiotherapy for people with PD.

There were few commonalities in outcome measures used between studies, which led to limited meta-analysis. From the 10 studies in this review, there were 24 different outcome measures used; three studies only used a single outcome measure [22,24,26], and the largest study used eight separate outcome measures [19]. This highlights the need for a minimum dataset to be used in future aquatic therapy studies in people with PD, so that data can be pooled to allow definite conclusions across studies to be made more effectively. Recommendations for future studies include using at least one measure of disease severity and disability such as the UPDRS and one measure of health-related quality of life such as the Parkinson's disease questionnaire-39, as per suggested by the International Parkinson and movement disorder society (MDS) taskforce. Additional outcome measures would be dependent on the focus of the trial.

Study limitations

Several limitations of this systematic review warrant noting. Since the majority of participant samples had a similar level of disability (HY stages 1–3), generalization of the findings to individuals with more severe disease (HY stages 4 and 5) is uncertain. There were also large variations in sample sizes, with no studies reporting *a priori* calculations to determine study power reducing the chance of determining a true effect of aquatic physiotherapy for people with PD [44]. Given that the primary focus of this systematic review was evaluating the efficacy of aquatic intervention in people with PD, search terms regarding feasibility were not included in the search strategy. Therefore, it is possible that there may be relevant research that has not been included in this review. Quality assessment of included studies was completed using two different scales. Given that the PEDro scale is not specific to aquatic physiotherapy, caution is required when interpreting the results of the quality assessment. Finally, the variable outcome measures used, intervention dosage and duration and aquatic intervention delivered did not allow statistical synthesis of the findings.

Conclusions

Due to the small number of studies identified for this systematic review and the variability in the quality and intervention delivered, definitive conclusions regarding the efficacy of aquatic physiotherapy for people with PD are limited. It is recommended that a minimum dataset is utilised for future studies to enable more definitive conclusions to be drawn. Additionally, safety criteria need to be well documented and addressed when delivering aquatic physiotherapy to people with PD. In particular, pool temperature, pool depth, number of staff present, level of staff experience and exercise intensity needs to be documented to allow accurate study evaluation and replication.

Note

1. Ai-Chi: a form of Tai Chi exercises performed in an aquatic environment.

Disclosure statement

No potential conflict of interest was reported by the authors.

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