

## **The effect of water based exercises on fall risk factors: a mini-review**

Dr Esther Vance, Professor Stephen Lord

Falls and Balance Research Group, NeuRA.

There is considerable evidence from systematic reviews and meta-analyses that exercise programs that challenge balance can prevent falls in older people living in the community ([1-3]. A recent Cochrane review concluded that multicomponent group exercise significantly reduce the rate of falls (number of fall events in a given population) by 29% (RaR 0.71, 95% CI 0.63 to 0.82, 16 trials, 3622 participants) and the risk of falls (number of people who have fallen in a given population) by 15% (RR 0.85, (95% CI 0.76 to 0.96, 22 trials, 5333 participants). The exercise programs included in these reviews have been land based programs, and to date no randomised controlled trials of water based programs have been conducted with falls as an outcome measure.

Water based exercise programs are often recommended for older people with musculoskeletal conditions such as arthritis as water provides a buoyancy-supported environment that is less stressful on joints [4]. In a Cochrane review on aqua exercises for the treatment of knee and hip osteoarthritis, Bartels and colleagues (2007) concluded that water based exercises had beneficial short term effects on function and quality of life [5]. There were however too few studies to provide further recommendations on the use of aqua exercise in the treatment of hip and knee osteoarthritis [5].

For the current review, we searched Medline and PubMed to identify randomised controlled trials that evaluated the effects of water based exercises on fall risk factors such as poor balance control and reduced strength. Thirteen studies were identified, however eight were of low quality with Physiotherapy Evidence Database (PEDro) scale scores <6 [6], so were not considered further in this article.

The five higher quality studies (PEDro scores  $\geq 6$ ) are listed in Table 1. These studies all involved community dwelling people aged over 40 years; with four of the five studies focusing on specific populations: i.e. those with osteoarthritis, osteopenia or osteoporosis or an increased risk of falls. Brief summaries of the study findings are outlined below and in Tables 1 and 2.

In their study on adults with osteoarthritis of the knee or hip, Wang and colleagues (2007) found that an aquatic exercise program over 12 weeks led to a statistically significant improvement in knee and hip flexibility, strength and aerobic fitness compared to a non-exercise control group, but there was no effect on self-reported physical functioning and pain [7]. They concluded that there were short term beneficial effects of an aquatic exercise program on physical functioning in adults with knee or hip osteoarthritis [7].

The study by Foley and colleagues (2003) compared 6-week gym-based and aqua exercise programs with no-exercise (control group) in older people with osteoarthritis [8]. This study found that the gym program significantly improved quadriceps strength compared with the control group whereas the aqua exercise hydrotherapy program significantly improved quadriceps strength in the left leg

only. [8]. Both groups also resulted in significant improvements in walking speed and distance walked in the 6 minute walk test compared with the control group.

The study by Arnold & Faulkner (2010) also involved older adults with osteoarthritis and comprised an 11 week water based exercise program (two session/week) administered either as a stand-alone intervention or combined with fall prevention education. They found that the combined program significantly improved chair stand test performance and falls efficacy (i.e. reduced concern about falling). The aquatic exercise program alone, however did not result in any significant improvements in either fall risk factors or falls efficacy [9].

Hale and colleagues (2012) compared a water based twice weekly program for 12 weeks (with exercise time increasing from 20 to 60 minutes) with a control program of a time-matched computer training program in women with mild to moderate osteoarthritis [10]. This study found that neither program significantly reduced fall risk as measured by the Physiological Profile Assessment (PPA short form). Both groups showed significant improvements in the Step Test (i.e. the number of times a participant can step onto and then off a 7.5 cm step in 15 seconds, with each leg is tested separately) at follow-up.

The 10-week randomised controlled trial by Deveraux (2005) and colleagues comprised women with osteoporosis and the intervention group received both a weekly water based exercise program as well as a short (10minute/week) education program related to osteoporosis, medications, footwear, physical activity, goal setting, home exercise, fall risks and hazards. The control group was requested not to change their physical activity or social habits during the study period [11]. This study found significant between-group improvements in left and right Step Test performance and physical functioning as well as in quality of life measures (SF36 Health Survey), but no differences in falls efficacy as measured with the Modified Falls Efficacy Scale [11].

In summary, the above studies report improvements in some measures of strength, balance, flexibility, fitness, falls efficacy and quality of life. Adherence to the programs has been relatively good (ranging from 65% to 82%) indicating that water exercise is an acceptable intervention for older people, including those with clinical conditions such as osteoarthritis. However, some caution in evaluating these findings is required. First, the pattern of beneficial effects across physical and emotional domains has been inconsistent (see Table 2). Further, each study used different exercise protocols, different trial periods (6 -12 weeks) and different outcome measures; factors that make comparisons between the studies difficult. Three studies also had limitations in that they contained sampling biases due to sub-optimal recruitment processes [8, 10, 11] and in two studies the assessors were not blinded to group allocation [7, 11].

The study by Arnold & Faulkner [9] demonstrated that beneficial effects were only evident in the group randomised to water based exercise classes supplemented with an education session that included information on fall risk factors and prevention strategies and reinforcement with respect to translating the exercises to activities of daily living and further practice of the exercises on the land. This indicates that in addition to water-based exercise, additional fall prevention components may be required to gain important fall prevention benefits.

A previous systematic review has shown that exercise programs that are most effective in reducing falls are those that not only include balance-challenging exercises but also have a high dose, i.e. 2

hours/week for 6 months or more [1]. The studies included in this review did not meet this recommended mode and volume of exercise, all being completed within 12 weeks. While sufficient for measuring beneficial effects on physical outcomes, such short term programs are unlikely to have enduring benefits with respect to fall prevention.

In conclusion, the research conducted to date provides only limited evidence that water based exercise programs can improve strength, balance and quality of life measures. However, importantly, while these outcome measures are known fall risk factors, these findings do not necessarily translate to preventing actual falls. High quality studies are needed to provide definitive evidence that water based exercise programs are effective in improving strength, balance, stepping and gait and for preventing falls in older people.

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**Table 1 Details of included water based exercise studies (RCT=randomised controlled trial, SD=standard deviation)**

Authors and Year	Study Design (PEDro score)	Participant characteristics	Intervention	Outcome measures	Main findings
Foley, Halbert, Hewitt & Crotty 2003 [8]	Single blind, three arm RCT (8/10)	105 Community dwelling adults with osteoarthritis 70.9 years (SD 8.8 years), 52% women	Hydro exercises (n=35) Gym (n=35) Control (n=35) 2 exercise groups 3 x 30min sessions/week for 6 weeks	Quadriceps strength, 6 minute walk test, Western Ontario and McMaster Universities WOMAC, OA Index, Adelaide Activities profile and SF-12 Health Survey, Arthritis self-efficacy questionnaire	Hydrotherapy group ↑ left quadriceps strength, Gym group ↑ left and right quadriceps strength. Walking speed and distance ↑ in both exercise groups Arthritis self-efficacy score improved in gym group
Deveraux, Robertson & Briffa 2005 [11]	RCT with concealed randomisation (7/10)	50 community dwelling women with diagnosis of osteopenia or osteoporosis 73.3 years (SD 3.9 years), 100% women	Intervention (n=25) water based exercise (50 minutes) and education (10 minutes) per week conducted by Physiotherapist for 10 weeks Control (n=25)	SF 36 Health Survey, Modified Falls Efficacy Scale (MFES), Step Test (maximal times a participant can step up onto and down from a single step in 15 s)	Significant improvement in Step Test and the physical functioning, vitality, social functioning and mental health domains of the SF36 in the intervention group compared with control group.
Wang, Belza, Thompson, Whitney & Bennett 2007[7]	RCT, two group convenience sample (6/10)	38 community dwelling adults with osteoarthritis 66 years (SD 12), 84% women	Exercise (n=20) water based (1 x 50 min session/week for 12 weeks) Control (n=18)	6 minute walk test, flexibility, muscle strength, 14 items on ADL on Health assessment Questionnaire (MDHAQ)	Exercise group showed significant improvement in knee and hip flexibility and strength and aerobic fitness (six minute walking distance), no effect on self-reported physical functioning and pain.
Arnold & Faulkner 2010 [9]	Single blind, three arm RCT (6/10)	79 community dwelling with hip osteoarthritis and at least 1 falls risk factor Aquatic Exercise + education (A+E): 73.2 (SD 4.8 years), 71% women Aquatic Exercise (A): 74.4 (SD 7.5 years), 77% women Control: 75.8 (SD 6.2 years), 64% women	A+E (n=28) 2 x 45 min/week Aquatic Exercise and education 30 min/week for 11 weeks A (n=27), 2 x 45 min session/week aquatic exercise for 11 weeks Control (n=27)	Berg Balance Scale, 6 min walk, 30s chair stand, Activities and Balance Confidence (ABC) scale and Timed up and Go TUG <sub>COG</sub> (included a cognitive task while completing standard test)	A+E significant improvement in number of chair stands and for ABC scale compared with A and Control group (for completers).
Hale, Waters & Herbison 2012 [10]	RCT, two arm concealed randomisation (8/10)	39 community dwelling with mild to moderate osteoarthritis and risk of falling Intervention: 73.6 (SD 1.5) years, 74% women Control :75.7 (SD 1.1 years), 75% women	Water based program (n=23) 2x/week for 12 weeks progressed from 20 to 60 min sessions over first 9 weeks of the program Control Group (n=16)- time matched computer training program	Short form PPA Step Test, TUG WOMAC, Arthritis Impact Measurement Scale 2- short form AIMS2-SF, ABC scale	No significant between-group difference found for any outcome measured. Two PPA items (contrast sensitivity and reaction time) improved significantly in the control group. The Step test improved significantly in both groups.

**Table 2**

**Significant improvements in water exercise groups (between group comparisons)**

<b>Study</b>	<b>Strength</b>	<b>Balance</b>	<b>Fitness #</b>	<b>Flexibility</b>	<b>Falls Self Efficacy / Balance Confidence</b>	<b>Quality of Life Measures</b>
<b>Foley et al 2003</b>	√	-	√	-	-	√
<b>Deveraux et al 2005</b>	-	√	-	-	X	√
<b>Wang et al 2007</b>	√	-	√	√	-	X
<b>Arnold &amp; Faulkner 2010 - Aquatic Exercise</b>	X	X	X	-	X	X
<b>Arnold &amp; Faulkner 2010 - Aquatic Exercise + education</b>	√	√	X	-	√	√
<b>Hale et al 2012</b>	X	X	-	-	X	X

√ significant improvement, X no significant change, - not examined

# Six minute walking distance

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