Effect of Water Specific Therapy (Halliwick Method), Bad Ragaz Ring Method and Clinical Ai Chi aquatic therapy techniques on improving Balance in Older Adults – A Scoping Review

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ABSTRACT

Background: Exercises are recognized as a mainstay in the prevention and management of falls and balance in the elderly. Aquatic environments have been found to increase proprioceptive input to the immersed body through increased balance and alignment. Evidence suggested that Water Specific Therapy (Halliwick Method), Bad Ragaz Ring Method and Clinical Ai Chi aquatic therapy techniques using laws of fluid mechanics improve balance in elderly.
Objective: To compile available research on the effect of Water Specific Therapy (WST), Bad Ragaz Ring Method (BRRM), and Clinical Ai Chi forimproving balance in the elderly.
Methods: The search was conducted in PubMed, EMBASE,CINAHL, PEDro,and SPORTDiscusdatabases. The PICO model was used in the selection of the papers.Selection criteria included randomized controlled trials (RCT), quasi-experimental studies, pilot trials, and Cohort with either of the three interventions as the main aquatic intervention forthe elderlywith the report of a standardized outcome measure for balance.
Results: Thirteen articles, with a total of 393 participants, met the inclusion criteria including 8 RCT's, 2 Cohort, 2 pilot trials, and 1 QES ranging from fair to good assessed using the Downs and Black checklist. The study population was persons with Chronic stroke, Parkinson's disease, and community-dwelling elderly. Aquatic intervention treatment dosage varied from 30 to 60 minutes, 2 to 12 times per week, for 2 to 24 weeks. Comparison groups included conventional aquatic interventions&land-based exercise.
Discussion: The qualitative analysis reveals a number of encouraging results with Significant improvement in Balance following Ai Chi, WST, and BRRM intervention. All the studies specifically described the whole program, thus facilitating the recommendation of a certain protocol specific to the elderly population relative to balance.
Conclusion: There is a need for more rigorous study designs, as well as more structured and outlined programs in order to prove the effectiveness of these techniques in improving balance and reducing the risk of elderly people falling.

Keywords: Balance; Elderly; Halliwick; Ai Chi; BRRM.

INTRODUCTION

Aging is a dynamic, progressive, and physiological process accompanied by changes in health, morphology, biochemistry, and psychological function.It has been projected that India's elderly population will reach 324 million by 2050, being the second-most populous country in the world.[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]Apart from neurological disorders, musculoskeletal abnormalities, sensory dysfunctions, and loss of anticipatory control mechanisms directly cause impairment of balance and gait in the elderly. 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 isone of the most common problems 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 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]

Exercise is recognized as a mainstay in the prevention and management of falls and balance issues, both in the elderly and in disease conditions like stroke. Evidence suggests that participation in exercise programs not only strengthensthe working muscles,increases walking velocity[8], with improved response time and balance control[9] but also enhances functional performance and quality of life in the elderly.

It has been established since the post-World War 2 era that aquatic therapy is an effective wayof addressingmusculoskeletal problems, neurological problems, balance dysfunctions by allowing patients in a low-impactenvironment.A more beneficial balance training can be achieved in an aquatic environment by utilizing the properties of water.The benefits of aquatic therapy may include increased neuromuscular coordination, proprioception, and balance.

It has been speculated that being immersed in an aquatic environment will enhance proprioceptive input to the immersed body through increased stability and alignment, leading to a better sense 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 the air.[11]
For these reasons, the aquatic environment may be an effective medium for balance training in the elderly. There are various aquatic therapy methodsthathave been introduced during the course of time. These methods include
Halliwick Ten-point program/ Water specific Therapy
Clinical Ai Chi
Bad Ragaz Ring Method
Watsu
Aqua running
Burdenko Method

Halliwick Ten-point Program/Water Specific therapy
The therapeutic application of the Ten-point program of Halliwick concept is called Water Specific Therapy. It is focused on treating impairments of body functions or body structure. Metacentric effects are used frequently for balance control.It has three stages of learning- Mental adjustment, Balance control and

Movement.[12]The balance consists of a mix of intentional task-oriented activities and non-intentional balance strategies. These postural adaptations (non-intentional strategies) can either have predictive purposes or reactive purposes. Reactive strategies can be trained safely in water using WST.[13]

Bad Ragaz Ring Method

One-to-one aqua therapy is the essence of the BRRM. Based on the principles of Proprioceptive Neuromuscular Facilitation (PNF), it is a model of strengthening and mobilizing resistance exercises.BRRM uses active and passive counterforces. It uses fluid mechanical forces as a resistance.[12]Therefore, flotation aids are used to keep patients floating at the water surface during BRRM treatments. BRRM works on strength, mobility, and core stability and thereby improving balance.

Clinical Ai Chi

The Ai-Chi methodis based on Qigong and Tai-Chi movementswere originally developed as a form of martial art in China but have been practiced as a physical exercise, mainly by the elderly population, because of its low-speed[14-15]

The term Clinical Ai Chi is used when Ai-Chi is applied for therapeutic purposes based on evidence level. Previousstudies found improved positive effects of both Ai-Chi and Tai-Chi on static and dynamic equilibrium&fallrisk[16]

It combines posture, breathe and relaxation.Progressions in Ai Chi are designed to present increasingly difficult challenges as skills advance.The goal is to fine-tune the movement to be performed with a high level of consistency and little cognitive/ physical effort as skills increase over time.[17]

Till date, there has not been a systematic review evaluating the effects of these aquatic therapy techniques on improving balance in the elderly. The aim of this study is to systematically review the evidence from randomized controlled trials (RCTs), quasi-experimental studies, cohorts& Pilot trials to assess the effectiveness of 3 specific aquatic therapy techniques for balance improvement in the elderly.

METHODS

Literature search

An electronic literature search was conducted in PubMed, EMBASE, CINAHL, PEDro, and SPORT Discus databases using the following combination of various terms: (aquatic therapy OR pool therapy OR hydrotherapy) AND (balance ORpostural control) AND (elderly OR older adults) AND (Halliwick method OR BRRM OR Ai Chi). We limited our review to publications prior toDecember 31, 2007. The Cochrane Library and five databases(included in this review) were searched to ensure therewere no other systematic reviews on this topic.All relevant article reference lists were thoroughly searched. Only articles written in English were included.Inclusion criteria were

(1) elderly patients (60 years andabove);

(2) trials included only Clinical Ai chi, BRRM, and Halliwick(Water Specific Therapy) methods as primary interventions.

(3) the outcome measure was balanceand/or postural control; and

(4) the study was an RCT, aquasi-experimental study, or a pilot trial, cohort.

Exclusion criteriawere

(1) methods or technics are not clearly documented in the study;

(2) other forms of aquatic therapywere considered as primaryintervention;

(3) the interventions failed to meet therecommendation of exercise for improving balance ability;

(4) the studies where the intervention was given for a period of less than two weeks

Data extraction and management

All relevant titles and abstracts were screened from the databases. Studies that failed to meet the selection criteria were excluded. The data was extracted, evaluated, and synthesized.The data extraction form was developed based on the PICO questions [18] on population, intervention, comparison, and outcomes.

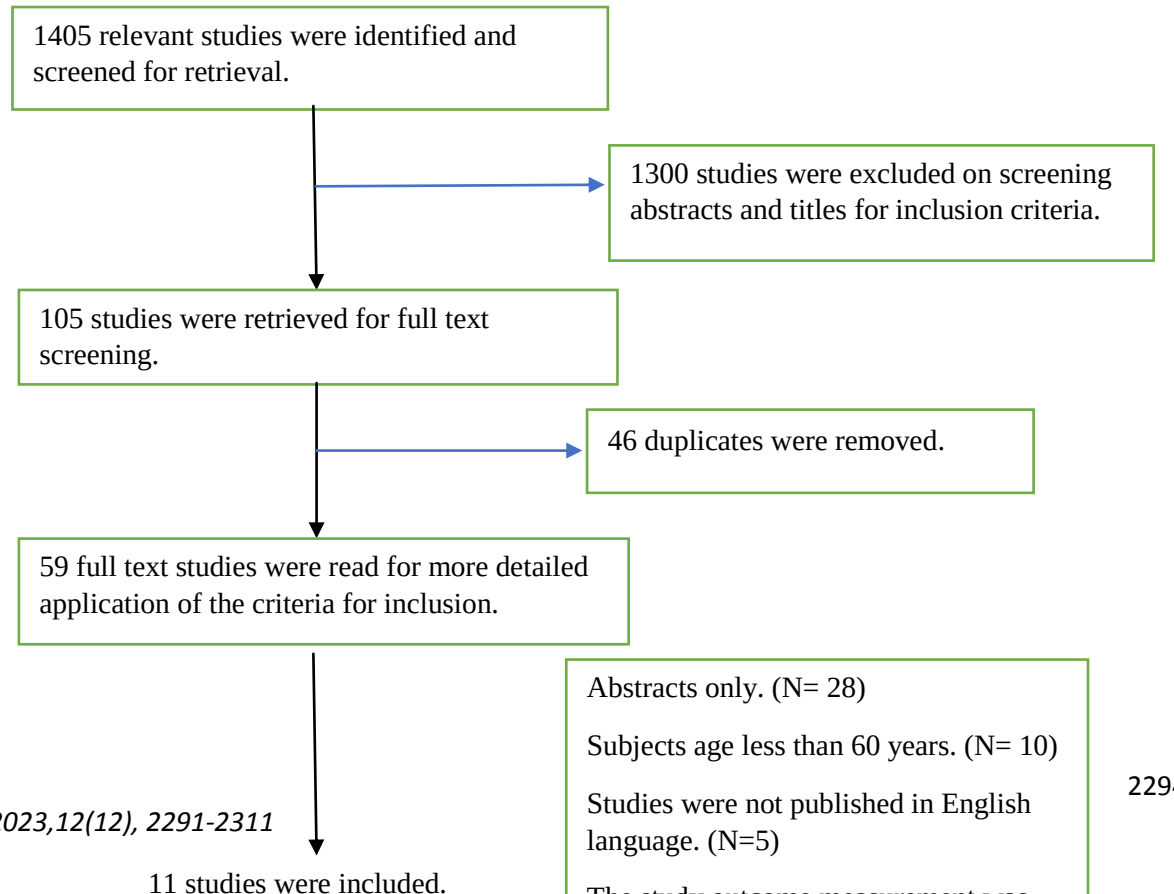
The quality of the included studies was determined using Downs and Black's criteria. Quality scores of 19 or higher were considered "good," 11 to 19 "moderate," and less than 11 "poor."[19]

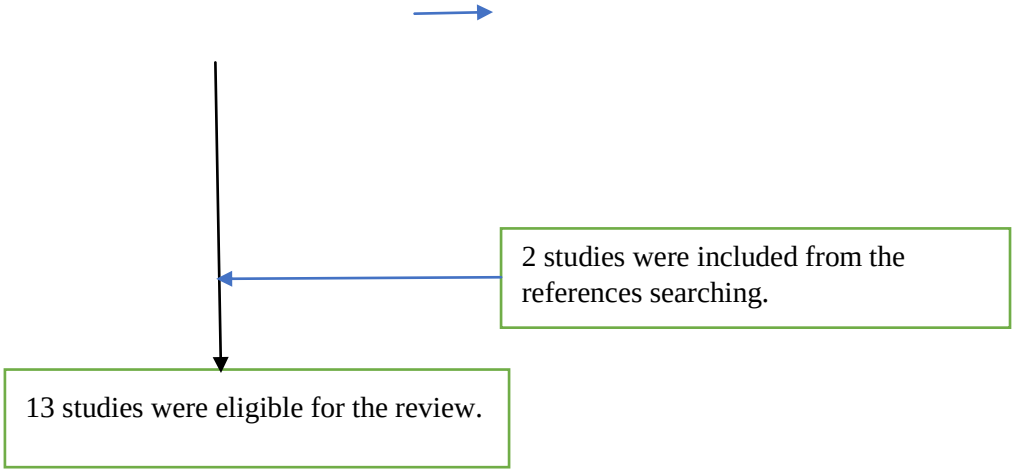
Data Synthesis and Analysis

First, a descriptive overview of study characteristics wasorganized based on either of the three aquatic interventions used. Then, all study balance outcomewas reported.The results of the outcome measure were divided into two groups: "no substantial improvement in balance after either of the aquatic interventions" (P >.05) and "considerable improvement in balance after either of the aquatic interventions". When P values were presented in the study results, they were reported.When sufficient data were available, the effectsize of the three-intervention group also was calculated and
reported using Cohen's *d*andHedges's *g*to provide a statistical indicator about
within-group differences.[20]
Cohen's d effect sizes are interpreted this way:
Any value below 0.2 was considered very small;
The range of 0.02 to 0.49 was considered small;
A moderate score was considered between 0.5 and 0.79; and
A score of 0.8 or above was considered large.[20]
The last grouping included studies that compared Aquatic interventions with a comparison group and were further separated by 2 types ofcomparison groups: land and conventional aquatic intervention.
The results were further organized into subcategories: effect of AiChi on balance, the effect of WST on balance, the effect of BRRM on balance, and combination of these three on balance. The provided outcome results are grouped based on many criteria, including statistically significant findings and effect size magnitude.When sufficient data were available,the *P-value* was reported and effect size (ES) was calculated.

RESULTS

The flow chart below shows the steps in the selection of studies. From the electronic databases, a total of 1405 published articles were identified. Of these, 1300 were eliminated after the screening of titles and abstracts. When duplicates were excluded, 59 remained. After reading the full-text articles, 48more studies were excluded because they failed to meet the inclusion criteria;after adding two articles from the reference search;THIRTEEN remaining studies were included in the review.





Study characteristics

Table-1 provided data for 393 participants: 154 were community dwelling older adults WITH BALANCE IMPAIRMENTS [21-22],[25], [27]; 102 with Parkinson's disease [23-24], [28], [32]; and 137 with stroke [26], [29-31], [33]. EIGHT of the studies were RCTs [21], [24-26], [29-31], [33], one was quasi-experimental studies [32], one 3 arm parallel pilot study [22] one being single blind pilot trial [23], and two cohorts [27-28]. The aquatic intervention comprised the following: WST, Ai-Chi & BRRM.

Focusing on the aquatic setting, studies that reported the dimensions of the therapeutic pool are, [21-28], [31], [33]. One study used 2 different community pools [25], though the dimensions are not reported. Only two studies [30], [32] failed to identify the place where the intervention took place. Ten studies[21-26], [29-32], had comparison groups and of these, nine studies [21-24], [26], [29-31], [33] compared the aquatic intervention with a land-based exercise. Terrens et al [23]& Covill et al [25] compared two aquatic therapy technics viz halliwick method with traditional aquatic therapy exercises and aquatic-Ai-Chi with Impairment based aquatic therapy (IBAT) respectively. Three studies[27-28], [32]do not have a control group. To deliver the intervention, Nissim et al [22] used certified hydrotherapist Ai Chi instructors. Six studies [21], [23-25], [27],[29] used physiotherapists trained in specific aquatic therapy technics, study [29] used physiotherapists but their training in aquatic therapy is unclear. In the study by Pompeu et al [32] physiotherapy students provided the exercises to the participants.

The duration of the intervention varied between studies from 30-60 minutes/session. Four studies[21-22], [25], [28]used two times a week protocol and five studies [26], [31-33] used three times a week protocol. Three studies[24], [29-30] used five times a week protocol and another two[23]& [27] used once in a week protocol. The length of provision of the exercise intervention ranged from 2 weeks to 24 weeks.

The measure of balance included Timed Up and Go Test, Berg Balance Scale, overall balance index measured using Biodex, Functional reach test,One leg stance test, Tinetti balance test, Mini BESTest and, Dynamic balance test.Balance measurement was performed in all studies before and after the intervention. One study tested balance at baseline, after six weeks and 12 weeks of intervention [22]. Silva et al [21]

measured the outcomes at the baseline, after 10 sessions and, after the end of 20 sessions. Another study monitored the balance performance of patients one month after the end of the intervention[32]. Long-term follow-up is not performed in any of these studies. Of these, [21-23], [26],[30], [32-33] provided concealed randomization.Because of the heterogeneity of the study designs, population, and outcome measures, it was not possible to conduct a meta-analysis.

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: the overall quality is rated as fair to good (range from 15 to 27). One study[23] has excellent methodological quality. Eightstudies reported randomization [21-25], [27-29]. Only fourstudies[21-24] conducted a power calculation. Sevenstudies provided statements of single blinding: [22-23], [25], [27-29]. Only two studies[21],[24] where participants were blinded to the intervention. ThreestudiesREPORTED [21], [23], [27] patient dropout. Only onestudy[23]reported the occurrence of adverse events.

Table 1- Study Characteristics

S. NO	REFERENCE	DESIGN	TYPE OF PARTICIPANTS	DROPOUTS	MEAN AGE	INTERVENTIONS			DOSAGE		DURATION	OUTCOME MEASURES			
			(N)	(E/C)	Years	EXP	C	C	Min/ses	T/wk	weeks				
1	Silva C, 2020	RCT	Elderly N=38	03	65	N=16 WST+ BRRM	N=19 Land exs		50	2	3	TUGT*	FRT*	Sit to stand in 30 secs	
2	Nissim M, 2020	3-arm pilot trial	community dwelling elders. N=42	NIL	74.4	N=13 API (Ai Chi)	N=14 OLPI	N=15 NPI	30	2	24	TBT*	DSF & DSB	CBTF & CBTB	
3	Terrens AF, 2020	Single blind Pilot trial	Parkinson Disease N=30	3	72	N=11 WST	N=10 Traditional Aqua	N=9 Land exs	60	1	12	BBS*	Mini BESTest*	UPDRS	mFES
4	Kurt, 2018	RCT	Parkinson's disease N= 40	NIL	62.41/63.61	N=20 Ai Chi	N=20 Land exs		60	5	5	BBS*	TUG*	OBI*	
5	Covill, 2017	RCT	Older adults with balance impairments N=32	NIL	72.2/75.5	N=15 Ai Chi	N=17 IBAT		35	2	6	BBS*	TUG*	ABCS	NPRS
6	Hyun-Gyun Cha, 2017	RCT	Chronic stroke N=22	NIL	64.0/63.3	N=11 BRRM + land rehab (NDT)	N=11 Land exs (NDT)		60	3	6	OBI*	TUGT*	EMG	
7	Skinner, 2016	Cohort	Community dwelling elders N= 42	NIL	64.2	Ai Chi	-		45	1	8	TUGT*	FRT*	FSST	10 m Walk Test
8	Pérez-de la Cruz S, 2016	Cohort	Parkinson Disease N=15	NIL	65.9	Ai Chi	-		45	2	10	TUGT*	TBT*	VAS	
9	Kim EK, 2015	RCT	Chronic stroke N=20	NIL	69/68	N=10 BRRM	N=10 Land PNF		30	5	6	BBS*	TUGT*	FRT*	OLST*
10	Tripp F, 2014	RCT	Post-acute stroke N=30	03	64.8	N=12 WST + CON PT	N=15 Standard PT		45	3 + 2	2	BBS*	FRT*	FAC	RMI
11	Furnari, A 2014	RCT	Chronic stroke N=40	NIL	68/72	N=20 WST	N=20 Standard PT		60	3	8	Baropodometric measurements	TBT*	Barthel Index	FIM
12	Pompeu J, 2013	QES	Parkinson Disease N=17	NIL	67.58	N=17 WST+BRRM+	-		40	3	12	BBS*	TUG*	DGI*	UPDRS

						Ai Chi									
13	Noh DK, 2008	RCT, Pilot	Chronic stroke N=25	NIL	61.9/66	N=12 WST+ Ai Chi	N=13 Gym Exs		60	3	8	BBS*	Weight bearing ability	Ms Strength	Gait

*Balance outcome measures.

Table 2 - Down & Black Checklist

	STUDIES →		1	2	3	4	5	6	7	8	9	10	11	12	13
CHECKLIS	1	Study aim	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y
	2	Main outcome	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
	3	Participant characteristics	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	4	Description intervention	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	5	Principal confounders	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y
	6	Outcome data	Y	N	Y	Y	Y	N	Y	Y	N	Y	Y	Y	Y
	7	Range of results	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
	8	Adverse effects	N	N	Y	N	N	N	N	N	N	N	N	N	N
	9	Lost to follow up	Y	Y	Y	U	Y	Y	Y	Y	N	Y	N	Y	Y
	10	Probability value (exact)	Y	Y	Y	Y	Y	N	Y	Y	N	Y	Y	Y	Y
	11	Source population	U	Y	Y	U	Y	Y	Y	Y	Y	U	Y	Y	Y
	12	Representative of population	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	13	Staff, place, facility	Y	N	Y	N	Y	Y	Y	Y	Y	Y	U	Y	Y
	14	Participants blind to intervention	Y	N	N	N	N	Y	N	N	N	N	Y	N	N
	15	Blind assessors	Y	Y	Y	N	N	Y	N	N	N	Y	Y	Y	Y
	16	Data dredging	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

T S	**17**	**Same length of follow up**	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	18	**Appropriate statistical tests**	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	19	**Compliance with the intervention**	Y	U	Y	Y	N	Y	Y	Y	Y	Y	Y	U	Y
	20	**Accurate outcome measures**	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	21	**Control recruited same**	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	22	**Recruitment at the same time**	U	U	Y	Y	U	Y	Y	Y	U	Y	U	N	Y
	23	**Randomization allocation**	Y	N	Y	Y	N	Y	N	Y	Y	Y	Y	N	Y
	24	**Concealed randomization**	Y	N	Y	N	N	N	N	N	N	Y	N	N	Y
	25	**Adjustment for confounders**	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	U	Y
	26	**Participants lost to follow up**	Y	Y	Y	U	Y	Y	Y	Y	U	Y	U	U	Y
	27	**Power analysis**	Y	Y	Y	N	Y	N	U	U	N	U	U	N	N
TOTAL SCORE-28			**25**	**20**	**27**	**19**	**21**	**22**	**20**	**23**	**16**	**24**	**21**	**16**	**25**
			Good	**Good**	**Excellent**	**Fair**	**Good**	**Good**	**Good**	**Good**	**Fair**	**Good**	**Good**	**Fair**	**Good**

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

In the present version of the checklist, we modified the scoring of item 27 that refers to the power of the study. Instead of rating according to an available range of study powers, we rated whether the study performed or not performed power calculation.

Downs and Black score ranges were given corresponding quality levels as previously reported (Hooper, Jutai, Strong, & Russell-Minda, 2008): excellent (26-28); good (20-25); fair (15-19); and poor (≤14).

Table-3: Within group Outcome

Intervention	Study	Study Population	No significant improvement in Balance	Significant improvement in Balance
Ai Chi				
	Nissim[22]	Community dwelling elders		TBT (ES= .86),

	Kurt[24]	Parkinson's disease		BBS (ES= .33), Biodex – OBI (ES= .46), TUGT (ES= .95)
	Covill[25]	Parkinson's disease		BBS (ES= .47), TUGT (ES= .35)
	Skinner[27]	Community dwelling elders		TUGT (ES= .58), FRT (ES= - 0.20)
	Pérez-de-la-Cruz[28]	Parkinson's disease		TBT (ES= .24), TUGT (ES= .58)
WST (Halliwick Therapy)				
	Terrens[23]	Parkinson's disease	BBS- 47 (45-51.5) **	Mini BESTest 22 (14–27) **
	Tripp[30]	Stroke	FRT (ES = .67) *	BBS (ES= .76),
	Furnari[31]	Stroke		TBT (ES = .55), SMA [ES = 2.42 (I)& 2.35 (A)]
BRRM				
	Hyun-Gyun Cha[26]	Stroke		Biodex – OBI (ES = 2.6), TUGT (ES = 1.95)
	Kim[29]	Stroke		BBS (ES = 1.30), FRT (ES = 1.13), TUGT (ES = 1.13), OLST (ES = 1.49)
Combined				
Ai Chi + BRRM	Silva[21]	Elderly		TUGT (ES = 4.4), FRT (ES = 6.6)
Ai Chi + WST	Noh DK[33]	Stroke	RFC [ES = .41 (A); .007(I)], LWS [ES = .04(A); .03(I)]	BBS (ES = 1.03), FWS (ES = 1.14), BWS (ES = 0.72)
Ai Chi + BRRM + WST	Pompeu[32]	Parkinson's disease		BBS (ES = .4), TUGT (ES= .70)

* Control and experimental group have same results

** Median & IQR

(I) – Intact leg

(A) – Affected leg

TBT – Tinetti Balance Test; BBS – Berg Balance Scale; OBI – Overall Balance Index; TUGT – Timed Up and Go Test; FRT – Functional reach Test; SMA – Stabilo-metric Analysis; OLST – One Leg stand Test; FWS – Forward Weight Shift; BWS – Backward Weight Shift; RFC – Rise from Chair; LWS – Lateral Weight Shift.

Effect of interventions on balance outcome within the group

Table 3 organizes studies by the subject population and provides a summary of balance outcome results following Ai Chi, WST, BRRM, and combined intervention.

Effect of Ai Chi on Balance performance

Five studies [22], [24-25], [27-28], assessed balance control using Ai Chi as aquatic physical intervention. Participants for two studies [22], [27] were community-dwelling older adults; study [24-25],[28], was on Parkinson's Disease Patients. Allthe studies investigated the effects ofAi Chi on balance using a variety of balance outcome measuresincluding the Tinetti Gait and Balance Assessment Tool [22], [28]Berg Balance Scale (BBS), [24-25]Biodex-Overall Balance Index (OBI) [24], Timed Up and Go Test [24-25], [27-28]and Functional reach test [27]. Ai Chi intervention led to significant improvements in these balance measures with small effect sizes.

Twostudies[22], [27] assessed balance control in community-dwelling older adults, despite the variation in the dosage and duration, both studies demonstrated a statistically significant improvement in their outcome measurement scores of balances, Tinetti Balance Score ($p < 0.001$); and TUGT ($p = .03$) respectively with large effect size. One study[25]has 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.When the balance was measured by Biodex-3,1 (Version 3.1, Biodex Medical
Systems, Shirley, NY) in one study [24], the Ai Chi group improved significantly in terms of dynamic balance performance (Overall balance index $p<0.001$) along with TUGT with large effect size.

Hence, Ai Chi as aquatic physical therapy is effective in improving balance compared to any land-based therapy across any population but its efficacy over other aquatic therapy interventions is still unclear.

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

Three studies [23], [30-31]improved balance control using the Halliwick method as aquatic physical therapy intervention. The study population was stroke in two studies [23], [30]and Parkinson's disease in one study [31]. One study [23] compared Halliwick with traditional aquatic therapy and land-based therapy on Parkinson's disease patients. Halliwick aquatic group improved significantly in the Mini BESTest post-intervention ($p = 0.011$). In another study[30], despite significantly more subjects in the Halliwick-Therapy group (83.3% versus 46.7%) than the control group, attained significant improvement of the Berg Balance Scale ($P < 0.05$).

A Modular Clinical Electronic Baro-pedometer was used in one study [31] for stabilometric analysis in balance for stroke patients. Affected side vs unaffected side paresis too was analyzed. It was observed that in the halliwick therapy group a significant difference emerged in almost all the tests performed in stabilometric analysis.

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

Two studies [26], [29] improved balance control using BRRM as aquatic physical therapy intervention on the stroke population. Both the studies compared BRRM with land-based exercises.

The study population in these two trials had almost 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 with significantly increased effect size. In one of the studies [26] balance was measured by Biodex-3 and muscle activity using surface EMG. The study confirmed that the Bad Ragaz Ring methodsignificantly improved lower limb muscle activities anddynamic and static balance in patients with chronic stroke with a significant gain in effect size especially for Tibialis anterior and gastrocnemius muscles which helps in maintaining balance.

Effect of combined techniques on Balance performance

There were three studies [21], [32-33]where a combination of AiChi, WST, and BBRM has been used as an aquatic intervention. Ai Chi was common in all studies and was performed on three different populations, one being elderly, the other being stroke, and Parkinson's disease.

One study [21] combined Halliwick and BRRM as aquatic physiotherapy to assess the risk of fall/ balance in the elderly. Aquatic physiotherapy showed certain advantages compared to conventional physical therapy, promoting beneficial effects in balance and other outcome measures. Improvement was seen in FRT (p= 0.00002).

Another study[32] evaluated the balance of Parkinson's patients on stages (1-4) of the Hoehn and Yahr scale without any control group. Intervention program composed of a combination of Halliwick, Bad Ragaz Ring Method, and Ai Chi. There was a statistically significant difference among results before and after the intervention training evaluated by especially TUGT.

Another study [33] 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 the control group.

Table-3: Between Group Comparison

Comparison	Study	Balance		
		Intervention better	**Both similar**	**Comparison better**
Land Exercises				
	Silva[21]	TUGT (ES = **4.4**), FRT (ES = **6.6**)		
	Nissim[22]			
	Kurt[24]	BBS (ES= .33), Biodex – OBI (ES= .46), TUGT (ES= .95)		
	Tripp[30]		FRT (ES = .67)	
	Furnari[31]	TBT (ES =.55), SMA [ES 2.42(I) & 2.35 (A)]		
	Hyun-Gyun Cha[26]	Biodex – OBI (ES = 2.6), TUGT (ES = 1.95)		
	Kim[29]	BBS (ES = 1.30), FRT (ES = 1.13), TUGT (ES = 1.13), OLST (ES = 1.49)		
	Noh DK[33]	BBS (ES = 1.03), FWS (ES = 1.14), BWS (ES = 0.72)		RFC [ES = .41 (A); .007(I)], LWS [ES = .04(A); .03(I)]
Conventional Aqua therapy				
	Covill[25]		BBS (ES= .47), TUGT (ES= .35)	
	Terrens[23]	Mini BESTest 22 (14–27) **		BBS- 47 (45-51.5) **

** Median & IQR

(I) – Intact leg

(A) – Affected leg

TBT – Tinetti Balance Test; BBS – Berg Balance Scale; OBI – Overall Balance Index; TUGT – Timed Up and Go Test; FRT – Functional reach Test; SMA – Stabilo-metric Analysis;OLST – One Leg stand Test; FWS – Forward Weight Shift; BWS – Backward Weight Shift; RFC – Rise from Chair; LWS – Lateral Weight Shift

Effect of interventions on balance outcome between group

Table 4 summarizes all studies that compared Ai Chi, WST, BRRM exercise with a comparison group. These studies are grouped by 2 comparison intervention types: land-based exercise and conventional alternative aquatic intervention.

Aquatic interventions versus land exercises

Eight studies[21-22], [24], [26], [29], [30-31], [33] compared Ai Chi, WST or BRRM with the land-based exercises. All 8 studies found Aquatic interventions to provide greater improvement than land-based exercise for the balance measures, with effect sizes ranging from very small to large.

Aquatic interventions versus conventional aqua therapy

Two studies [23], [25] compared WST and Ai Chiwith conventional aquatic therapy exercises.A notable exception comes from one of the studies [23], which reported superior improvement observed in the Halliwick aquatic intervention group ($p = 0.011$, 95% CI).However, when compared to the typical aquatic intervention groups, the Halliwick aquatic intervention group had considerably lower Mini BESTest ratings at baseline.Lower Mini BESTest scores suggest poor balance.

On the other hand, another study[25] revealed no difference between Ai Chi and IBAT

usedBBS and TUGT to measure balance. The study concluded that Aquatic physical therapy as a whole irrespective of any intervention type improves balance overtime.

DISCUSSION

This systematic review has provided information about the therapeutic effects of three aquatic exercises viz Ai Chi, WST and BRRM on balance ability in selected neurological disorders, in comparison with land-based exercises [21-22], [24], [26],[29], [30-31], [33], other aquatic therapy methods [23]& [25] or with no comparison [27-28], [32]. The findings of the review highlighted that all the three aquatic technics might increase static and dynamic balance in community-dwelling older adults with balance impairments with/without other associated neurological disorders.

The quality of studies

Four Pilot trials are included in this review; 3-arm pilot trial [22], single-blind[23], pilot observational cohort [27],and RCT pilot trial[33]. SevenRCTs [21], [24-26], [29-31], one cohort [28] and one QES [32]are included in this review.RCT's demonstrated methodological flaws. Onlytwo of them [21], [23]described the randomization method in detail. There was a lack of concealment of allocation potentially leading to selection bias. Only three RCT [21], [25]& [30]

provided details of blinding. For randomization, sealed envelopes were prepared and were performed by a third party totallyunaware of the study content. Even the outcome measures were assessed by a physician who was blinded to treatment allocations.

Compared to RCTs, the study quality of pilot trials was good to excellent on Down's and Black criteria.

When considering the external validity of the studies in this review, the patients included in the studies were not representative of the neurological population. Sevenstudies [25-26], [28-30], [32-33] have small samples and FOUR studies reported consideration of powering the sample [21-23], [25].Small sample size can increase the risk of a Type II error and a false-negative result.[34]

Methodological and Reporting Concerns

In addition to the Black and Downcriteria items in Table 2 that werenot met in some studies, several reporting concerns deservediscussion.Two studies did not report pool water temperature or depth,which is an important factor with any type of aquatic exercise.

In a few studies,the aquatic intervention was not explained in detail. In addition, whereaquatic interventions were reported in enoughdetail to replicate the intervention, comparative exercise groupslacked details.

Finally,few studies had inconsistent or unclear reportingand the numerical data provided in the article did not matchthe written explanation. When results could not be confidently interpreted, we contacted authors.

WST on balance

This review was able to find three studiesexamining the therapeutic effects of the halliwick method of aquatic exercises on balance in elderly patients with/without neurological deficits. The overall findings show improvement in balance when WST is used. In Two studies where WST is used in combination with especially Ai Chi, improvement in balance was observed with large effect size.The methodological quality was fair to excellent. However, there was minimal change in balance was observedon the BBS outcome measure when it was compared with traditional aquatic therapy intervention.

In spite of having different study population, the efficacy of WST in balance improvement across population have been proved.

Montagna et al in 2014 in their study also used the principle of Halliwick (2x of 40 minutes per week) to improve balance and corporal symmetry in stroke survivors.After the intervention, participants had a significant improvement on their static balance measured by the Berg Balance scale and TUG.[35]

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 [33]

Clinical Ai Chi on balance

Just over half of the research in this review assessedthe effects of Ai Chi on balance. The common outcome measurement tool used for balance is BBS & TUGT. All the study's findings indicated improved balance across all study populations. Like WST, when Ai Chi was compared with impairment-based Aquatic therapy (IBAT) intervention, it revealed nodifference between Ai Chi and IBAT in any of the outcome measures.

However, in 2020 study by Ku PH et al evaluated the effectiveness of Ai Chi on balance in individuals with chronic strokes compared with conventional water-based exercise. While both groups improved significantly on BBS and FMA, the Ai Chi group showed significantly better results than the control group ($p = 0.025$).[36]

Improvement after AiChi may be attributable to the buoyancy of water supporting body weight and enhancing the ability to move.Balance might also be achieved by turbulence and resistance in the water.[37]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. Participating in a group or having an instructor guide them can improve patients' compliance, motivation, and adherence to exercise.[38]

BRRM on Balance

This research found very limited studies on BBRM. Studies, where BBRM is used in combination with other aquatic therapy techniques, are also included. All studies reported favorable benefits in improving balance using the techniques.

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 the intervention of aquatic exercise program applied PNF patterns improved the balance performance in people who had a stroke.[39]

The reason for the increase in balance can be due to the following reason- when Bad Ragaz Ring Method was applied underwater, muscle activation and proprioception for maintaining balance and stabilizing the trunk are enhanced.[12]

The bulk of findings from all the studies on balance outcome followed a similar pattern: superiorimprovement following these Aquatic interventions compared with land-basedexercise and similar improvement following analternative aquatic exercise program. This suggests the Water medium in itself facilitates core stability which in turn can improve balance, however administrating these technics in water medium will hasten the process of balance recovery. Aquatic exercise is not clearly superior to land-based exercise in all respects, according to the literature.In any case, it is well documented that various forms of exercisetherapy are effective to improve balance[40-44].Exercise in the aquatic environment provides the added benefits of buoyancy and hydrostatic pressure that result in greater ease of movement, allow more time to use balance strategies, and decrease fear of falling. [45]

The three technics (Halliwick method, BRRM & Clinical Ai Chi) of aquatic therapy uses different water principles to achieve the same results.

All of these methods require specialized training to ensure maximum effectiveness.

Limitations of the review

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

No studies included where the balance impairment is due to orthopedic or other issues in the 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. Multiple outcome measures used in the studies halted the statistical calculation and comparison of effectiveness among these studies. The review can therefore not be generalized.

Implications for Research

There are very limited numbers of high-quality RCTs assessing the effects of individual aquatic exercise methods amongelderly patients with or without neurological conditions. More RCTs with upgraded methodological quality are required. Furthermore, the majority of studiesareeither pilot trials or QES,it may have been underpowered to detect clinical effects due to the small number of participants. Future research should aim to focus on larger sample sizes to provide a better estimation of intervention effects.
Moreover, intervention and assessment must be made by a physiotherapist or trained professional and assessors who are blinded to group allocation. The outcome measure must also be standardized for statistical tests and meta-analyses to be replicated.

Many neurological/ orthopedic conditions may cause long-term impairment of balance and gait in the elderly. A long-term follow-up of outcomes was not included in any of the trials.Future research should examine the influence of each technic individually with long-term follow-up.

CONCLUSION

This review identified thirteenstudies that investigated the effect of WST, Ai Chi, and BRRM on balance in elderly patients.Study characteristics, treatment protocols, and outcome measurements varied greatly.Consequently, there is no way to compare studies due to their heterogeneity. Study participants showed evidence of balance and gait impairment which is likely due to differences in their balance mechanisms and the nature of their clinical disorder. Aquatic exercise may be more or less effective based on the nature of the underlying disease and impairment.
The overall methodological quality of eligible trials in the review was fair to good and eight RCTs were found. There is some missing information (i.e., adverse effects) and inadequate descriptions of population characteristics (i.e., duration of symptom and baseline impairment) that may compromise the reliability and validity of the included studies.
Based on the finding of this review, the administration of all three forms of aquatic exercise programs potentially offers short-term benefits on balance in the elderly. In one study, it has been demonstrated that combining all three forms of aquatic exercise is effective in improving balance in PD.[32]
When Ai Chi was compared with conventional impairment-based aquatic therapy (IBAT) for older adults with balance deficits, there were no significant differences found in balance measures, balance confidence, or pain levels for community-dwelling older adults between the Ai Chi and IBAT programs.[25]
Study [26]supports the use of BRRM to improve balance in chronic stroke patients due toimprovement in lower limb muscle strength.

In conclusion, the findings of this review suggest that therapeutic benefits are gained from the use of these technics in water for patients with balance deficits. However, the superiority of aquatic exercise programs over other interventions (i.e., conventional aquatic therapy programs, conventional physiotherapy, land-based exercises) and between them is unclear due to the limitations of existing research.These results can guide researchers to develop higher-quality research to further investigate the benefits of
WST, Ai Chi, and BRRM on balance in elderly.

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