

Effect of Aquatic Therapy Approaches on Balance in Geriatric Population: A Scoping Review

Purnima Singh

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Abstract

Background: Apart from neurological disorders, musculoskeletal abnormalities, sensory dysfunctions, and loss of anticipatory control mechanisms directly cause impairment of balance and gait in elderly. It is suggested that various aquatic therapy techniques using laws of fluid mechanics offer an effective environment for improving balance in elderly.

Objective: To conduct a scoping review of studies that assesses the effectiveness of aquatic therapy techniques on improving balance in elderly.

Methods: The research was conducted in PubMed databases from 31 December 2007 till 30 December 2020. The PICO model was used in the selection of the articles. Studies: randomized controlled trials (RCT) or quasi-experimental studies or pilot trials. Population: elderly with/without neurological deficits, independent in ADL. Primary outcome: balance. Methodological quality was assessed using the Downs and Black checklist. The data was analysed and synthesized by two independent reviewers.

Results: The methodological quality of NINE studies included in this review ranged from fair to good. Two studies found improvements in balance using Ai Chi as aquatic therapy intervention. There were significant improvements in the balance in the Halliwick method of aquatic therapy intervention group when compared with the control group in 5 studies. Similar results were found in 4 studies where BRRM intervention is used to improve Balance.

Conclusion: There are scientific evidence regarding the positive impact of various technics of aquatic therapy program in improving balance in older adults and consequent reduction in risk of falls. However, future studies with more rigorous study designs and with more structured and outlined programs are needed to prove the efficacy of these methods in improving balance and risk of falls in geriatric population.

Keywords: Elderly; Balance; Aquatic Therapy.

Introduction

Ageing is a dynamic, progressive and physiological process accompanied by functional, morphological, biochemical and psychological changes. India being the second most populous country in the world has seen a sharp increase in the population of elderly and it has been projected that it would rise to about 324 million by 2050.¹

Balance, or postural control, can be described as

the ability to control one's body position in space for the dual purposes of stability and orientation.² Balance depends on vision, vestibular system, proprioception, muscle strength and reaction time. A poorer functioning of these systems in the elderly can lead to disturbances of balance.³ It is one of the most common problem that remain unnoticed before it causes serious injuries and one of the reasons that older adults seek medical help.⁴ Balance dysfunction results in a variety of mobility

Author Affiliation: Professor, PhD Scholar, Principal, Hosmat College of Physiotherapy, Laggere Bangalore 560058, Karnataka, India.

Corresponding Author: Purnima Singh, Professor, PhD Scholar, Principal, Hosmat College of Physiotherapy, Laggere Bangalore 560058, Karnataka, India.

Email: purnimasingh29@gmail.com

disorders; the most significant of which is falls.⁵ Among older adults, falls are the leading cause of injury and deaths and the most common cause of nonfatal injuries and hospital injuries for trauma.⁶

Even fallers who are not injured are likely to develop a fear of falling and may limit their activities resulting in reduced mobility and physical fitness, increasing their risks for future falls.⁷

Evidence suggests that participation in exercise programs not only strengthens the working muscles, increase walking velocity⁸, with improved response time and balance control⁹ but also enhance functional performance and quality of life in elderly.

There is speculation that an aquatic environment will increase proprioceptive input to the immersed body by providing more stability and body alignment, leading to enhancement of balance.¹⁰

Sensory feedback may also increase, promoting a sense of body awareness, because resistance to movement through a viscous fluid (water) is greater than resistance through air.¹¹

Therefore, the aquatic environment may be an effective medium for balance training in elderly. Various aquatic therapy methods include-

Halliwick Ten-point program/Water specific Therapy

Clinical Ai Chi

Bad Ragaz Ring Method

Watsu

Aqua running

Burdenko Method

Till date, there has not been any review evaluating the effects of these aquatic therapy techniques on improving balance in elderly. The aim of this study is to review the evidence from randomized controlled trials (RCTs), quasi-experimental studies & Pilot trials to assess the effectiveness of aquatic therapy techniques on balance in elderly.

Methods

Literature search

An electronic literature search was conducted in Medline, Pedro, Amed, using the following combination of various terms: (aquatic exercise or aquatic therapy or water-based exercises or water exercises or pool exercises) and (balance or postural control) and (elderly). We limited our review to publications prior to December 31, 2007. Only articles written in English were included. Inclusion

criteria were

- Elderly patients (60 years and above) with balance dysfunctions;
- Trials included only Clinical Ai chi, BRRM and Halliwick method (Water Specific Therapy) methods;
- The outcome measure was balance and/or gait performance.
- Studies were excluded when-
- Methods or technics are not clearly documented;
- Other forms of aquatic therapy were considered as an intervention;
- The interventions failed to meet the recommendation of exercise for improving balance ability.
- The studies that delivered the intervention <2 weeks and
- Studies appeared in previous relevant systematic reviews.

Data extraction and Management

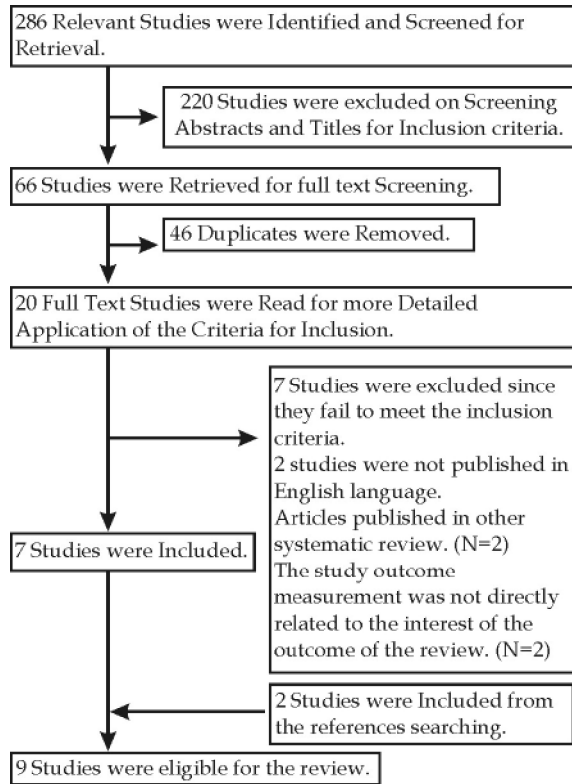
Independent reviewers, individually merged and screened all the titles and abstracts from the databases. Studies that failed to meet the selection criteria were excluded. Data extraction was analyzed and synthesized by two reviewers independently. The data extraction form was developed based on the PICO questions¹² on population, intervention, comparison, and outcomes.

Methodological quality

The quality of included studies was assessed by two independent reviewers using the criteria proposed by Downs and Black. Quality scores above 19 were considered as "good," between 11 and 19 as "moderate," and below 11 as "poor".¹³

Results

The flow chart below shows the steps in the selection of studies. From the electronic databases, a total of 286 published articles were identified. Of these, 220 were eliminated after screening of titles and abstracts. After duplicates were excluded, 20 remained. After reading the full-text articles, 13 more studies were excluded because they failed to meet the inclusion criteria; adding two articles from reference search; thus, the NINE remaining studies were included in the review.



impairments^{14,15,17}; 47 with Parkinson’s disease^{21, 22}; and 97 with stroke.^{18-20,22} Six of the studies were RCTs^{14, 17-20, 22}, one was quasi-experimental studies²¹, one 3 arm parallel pilot study¹⁵ and another being single blind pilot trial.¹⁶ The aquatic intervention comprised the following: Halliwick, Ai-Chi & BRRM.

Focusing on the aquatic setting, studies reported the dimensions of the therapeutic pool are,^{14-16, 18,19, 22}. One study used 2 different community pools¹⁷, though the dimensions are not reported. Only in two studies^{20,21} failed to identify the place where the intervention took place. Eight studies^{14-19,21}, had comparison groups and of these, six studies^{14-18, 20, 22} compared the aquatic intervention with a land-based exercise. Terrens et al¹⁶ & Covill et al¹⁷ compared two aquatic therapy technics viz aquatic-Ai-Chi with Impairment based aquatic therapy (IBAT) and halliwick method with traditional aquatic therapy exercises respectively. Single study²¹ does not have a control group. To deliver the intervention, Nissim et al¹⁵ used certified hydro therapist Ai Chi instructors.^{14,16-18,20,22} used physiotherapists trained in specific aquatic therapy technics, study¹⁹ used physiotherapists but their training in aquatic therapy is unclear. In the study by Pompeu et al²¹ physiotherapy students provided the exercises to the participants.

The duration of the intervention varied between

Study characteristics

Table 1 provided data for 272 participants: 128 were community dwelling older adults with balance

Table 1: Main characteristics of the NINE eligible studies.

Reference	Design	Type of Participants (N)	Drop-outs (e/c)	Mean Age (Yrs.)	Interventions			Dosage		Duration (wk.)	Outcome Measures		
								Min/ ses	T/ wk				
Silva C et al, 2020	RCT N=38	Elderly	03	65	Halliwick + BRRM N=16	Land based PT N=19		50	2	3	T U GT	FRT	Sit to stand in 30 secs
Michal Nissim et al, 2020	3-arm pilot trial	community dwelling elders. N=42	NIL	74.4	API (Ai Chi) N=13	N=14 OLPI N=15 NPI		30	2	24	Tinn etigait and balance test	DSF & DSB	CBTF & CBTB
Terrens AF et al, 2020	Single blind Pilot trial	Parkinson Disease N=30	3	72	N=11 Halliwick	N=10 Traditional Aqua	N=9 Land based	60	1	12	BBS	Mini BES Test	UPD RS-111 mF FS
Covill et al, 2017	RCT	Older adults with balance impairments N=48	NIL	72.2/ 75.5	N=15 Ai Chi	N=17 IBAT		35	2	6	BBS	TUG	ABCS NP RS

Table to be cont....

Hyun - Gyun Cha et al, 2017	RCT	Chronic stroke N=22	NIL	64.0/63.3	N=11 BRRM + land rehab (NDT) N=11	N=11 Land rehab (NDT)	60	3	6	EMG	TUG	Balan- ce index
Kim EK et al, 2015	RCT	Chronic stroke N=20	NIL	69/68	N=10 BRRM	N=10 Land PNF	30	5	6	BBS	TU GT	FRT 10M WT
Tripp F, Krakow K. 2014	RCT	Post-acute stroke N=30	03	64.8	N=12 Halli-wick + CON PT	N=15 Standard PT	45	3+2	2	BBS	FR	FAC RMI
Jose Pompeu et al, 2013	QES	Parkin-son Disease N=17	NIL	67.58	N=17 Halli-wick + BRRM + Ai Chi	-	40	3	12	BBS	TUG	DGI UPD RS
Noh DK et al, 2008	RCT, PILOT	Chronic stroke N=25	NIL	61.9/66	N=12 Halli-wick + Ai Chi	N=13 Gym Exs	60	3	8	BBS	Weig-ht bearing ability	Ms Strength Gait

studies from 30 minutes/session to 60 minutes/session. Three studies^{14, 15, 17} used two times a week protocol and four studies^{18, 20-22} used three times a week protocol. One study¹⁹ used five times a week protocol and another one¹⁶ used once in a week protocol. The length of provision of the exercise intervention ranged from 2 weeks to 24 weeks.

Because of the heterogeneity of the study designs, participants, and outcome measures, it was impossible to conduct a meta-analysis. The measure of balance included Timed Up and Go Test, Berg Balance Scale, dynamic balance, functional reach test, 10-minute Walk test, One leg stance test, TinettiGait and Balance test, Activity Specific Balance Confidence Scale, Mini BESTest, Balance index and Dynamic Gait Index.

Balance measurement was performed in all studies before and after intervention. One study tested balance at baseline, after six weeks and 12 weeks intervention.¹⁵ Silva et al¹⁴ measured the outcomes at the baseline, after 10 sessions and after the end of 20 sessions. Another study monitored balance performance of patients one month after the end of the intervention.²¹ Long term follow up was not performed in any of these studies. Of these,^{14-16, 18, 20-22} provided concealed randomization.

Methodological quality

Results of the methodological quality assessment, modified from the Downs and Black’s checklist, are presented in Table 2. The methodological quality of the included studies in this review are variable:

Table2: Down & Black Checklist.

N = answer is no; P = partial answer; U = unable to determine; Y = answer is yes.

Studies →	1	2	3	4	5	6	7	8	9
Study Aim	Y	Y	Y	Y	N	Y	Y	Y	Y
Main Outcome	Y	Y	Y	Y	Y	Y	Y	N	Y
Participant Characteristics	Y	Y	Y	Y	Y	Y	Y	Y	Y
Description Intervention	Y	Y	Y	Y	Y	Y	Y	Y	Y
Principal Confounders	Y	Y	Y	Y	Y	Y	Y	N	Y
Outcome Data	Y	N	Y	Y	N	N	Y	Y	Y
Range of Results	Y	Y	Y	Y	Y	N	Y	Y	Y
Adverse Effects	N	N	Y	N	N	N	N	N	N

Table to be cont....

Lost To Follow Up	Y	Y	Y	Y	Y	N	Y	Y	Y
Probability Value (Exact)	Y	Y	Y	Y	N	N	Y	Y	Y
Source Population	U	Y	Y	Y	Y	Y	U	Y	Y
Representative Of Population	Y	Y	Y	Y	Y	Y	Y	Y	Y
Staff, Place, Facility	Y	N	Y	Y	Y	Y	Y	Y	Y
Participants Blind to Intervention	Y	N	N	N	Y	N	N	N	N
Blind Assessors	Y	Y	Y	N	Y	N	Y	Y	Y
Data Dredging	Y	Y	Y	Y	Y	Y	Y	Y	Y
Same Length of Follow Up	Y	Y	Y	Y	Y	Y	Y	Y	Y
Appropriate Statistical Tests	Y	Y	Y	Y	Y	Y	Y	Y	Y
Compliance with the Intervention	Y	U	Y	N	Y	Y	Y	U	Y
Accurate Outcome Measures	Y	Y	Y	Y	Y	Y	Y	Y	Y
Control Recruited Same	Y	Y	Y	Y	Y	Y	Y	Y	Y
Recruitment at the same Time	U	U	Y	U	Y	U	Y	N	Y
Randomization Allocation	Y	N	Y	N	Y	Y	Y	N	Y
Concealed Randomization	Y	N	Y	N	N	N	Y	N	Y
Adjustment for Confounders	Y	Y	Y	Y	Y	N	Y	U	Y
Participants Lost to Follow Up	Y	Y	Y	Y	Y	U	Y	U	Y
Power Analysis	Y	Y	Y	Y	N	N	U	N	N
Total Score-28	25	20	27	21	22	16	24	16	25
	Good	Good	Excellent	Good	Good	Fair	Good	Fair	Good

the overall quality is rated as Fair to excellent (range from 15 to 27). One study¹⁶ has excellent methodological quality. Six included studies demonstrated good methodological quality.^{15,17,18,20,22} Eight studies reported randomization.^{14-18,20-22} Only four studies¹⁴⁻¹⁷ conducted a power calculation. Six studies provided statements of single blinding:^{15,16,18,20-22}. Only two studies^{14,17} where participants blinded to intervention. Three studies reported^{14,16} &²⁰ patient dropout. Only one study¹⁶ reported occurrence of adverse events.

Effect of Ai Chi on Balance performance

Four studies^{15,17,21&22} assessed balance control using Ai Chi as aquatic physical intervention. One study²¹ used combination of Ai Chi, Halliwick and BRRM. Another study²² combined Ai Chi with only halliwick method. There was variation in design, intensity, frequency, duration of exercise and even in the type participants across the studies (Table 1). Participants for the study^{15,17} are community dwelling older adults with balance impairments; study²¹ was on Parkinson's Disease Patients; and study²² was conducted on Chronic Stroke patients. However, it was concluded that Ai Chi in water improved balance control across the patients.

Study^{15,17} assessed balance control in community dwelling older adults, despite the variation in

the intervention, dosage and duration, both studies demonstrated a statistically significant improvement in their outcome measurement scores of balances. Study¹⁷ compared 2 aquatic therapy interventions (Ai Chi & IBAT-Impairment based aquatic therapy), it revealed no difference in any of the outcome measures, but all participants as a group showed statistically significant improvement in the BBS and TUG scores.

Jose Pompeu et al²¹ evaluated balance of Parkinson's patients on stages (1-4) of Hoehn and Yahr scale. Intervention program composed of combination of Halliwick, Bad Ragaz Ring method and Ai Chi. There was a statistically significant difference among results before and after the intervention evaluated by BBS and TUG.

Noh D K et al²² evaluated balance in stroke survivors using aquatic therapy. Aquatic therapy was given in the form of Halliwick& Ai Chi. The aquatic therapy group showed improvements in the mean BBS ($p = 0.032$) compared to control group.

In all the studies there was overall improvement of balance using aquatic physical therapy compared to any land based exercises but the study²⁴ that compared Ai Chi with other aquatic physical therapy intervention showed no significant difference in the balance score.

Effect of Halliwick method (Water Specific Therapy) on Balance performance

Five studies^{14,16,20-22} improved balance control using Halliwick method as aquatic physical therapy intervention. Two studies^{16,21}, where Halliwick method was used to improve balance control in the Parkinson's population and other two studies^{20,22} assessed balance control in the stroke population. Two studies^{16,20} administered only Halliwick method as aquatic physical therapy intervention. Study¹⁶ compared Halliwick with traditional aquatic therapy and land-based therapy. No significant differences were found post intervention in BBS balance scores within the group but the Halliwick aquatic group improved significantly in the Mini BES Test post-intervention ($p = 0.011$). In Tripp F et al²⁰ study, compared to the control group, significantly more subjects in the Halliwick-Therapy group (83.3% versus 46.7%) attained significant improvement in the Berg Balance Scale ($P < 0.05$).

Silva et al¹⁴ combined Halliwick and BRRM as aquatic physiotherapy to assess risk of fall/balance in elderly. Both aquatic and conventional interventions, showed to be greatly efficient however aquatic physiotherapy showed certain advantages compared to conventional physical therapy.

Effect of Bad Ragaz Ring method (BRRM) on Balance performance

Four studies^{14,18,19,21} improved balance control using BRRM as aquatic physical therapy intervention. Study^{14,18,19} compared BRRM with land-based exercises.

The study population in two trials^{18,19} had similar mean ages, symptom stage and intervention & both studies demonstrated a statistically significant increase in the TUG score ($p \leq 0.05$) in the experimental group. Study¹⁸ used trunk pattern, Diagonal patterns of legs of BRRM. Apart from balance testing they also measured lower limb muscle activity using EMG. There were significant improvements in the activations of tibialis anterior ($p = 0.036$) and gastrocnemius muscles ($p = 0.029$). They also found that even the control group showed significant improvement in TUGT results.

Discussion

This review has provided information about the therapeutic effects of aquatic exercises viz on

balance ability in selected neurological disorders, in comparison with land based exercises^{14,15,16,18,20,22} other aquatic therapy methods^{16&17} or with no comparison.²¹ The findings of the review highlighted that all the aquatic techniques might increase static and dynamic balance in community dwelling older adults with balance impairments with/without other associated neurological disorders.

When considering external validity of the studies in this review, the patients included in the studies were not representative of the neurological population. Five studies¹⁷⁻²¹ have small samples and four studies reported consideration of powering the sample.¹⁴⁻¹⁷ A small sample size can increase the risk of a Type II error and a false-negative result.²³

Halliwick method

This review was able to find one quasi-experimental studies²¹ and two pilot studies^{16,22} and two RCT^{14,20} examining the therapeutic effects of halliwick method of aquatic exercises on balance in elderly patients with neurological deficits and without neurological deficits. The results of the studies demonstrated that proposed aquatic therapy in respective studies promoted improvement in static and dynamic balance assessed by the BBS and other outcome measurement tools.

In the similar study by Montagna et al in 2014 used the principle of Halliwick (2x of 40 minutes per week) to improve balance and corporal symmetry in stroke survivors. After intervention, participants had a significant improvement on their static balance measured by Berg Balance scale and TUG.²⁴

The findings of the review suggest that Halliwick method of aquatic exercise programs alone or when combined with other techniques like BRRM, Ai Chi benefit elderly with balance impairment.

The Halliwick method, through the water properties like the hydrostatic pressure, turbulence and buoyancy, creates instability that increases sensory stimulation and, as a consequence, causes balance reactions that could contribute to improvement on postural control and mobility of patients.²²

Clinical Ai Chi

Four studies investigating the effects of Clinical Ai Chi aquatic exercises across elderly population with or without neurological deficits were identified in this review.^{15,17,21,22}

Even in 2020 study by Ku PH et al who

investigated the effectiveness of Ai Chi compared to conventional water-based exercise on balance performance in individuals with chronic stroke. Both groups showed significant improvement in BBS and FMA yet the Ai Chi group demonstrated significantly better results than control group ($p = 0.025$).²⁵

Improvement after Ai Chi may be attributable to the buoyancy of water supporting body weight and enhancing the ability to move. Water turbulence and resistance might also provide a suitable environment for balance.²⁶ It is possible that the superior results shown in aquatic Ai Chi group exercise may be also due to the degree of exercise supervision influencing exercise compliance. It is suggested that patients have better compliance, motivation, and adherence to exercise when they participate since Ai Chi majorly done in group or have an instructor to guide them.²⁷

BRRM

Four studies included in this review that evaluated the effect of BRRM on Balance in elderly.^{14, 18, 19, 21} In 2008 a Korean study by Song JM et al also assessed balance performance in stroke patients using aquatic PNF (BRRM). The results of the study showed that intervention of aquatic exercise program applied PNF patterns improved the balance performance in people who had stroke.²⁸

The reason for the increase in balance is when Bad Ragaz Ring Method was applied underwater, muscle activation and proprioception for maintaining balance and stabilizing the trunk are enhanced. Therefore, the Bad Ragaz Ring Method is considered to be a method that can clinically improve the leg strength and balance ability without putting an excessive joint load on the joint.²⁷

Limitations of the review

One generalized limitation of all aquatic therapy studies is low uptake of participants into the study. The majority declined to participate or were unable to attend. The main reason for declining to participate is that participants are not interested in water exercises, transport and availability difficulties. Most of the studies are done with combining various aquatic therapy methods and on patients with neurological deficits affecting balance.

No studies included where the balance impairment is due to orthopedic or other issues in elderly. Only two studies were done on community

dwelling older adults. Further limitations include the small number of trials meeting the eligibility criteria and the dearth of methodological quality. In addition, most studies had small sample sizes and significant heterogeneity in the treatment protocols. For example, the different outcome measures used in studies prevented the statistical calculation and comparison of effectiveness among these studies. This limits the generalizability of this review.

Conclusion

This review identified nine studies that investigated the effect of aquatic therapy methods on balance in elderly patients. There was substantial variation in population characteristics, treatment protocols, and outcome measurements among the studies. Hence, a comparison between studies is difficult due to this heterogeneity. Participants in the studies had evidence of balance and gait impairment that may be due to differences in balance mechanisms and the nature of their clinical disorder. It is possible that the effectiveness of aquatic exercise is dependent on the nature of the underlying disease or impairment.

The overall methodological quality of eligible trials in the review was fair to good and only five RCTs were found. Inadequate description of population characteristics (i.e., duration of symptom and baseline impairment) and some missing information (i.e., adverse effects) potentially decreases the reliability and validity of the included studies.

In conclusion, the findings of this review suggest that therapeutic benefits are gained from the use of these techniques in water for patients with balance deficits. However, the superiority of aquatic exercise program over other interventions (i.e., conventional aquatic therapy program, conventional physiotherapy, land-based exercises) and between them is unclear due to the limitations of existing research.

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