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| **CRITICALLY APPRAISED TOPIC** |

**FOCUSED CLINICAL QUESTION**

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| In a 70 year old male, is aquatic therapy more effective than no intervention or land-based therapy to improve functional balance and gait? |

**AUTHOR**

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**CLINICAL SCENARIO**

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| **Clinical Scenario:**A 70 year-old male was referred by his MD to an outpatient physical therapy clinic with a prescription to evaluate and treat falls risk. The patient was 6’3’’, weighed 170lbs, and reported loving swimming in his pool at home and playing golf with his neighbourhood friends; he used to walk the course, but now rides in the golf cart because of fatigue and instability with walking long distances. The patient lived in a 2-story home on the golf course with his supportive wife and has grown children that live 50+miles away. The patient reported eating balanced home-cooked meals on a regular basis and attending all necessary doctors appointments. The patient does not use an assistive device. The patient is the former CEO of a large company and money for PT visits is not an issue, even if insurance runs out. **Rationale:** Physical Therapists are well equipped to evaluate and treat patients who have had a fall or who are at a high risk of falling.1 As the baby boomer population ages, the incidence of falls is likely to increase. With 20% of the population estimated to be over the age 65 from 2030-2050, physical therapists will have their hands full with patients and clients that require functional balance and gait training.2 For patients who enjoy being in the water and who have access to a pool, aquatic therapy is an ideal medium. Water provides surrounding protection that decreases the patient’s fear of falling, load on joints, and edema.3 Water has many properties that can be taken advantage of when treating patients. Properties of water include but are not limited to, buoyancy, relative density, hydrostatic pressure, resistance, refraction, and the fluid dynamic properties of water.3 Patients who are at a high risk of falling secondary to decreased balance and an unsteady gait pattern can benefit from physical therapy. For practitioners and clinicians who have access to a pool, aquatic therapy could be an enjoyable starting point for this patient population. I am proposing this clinical question to see if aquatic therapy would be more effective than land-based interventions in treating a patient who has decreased balance and an unsteady gait pattern.  |

**SUMMARY OF SEARCH**

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| Although there have been many studies conducted comparing aquatic therapy versus land based therapy, I was only able to find one study that specifically addressed body composition and physical performance. Much of the literature addresses specific patient populations such as Osteoarthritis, Stoke, Parkinson’s Disease, Fibromyalgia, Cerebral Palsy, Multiple Sclerosis, Total Joint Replacements, etc. The overall quality of the 7 randomized controlled trials consistently scored between 6 and 8 out of 11 possible points. Of the 3 systematic reviews, Scores ranged from 6-11 out of 11 total points. The systematic reviews provide better insight into the overall picture of aquatic therapy versus land therapy in the OA and Neurological patient populations |

**CLINICAL BOTTOM LINE**

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| Based on available research, there are positive findings that indicate the use of aquatic therapy for older adults. While limited information is available that specifically addresses balance and gait, there is a small body of recent evidence that supports the use of aquatic therapy for many conditions including stroke, OA, and healthy older adults with limited co-morbidities. Each of the studies reported that participation rates were high and drop-out rates/adverse events were low, thus indicating that aquatic exercise were a safe and appropriate medium for therapeutic interventions. Aquatic exercise and therapy is beneficial for numerous reasons, ultimately depending on the patient or client and their condition.  |

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| ***This critically appraised topic has been individually prepared as part of a course requirement and has been peer-reviewed by one other independent course instructor*** |

**SEARCH STRATEGY**

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| **Terms used to guide the search strategy** |
| **P**atient/Client Group | **I**ntervention (or Assessment) | **C**omparison | **O**utcome(s) |
| MaleOlder Adult\*ElderlyGeriatric  | Aquatic TherapyHydrotherapyAqua TherapyWater Therapy Aquatic exerciseAquatic rehabilitationWater | Land-Based TherapyLand TherapyLand exerciseRehabilitationExercise  | BalanceFunctional BalanceGait Functional GaitFunctionWalk\*Ambulat\*Falls risk |

**Final search strategy:**

PubMed Search Strategy-115 results

1. Search “Older adult\*” OR Elderly OR Geriatric
2. Search “Aquatic therapy” OR Hydrotherapy[mesh] OR “Aqua therapy” OR “Water therapy” OR “Aquatic exercise” OR “Aquatic rehabilitation” OR aquatic[ti] OR water [ti]
3. Search “Land-based therapy” OR “Land therapy” OR “Land exercise” OR Rehabilitation[mesh] OR land[ti] OR exercise[ti] OR therap\*[ti] OR exercise therapy[mesh]
4. (Gait OR Walk\* OR Ambulat\* Or Balance Or Fall) AND Function Search
5. #1 AND #2 AND #3 AND #4

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| **Databases and Sites Searched** | **Number of results** | **Limits applied, revised number of results (if applicable)** |
| **PubMed** | **115** |  |
| **CINHAL** | **231****70** | **Full text limit applied** |
| **PEDro** | **27** |  |

## INCLUSION and EXCLUSION CRITERIA

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| **Inclusion Criteria** |
| 1. Published in English
2. Published 1990-September 2015
3. Randomized controlled trials, controlled trials, uncontrolled trials, systematic reviews, or meta-analysis
4. Peer Reviewed
5. Outcome measures used before and after intervention
6. Intervention population of older adults, preferably male who have decreased balance and gait.
7. Comparison of aquatic therapy rehabilitation versus land-based rehabilitation or control group
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| **Exclusion Criteria** |
| 1. Levels of evidence 3-5 in hierarchy
	1. Ex. Case studies, case series, qualitative studies, narrative review articles, expert opinion papers, abstracts, or dissertations
2. Articles published prior to 1990
3. Articles without a comparison group
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**RESULTS OF SEARCH**

**Summary of articles retrieved that met inclusion and exclusion criteria**

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| **Author (Year)** | **Study quality score** | **Level of Evidence** | **Study design** |
| **Arnold, C., and Faulkner, R. (2010)4** | Pedro 8/11 | 1b | Randomized Controlled Trial |
| **Avelar et al. (2010)5** | Pedro 6/11 | 1b | Randomized Controlled Trial (Prospective)  |
| **Bergamin et al. (2013)6** | Pedro 7/11 | 1b | Randomized Controlled Trial |
| **Foley et al. (2003)7** | Pedro 8/11 | 1b | Randomized Controlled Trial  |
| **Mehrholz et al. (2011)8** | AMSTAR 6/11  | 1a | Systematic Review |
| **Marinho-Buzelli et al. (2015)9** | AMSTAR 11/11 | 1b  | Systematic Review |
| **Noh et al. (2008)10** | Pedro 7/11 | 1b | Randomized Controlled Trial (Pilot) |
| **Vivas et al. (2011)11** | Pedro 7/11 | 1b | Randomized Controlled Trial (Open Label Pilot) |
| **Volpe et al. (2014)12** | Pedro 8/11 | 1b | Randomized Controlled Trial (Single Blind) |
| **Waller et al. (2014)13** | AMSTAR 10/11 | 1a | Systematic Review with Meta-Analysis |

**BEST EVIDENCE**

The following 3 studies were identified as the ‘best’ evidence and selected for critical appraisal. Reasons for selecting these studies were:

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| * Mehrholz et al.8 Water-based exercises for improving activities of daily living after stroke. Systematic Review.
	+ The Mehrholz article is a Cochrane Review and scored 11/11 on the AMSTAR, lending great insight into the studies available comparing aquatic therapy and land therapy with the neurologic population. Although my PICO question is unrelated to a neuro population, the information can be applied adequately, as it is a systematic review encompassing the elderly population.
* Waller B. et al.13 Effect of Therapeutic Aquatic Exercise on Symptoms and Function Associated With Lower Limb Osteoarthritis: Systematic Review With Meta-Analysis.
	+ There is a large amount of literature on Osteoarthritis and aquatic therapy including systematic reviews, meta-analyses, and Cochrane Reviews, but this systematic review is the most up to state review of the literature on OA and aquatic therapy. This study scored a 10/11 on the AMSTAR and emcompases a few of the other studies I evaluated on the PEDro Scale. This is also the only study found with a well-conducted meta-analysis.
* Bergamin M, Ermolao A.6 Water-versus land-based exercise in elderly subjects: effects on physical performance and body composition. Randomized Controlled Trial
	+ Although the Bergamin et al. articles only scored a 7/11 on the PEDro scale, the study most closely relates to my PICO question in that it uses a healthy population of older adults instead of a specific patient population such as Osteoarthritis, Stroke, Parkinson’s Disease, etc. This Randomized Controlled Trial included not only a land and aquatic intervention, but also a control group to assess both interventions compared to no intervention.
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**SUMMARY OF BEST EVIDENCE**

**(1) Description and appraisal of the Effect of Therapeutic Aquatic Exercise on Symptoms and Function Associated with Lower Limb Osteoarthritis: Systematic Review with Meta-Analysis by Waller B et al. (2014)13**

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| **Aim/Objective of the Study/Systematic Review:** |
| The objective of this Systematic Review and Meta Analysis of Randomized Controlled Trials was to determine the effect of therapeutic aquatic exercise on the function and symptoms in individuals who have lower extremity osteoarthritis. |
| **Study Design** |
| **Search Strategy:** * Systematic Review and Meta Analysis of Randomized Controlled Trials including articles published prior to December 1, 2013.
* Literature search through 6 databases (Medline, PubMed, CINHAL, SPORTDiscus, PEDro, and EMBASE) by combining the following key words: “hydrotherapy”, “water exercise”, “aquatic exercise”, “aquatic therapy, “water rehabilitation”, “aquatic physical therapy”, or “aquatic rehabilitation” with “osteoarthritis”, “OA”, or “arthritis”.

**Selection Criteria:*** 2 independent reviewers assessed articles and required a full agreement for inclusion in this study. When disagreements occurred, a third reviewer settled the decision.
* Duplicates and non-aquatic studies were discarded; remaining full text manuscripts were received and read by each reviewer.
* Each study included was required to be in English, have a Randomized Controlled Trial (RCT) Design, and fulfil criteria according to PICOS.
* The study population required individuals to be clinically diagnosed with OA in one or more joints of the lower extremity with no age or gender limitations. All included studies required outcome data before and after the intervention. The aquatic intervention group required full body immersion with no limitations to they type of aquatic intervention or outcome measure used. The comparison group was required to receive normal care or a sham therapy and was unable to participate in a land or water based program. Studies were also excluded if their PEDro score was equal to or less than 5 to exclude having studies with a high risk of bias or low methodological quality.

**Quality Assessment:*** Each RCT was scored by 2 reviewers on the PEDro Scale, a reliable and valid 11-point scale assessing methodological quality or risk of bias.
* The authors concluded that therapeutic aquatic exercise studies had the maximum capability of scoring an 8/11 secondary to difficulties blinding patients and therapists.
* Scores equal to or greater than 7/11 were considered to have high methodological quality, while those RCT with scores equal to or less than 5/11 were considered to have low methodological quality.

**Data Collection:*** 2 reviewers extracted data and were checked for accuracy by a third reviewer.
* Data collected included a description of the interventions, the RTC’s inclusion and exclusion criteria of participants, baseline and post-intervention data, any further follow up data, and outcome measures used.
* Original authors were contacted by reviewers and asked for means and standard deviations if such data was not presented in the published article.
* Outcomes were divided into 5 categories that included pain, stiffness, self-reported functioning, physical performance measures, and quality of life.
* Effect Size (ES) was calculated as the Standard Mean Difference (SMD). ES (SMD) were considered small if value lied between 0.2-0.5, moderate if between 0.5-0.7, and large if equal to or greater than 8.

**Meta Analysis:** * All specific outcomes described below in the “Outcome Measures” section were used in the meta-analysis. In order to compare the various outcome measures included in each category, the SMD was used with a 95% confidence interval.

**Test for Heterogeneity:** * For all analyses, an Inverse-variance weight random-effects model that incorporates heterogeneity was used. ES is presented as SMD. Confidence Interval is 95%.
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| **Setting** |
| Although this study did not specifically state the setting of the interventions included, it is presumable that each study was completed in and near an aquatic facility that allows for full-body immersion. |
| **Participants** |
| * 1,234 potential studies were found. 1,197 studies were excluded based on the article title and content presented in the abstract. 37 full texts were read, excluding 26 more articles. 11 RCTs were kept and used in this Systematic Review and Meta-Analysis.
* 1,092 Participants were included. Mean Age 62-76 years. Average BMI 26.6-32.9 kg/m2. Approximately 73% of participants were females.
* Out of the 11 studies, 6 included hip and knee OA, 3 included only knee OA, 1 included only hip OA, and 1 study included any lower limb with OA.
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| **Intervention Investigated** |
| *Control* |
| * All studies in this Systematic Review and Meta Analysis were required to have control groups that did not receive an exercise intervention (land or water based), but did receive continued usual care or participation in a sham intervention.
* Control Groups were required to participate and complete outcome measures in each study.
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| *Experimental* |
| * Each study completed full body water emersion therapeutic aquatic exercise (TAE).
* The duration, frequency, dose, intensity, exercise selection, and adherence for each TAE was different, unique to each individual study completed.
* TAE dose varied between 100-180 minutes per week for the course of 6-52 weeks.
* TAE subjects participated 2-3 times per week, with 2 times per week being the most common (n=7)
* Many studies did not report pool depth and temperature, but of the studies that did…
	+ Pool depth varied from 0.94 meters to 1.3 meters
	+ Pool temperature varied from 28°C to 34°C
* Reported TAE interventions included: Arthritis Foundation Aquatics Program (AFAP), upper and lower limb flexibility, range of motion, strength exercises, warm ups/cool downs, aerobic training, endurance exercises, and stretching.
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| **Outcome Measures**  |
| * Details in relation to who administered the tests/retests and where tests were administered was not provided.
* Outcome measures were categorized into 4 classifications according to their design and constructs:
	+ Pain and Stiffness, Self-reported Function, Physical performance Measures, and Quality of Life.
* If more than one outcome measure was used in a single study, then only one was picked to be included in this Systematic Review and Meta Analysis by means of a pre-described hierarchy.
	+ For Quality of Life, the SF-36 and SF-12 were ranked higher than other outcome measures.
	+ The SF-36 mental health section was used over the SF-role of mental health.
	+ Physical functioning tests were categorized into 3 groups:
		- Activity, muscle strength, and range of motion
	+ Outcomes that included different constructs were used in cases were there were disagreements about which tests to include.
		- Timed Up and Go (TUG) inclusion instead of Walking Ability
	+ Isokinetic strength was measured in newton/meters.
	+ Data from the right side of bodies were used unless studies included both affected and non-effected limb data.
* Pain and Stiffness Outcomes included:
	+ Health Assessment Questionnaire (HAQ), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) for pain (0-20 or 0-100) and stiffness (0-8), Visual Analogue Scale (VAS) for Pain (0-10 or 0-100), and the Knee Injury and Osteoarthritis Outcome Score (KOOS) symptoms (0-100).
* Self-reported Function Outcomes included:
	+ HAQ (14 question, 0-3), WOMAC function (0-68, 0-100, or 0-1,700), WOMAC global (0-96), Activities and Balance Confidence Scale (0-100), KOOS ADL (0-100), and KOOS ADL and sports recreation (0-100)
* Physical Performance Outcomes included:
	+ Isometric knee extension (N, kg, Nm, or 60°/s, Nm), stair climb ascending (seconds), 6 Minute Walk Test (6MWT) (seconds), Range of Motion (ROM) (degrees), TUG (seconds), and the 30-second chair stand.
* Quality of Life Outcomes included:
	+ Perceived Quality of Life (QoL) scale (0-10), SF-12 Mental Component Summary (MCS) (25-70), SF-36 mental health (0-100), SF-36 MCS (0-100), Assessment of QoL scale (range=-4 to 100), and the KOOS QoL (0-100)
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| **Main Findings** |
| Therapeutic Aquatic Exercise (TAE) had clinically small but statistically significant effects on pain and stiffness, self-reported functioning, objectively measured physical functioning (range of motion and activity level), and quality of life. TAE did not show significant effects in relation to increasing muscle strength.* Pain and Stiffness
	+ Pain: SMD= 0.26, CI= 0.11, 0.41, overall effect z=3.48 (P=0.0005), and heterogeneity: I2= 17%
	+ Stiffness: SMD= 0.20, CI 0.03, 0.36, overall effect z=2.37 (P=0.02), and heterogeneity: I2= 0%
* Self-reported Functioning:
	+ SMD= 0.30, CI 0.18, 0.43, overall effect z=4.81 (P<0.00001), and heterogeneity: I2= 0%
* Physical Functioning Tests Combined: SMD=0.22, CI 0.07, 0.38
	+ Activity level: SMD= 0.22, CI 0.01, 0.42, overall effect z=2.10 (P=0.04), and heterogeneity: I2= 29%
	+ Range of Motion: SMD= 0.56, CI=0.14, 0.99, overall effect z=2.79 (P=0.005), and heterogeneity: I2= 0%
	+ *Strength: SMD= 0.13, CI=-0.17, 0.43, overall effect z=0.88 (P=0.38), and heterogeneity: I2= 55%*
* Quality of Life:
	+ SMD= 0.24, CI 0.04,0.45, overall effect z=2.33 (P=0.02), and heterogeneity: I2= 51%

\*All confidence intervals (CI) are 95% |
| **Original Authors’ Conclusions** |
| The use of a therapeutic aquatic exercise (TAE) is an effective intervention and should be considered a “frontline management option” to manage symptoms for individuals who have lower extremity osteoarthritis. Using a TAE program is favoured over no intervention specifically for pain and stiffness, self-reported functioning, physical functioning (activity and range of motion), and quality of life. TAE was not shown to have significantly improved muscle strength. |
| **Critical Appraisal** |
| **Validity:****Strengths**:* Selection criteria and quality assessment were adequately obtained.
* High methodological quality study selection; only studies with PEDro scores 6-8/11 were accepted.
* Using SMD to report ES allowed for combining various outcome measures used for each section of analysis.
* This study included 5 more studies and 431 more participants than the previous systematic review and meta-analysis conducted in 2006; this study included studies published prior to July 2010.

**Weaknesses:** * Using the SMD to report ES is difficult to apply clinically.
* Only one study included reported the MCID, therefore the MCID was unable to be generalized across the OA population studied.
* Authors did not exclude studies that were unsuccessful in obtaining the optimal amount of participants to meet their power calculation.
* This study included studies with various focuses: hip and knee OA, only knee/only hip, and any lower extremity OA.
* The lack of interval validity (sample size and baseline differences) and insufficient intervention intensity documented in each study that was used in this study.
* Each study’s version of TAE was unique, none of the studies reported using the same interventions or outcome measures.

**Methodological Quality: HIGH*** AMSTAR score= 10/11
* Level of Evidence= 1a
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| **Interpretation of Results** |
| The results of this study indicate that there is indeed a use for therapeutic aquatic exercise (TAE) interventions to treat and manage symptoms of people who have osteoarthritis (OA) in their lower extremities. The statistically significant effects found in this study can assist therapists when making decisions to include TAE in their treatment program. Although this study found significant effects on pain and stiffness, self-reported function, physical performance, and quality of life, the effect size was small and caution must be used when interpreting these results. Generally, these results have small effect size with small significance, but represent the efficacy of TAE to treat patients with OA; a finding that can support the use of aquatic therapy. In relation to muscular strength not obtaining statistical significance, there are many factors that play important roles. Given that exercise intensity was poorly described in the included studies, it is possible that there was insufficient intensity in the intervention used to produce changes in muscular strength. It is also important to understand the aims/purposes of each study because aquatic interventions with the OA population tend to be implemented to decrease pain and prevent an increase in lower extremity OA instead of targeting increases in muscular strength. *Interpretation of secondary findings that were briefly reported:* Although this study reports that one study followed up with patients at the 3 and 6 months, more data is needed to understand TAEs effects in the long term. This study concludes that there were adverse effects in each of the studies used, thus indicating that TAE is not for everybody and that pain may increase with activity. This study also reports each individual study’s adherence and percentage of people that dropped out. In each study, adherence was high and drop out rates were low, possibly indicating that the participants felt as if the intervention was working or they simply enjoyed the interventions in the pool. Lastly, because there is a lack in uniformity between the studies designs and outcome measures used, this study is unable to reach any conclusion in relation to the mode, dose, frequency, intensity, and duration of the TAE. Each patient seen clinically must be assessed and treated individually, varying the mode, dose, frequency, intensity, and duration of all exercises based on the patient’s presentation and goals. |

**(2) Description and appraisal of Water-based exercises for improving activities of daily living after stroke by Mehrholz, J., Kugler, J., and Pohl, M. (2011)8**

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| **Aim/Objective of the Study/Systematic Review:** |
| The objective of this Cochrane Review was to quantitatively measure and evaluate the effectiveness of aquatic exercises to improve activities of daily living (ADLs), walking, strength, postural balance, and overall fitness after a stroke.  |
| **Study Design** |
| **Search Strategy:** * Systematic Review of Randomized Controlled Trials (RTCs) including articles published prior to April 2010.
* Literature search of 9 databases, Cochrane Stroke Group Trails Register, Cochrane Central Register of Controlled Trials, MEDLINE, EMBASE, CINAHL, AMED, PEDro, and OT Seeker.
* In addition the authors searched for other published, unpublished, and ongoing trials that were not available in major data bases by checking reference lists, ongoing trials and research (Internet Stroke Center Stroke Trials Registry, ClinicalTrails.gov, and Current Controlled Trials), contracting trialists and researchers, and hand searching 7 journals: World Congress of NeuroRehabilitation (3-6th), World Congress of Physical Medicine and Rehabilitation (2001, 2003, 2005, 2007, 2009), World congress of Physical Therapy (2003 and 2007), Deutsche Gesellschaft für Neurotraumatologie und Klinische Neurorehabilition (2001 to 2008), Deutsche Gesellschaft für Neurologie (2000 to 2009), Deutsche Gesellschaft für Neurorehabilitation (1999-2009), and Asian Oceania Conference of Physical Rehabilitation (2008).

**Selection Criteria:*** One independent review author read the titles and abstracts (when available) and discarded irrelevant studies. Two other review authors assessed the remaining studies based on predetermined inclusion and exclusion criteria. The full text from the remaining articles was obtained and two additional authors reviewed these studies and ranked them as relevant, irrelevant, or possibly relevant.
* Disagreements were solved via discussions between the review authors or by contacting trialists to obtain missing information.
* Studies/trials written in all languages were acceptable. Translations to English were arranged when necessary.

**Quality Assessment:*** The review authors each independently assessed the included trials using the PEDro Scale to assess for their methodological quality. Three of the studies scored 5/10 (Aidar 2007, Chan 2010, and Noh 2008) and one study scored 6/10 (Chu 2004).
* Disagreements were solved via discussions between the review authors or by contacting trialists to obtain missing information.
* The authors intended to test the robustness of the main results via a post-hoc sensitivity analysis for concealment of allocation, ITT analysis, and blinding of assessors, but were unable to secondary to not obtaining enough studies.

**Data Collection:*** Two authors (the same who used inclusion/exclusion criteria to rule in/out a studies) each extracted data and outcomes from included trials by using a checklist to record the methods of randomization, methods of concealment of allocation, assessor blinding, ITT analysis, adverse events, drop outs, deaths, imbalances in prognostic factors, participant baseline data, comparison data, and outcomes/time points of measures.
* Disagreements were solved via discussions between the review authors, then by a third review authors, and lastly by contacting trialists to obtain missing information when necessary.
* Outcomes were divided into Primary Outcomes (ADL scales) and Secondary Outcomes (ability to walk, postural balance, muscular strength, and fitness).
* When appropriate, the authors calculated a pooled estimate of the mean difference, standardised mean difference, risk ratio, and risk differences all with 95% confidence intervals.

**Test for Heterogeneity:** * I2 was calculated for inconsistency across studies and when there was heterogeneity, the authors used a random effects model opposed to a fixed-effect model approach.
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| **Setting** |
| Although this study did not specifically state the setting of the interventions included, it is presumed that each study was completed in and near an aquatic facility that allows for full-body immersion. The authors distinguish water-based exercises in a pool from bathtubs, spa pools, mud baths, day spas, or the use of shallower water in the methods section of the paper.  |
| **Participants** |
| * 43 potential studies were found, 34 were deemed irrelevant and were excluded. 4 RTCs met all criteria and were included in this systematic review.
* 94 participants were included in this systematic review. Aidar n=31, Chan n=25, Chu n=13, and Noh n=25.
	+ All participants were required to be 18 or older and have had a stroke.
* Of the 3 studies that mentioned patient demographics
	+ Mean age of participants: 51-64 years of age.
	+ Gender: 24 F: 41 M
* Of the 2 studies that mentioned information about the participant’s strokes, the stokes occurred approximately equal on both the left and right sides, ranged in duration from 1.6 years to 4 years post stroke, and the type of stroke varied between ischaemic and haemorrhagic, favouring ischaemic slightly.
* Drop out rates were between 0 and 20%; No-adverse events reported.
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| **Intervention Investigated** |
| *Comparable/Control Group* |
| * Each study in this systematic review was required to have an aquatic group and a comparable non-water based intervention group or a control group.
* Studies were not included in this systematic review if they compared two different types of aquatic intervention.
* When stated, the reported comparable group’s exercise interventions included upper extremity function, gross/fine motor skills, muscle strengthening, general conditioning exercising, and gait training.
 |
| *Experimental* |
| * Treatment interventions were required to occur in a pool by a trained health professional such as a physical therapist/physiotherapist.
* Water-based exercises were required to be planned, structured, and repetitive.
* The duration, frequency, dose, intensity, exercise selection, and adherence for each TAE was different, unique to each individual study completed.
	+ Aquatic exercise dose ranged from 45 minutes to 60 minutes per session 2-3 times per week for 8-12 weeks.
* When stated, the reported aquatic exercise interventions included Ai Chi Halliwick methods to focus on balance and weight-bearing exercises, leg exercises for cardiovascular fitness, aerobic activity, and stretching.
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| **Outcome Measures** (Primary and Secondary) |
| **Primary Outcome:** Activities of Daily Living (ADLs)* The authors decided acceptable global measures of activities of daily living (ADL) would include the Barthel ADL Index (BI), Rivermead ADL Assessment, Rivermead Motor Ability Scale, Modified Rankin Scale, Functional Independence Measure (FIM), Katz Index of ADL, Rehabilitation Activities Profile, and the Motor Assessment Scale (MAS)
* Only one trial that included ADLs post intervention, Aidar 2007, where the Capacidad Functional Subscale of the Brazilian-Portuguese version of the SF-36 was used.

**Secondary Outcomes:** Ability to walk, postural balance, muscle strength, and cardiorespiratory fitness* Ability to walk measure: Functional Ambulation Categories (FAC)
	+ One trial measured walking speed with meters/second as their measurement. (Chu 2004)
* Postural balance measure: Berg Balance Scale (0-56, Higher number indicating great balance, lower number indicating falls risk)
	+ Two trials measured postural control with the Berg Balance Scale (Chu 2004, Noh 2008)
* Muscular Strength measure: Motricity Index
	+ One trial measured muscular strength via Nm/kg. (Chu 2004)
* Cardiorespiratory fitness measure: Heart Rate and Oxygen Consumption (VO2)
	+ One trial measured aerobic fitness (VO2maxml/kg/min) (Chu 2004)
 |
| **Main Findings** |
| Aquatic exercise was found to be statistically significant for improving ADLs and muscular strength for individuals who have had a stroke. The ability to walk, postural control, and cardiovascular fitness were not found to have statistical significance from the assessed aquatic exercise interventions. Unfortunately, these conclusions should be interpreted cautiously; these results are based on four small RCTs with a total of 94 participants, half assigned to a control/comparable group. Results were as follows:* *Activities of Daily Living*
	+ N=31; Mean Difference (MD)= 13.2; Confidence Interval (CI)= 8.36, 18.04; Test for overall effect Z = 5.35;**P < 0.00001**, heterogeneity = not applicable (n/a)
* Ability to Walk
	+ N=13; MD = 0.14; CI= -0.32,0.60; Z = 0.60; P = 0.55, heterogeneity = n/a
* Postural Balance
	+ N=38; MD = 3.05; CI = -3.41, 9.52; Z = 0.93; P = 0.35, heterogeneity: I2= 81%
* *Muscular Strength*
	+ N=13; MD = 1.01; CI = 0.19, 1.83; Z = 2.41; **P = 0.016**; heterogeneity= n/a
* Cardiovascular Fitness
	+ N=13, MD = 3.60; CI = -0.53, 7.73; Z= 1.71; P=0.087; heterogeneity= n/a

\*All confidence intervals (CI) are 95% |
| **Original Authors’ Conclusions** |
| The authors conclude that there is a lack of RCTs that have conducted aquatic exercise interventions post stroke and that more evidence is required to understand how aquatic exercise affects individuals post stroke. The authors neither confirm nor deny that aquatic exercises post stroke may assist with decreasing disability after stroke. The evidence from the gathered data found that use of aquatic exercise post-stroke is effective for increasing muscular strength and improving ADLs, but this data is based off of one study and should be interpreted with caution. The authors lastly note that adverse events and drop-outs did not appear to be more common in participants who received aquatic interventions, indicating that aquatic exercises were acceptable for the participants included in these 4 RCTs.  |
| **Critical Appraisal** |
| **Validity:****Strengths**:* This is the first systematic review comparing aquatic interventions to either a control or comparison group.
* There was a rigorous review process and checklist for all included articles.

**Weaknesses:** * Strict inclusion/exclusion criteria led to obtaining only small 4 RTCs for this systematic review.
* Most RTCs had methodological limitations.
* Each study was diverse with their interventions, outcome measures, and control/comparison groups.
* The authors did not receive information requested from the trialists.

**Potential Sources of Bias*** Publication Bias
* Small number of studies with a small number of participants and no long-term follows up.
* Generalizability of this study’s results in terms of representing the entire stroke population (Average age of this study 51-67; Average age of most stroke individuals is 65-74)

**Methodological Quality: HIGH*** AMSTAR= 11/11
* Level of Evidence= 1a
 |
| **Interpretation of Results:**The results of this study overwhelmingly indicates a lack of published literature regarding the use of aquatic exercise post stroke when assessing changes in ADLs, the ability to walk, postural balance, muscular strength, and cardiorespiratory fitness. While the authors found that ADLs and muscular strength statistically increased over the course of these 8-12 week aquatic exercise program, the numbers of participants the data is based on is very limited. All of the findings should be interpreted with caution because the data gathered for each measure was based off of one of the four studies included in the systematic review with the exception of postural balance. With such limited evidence, it is difficult to generalize these findings with entire post-stroke population, therefore aquatic exercise is neither supported nor opposed by this systematic review. The last finding the authors concluded was that there were no more drop-outs or adverse events with the participants in the aquatic group when compared to the control/comparable groups. This data is encouraging because it indicates that aquatic exercise was appropriate and well tolerated in these post-stroke individuals. This conclusion is an important finding when deciding if a patient post stroke would be eligible to participate in such a program. As was previously stated, each of the four studies included in this systematic review had their own unique treatment protocol, dose, magnitude, frequency, and duration of exercises preformed. If a therapist is going to recommend aquatic exercise, he/she should understand different types of aquatic exercises and monitor the magnitude, frequency, and duration of all exercises performed based on the patient’s response to activity.  |

**(3) Description and appraisal of Water versus land-based exercise in elderly subjects: effects on physical performance and body composition by Bergamin et al. (2013)6**

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| **Aim/Objective of the Study:** |
| The objective of this randomized controlled trial was to assess the effectiveness of a twenty-four week aquatic exercise program, carried out in geothermal spring water, to improve overall physical functioning and increase muscle mass for a group of healthy older adults. A second objective was to compare the aquatic intervention with both a land-based exercise intervention and a control group.  |
| **Study Design** |
| **Type of Study:** Randomized Controlled Trial (RTC)**Eligibility Criteria:*** Inclusion Criteria: Participants were required to be 65 year of age or older, have no exercise contraindications (cardiovascular, pulmonary, musculoskeletal, or abdominal- detected from a physical examination), and were not allowed to attended an exercise program or structured physical activity within the past 6 months.
* Exclusion Criteria: Participants were excluded from this study if they had a history of central nervous dysfunction or severe cardiovascular disease, angina, postural hypotension, use beta-blockers, or have myelopathies, ataxia, significant musculoskeletal deformities, such as an amputation or severe scoliosis, or any abnormalities/limited movement from painful arthritis.

**Allocation:** All subjects were randomly allocated to one of three groups: aquatic group (AG), land group (LG) or a control group (CG).**Intervention Overview:*** Each subject was given information about the study’s purpose/procedure and was required to accept it by providing written consent prior to participation in this study. Subjects were randomly allocated and baseline data and outcome measures were collected from each group prior to the intervention. The two experimental groups performed exercises according to the details below for 6 months. The control group continued with their lives, not changing their daily routine. After 6 months, all subjects completed the same testing and outcome measures.

**Data Collection and Specific Outcome Measures:*** Functional evaluations were performed prior to the beginning of the intervention (T0) and after the 24-week exercise program (T1).
* Outcomes included: Body mass and height, strength, dynamic balance, flexibility and body composition.
	+ *Specific are in the Outcome Measure Section of this paper.*

**Statistical Methods:*** All statistical analyses were completed using SPSS, results were stated as means ± standard deviation (SD) or percentage, and significance limits were set at P <0.05.
* Tests used:
	+ Kolmogorov-Smirnov Test: normal data distribution
	+ Levene’s Test: homogeneity of variance
	+ Student’s t-tests: evaluate before/after variables within each group
	+ One-way ANOVA: compare before/after differences between all 3 groups
	+ Post-hoc analysis with Bonferroni correction: analysis of interaction among groups.
 |
| **Setting** |
| * This study was conducted in the Veneto Region of Italy in the geothermal springs of the Euganean Basin.
* Pool depth ranged between 1.3 and 1.8meters (4ft 3in to 5ft 10in). Average pool temperature 36.2°C or 97°F
* Land-based activates were performed in a room that was 20.1°C or 68°F
 |
| **Participants** |
| * 59 total subjects recruited by 8 family physicians in the towns of Abano Terme, Montegrotto Terme, Battaglis Terme and Teolo.
* Baseline characteristics: Gender= 29 male 30 female; Age= 71.2 ± 5.4 years; Body Mass= 68.1 ± 6.5kg; BMI= 26.5 ± 3.0 kg/m2
	+ No statistically significant difference found between the AG and LG
* Random group allocation. AG: n= 20; LG: n= 20; CG: n=19.
	+ 3 individuals discontinued both the AG and LG interventions leaving AG: n=17; LG: n=17; and CG: n=19 for analysis
* Average adherence for the 28 sessions was 81.25%
 |
| **Intervention Investigated** |
| ***Control Group*** |
| * The control group performed the same baseline testing and outcome measures prior to the start of the program (T0) and twenty-four weeks later (T1).
 |
| ***Experimental Groups*** |
| **Aquatic Group (AG):*** Aim of exercise was to improve overall fitness in a geothermal environment.
* Each subject was asked to perform exercises where the water level reached their mid-sternum.
* When performing upper extremity exercises, participants were instructed to flex their knees in order to perform the exercises under the water.

**Land-based Group (LG):*** Aim of exercise was to improve overall fitness in a land-based environment

**Both Groups:*** Participants met 2 times per week for 60-minute sessions for a total of 6 months.
	+ Sessions were broken into 3 sections:
		- **8-minute** warm up
			* Exercises at a low intensity: cervical movements, shoulder, wrist, pelvis and ankle active mobilizations
		- **45-minute** program consisting of 10 exercises performed in standing wherein each exercise was performed for 1 minute and repeated 3 times with a 30-second recovery between sets. The intensity of exercise: Month 1: Borg RPE <13, Months 2-4: Borg RPE = 12-14, Months 5-6: Borg RPE = 15-16.
			* *Lower-body exercises*
				+ Single-leg knee extension and flexion
				+ Hip extension and flexion (with knee extended)
				+ Lateral side bounces
				+ Calf-raises
				+ Lower-limb abduction and adduction
			* *Upper-body exercises*
				+ Shoulder horizontal abduction and adduction
				+ Shoulder extension and flexion
				+ Shoulder abduction and adduction
				+ Pushes forward
				+ Lateral pushes
		- **8-minute** cool down
			* 60-90-second stretches were held at a moderate intensity for 6 different body regions: the chest, shoulder, upper and lower back, quadriceps, and hamstrings.
* Intensity of exercise was measured using rate of perceived exertion (RPE), both groups were required to maintain the same RPE when exercising the same muscular groups.
* No devices were used to increase/decrease drag or resistance
* Exercise trainer was informed about the objective of this study and told to follow a predetermined protocol. The same exercise trainer conducted all sessions.
* The same exercise therapist supervised each class session and was available for participants to report any problems or injuries that occurred between the then and last session.
 |
| **Outcome Measures**  |
| **Body Mass and Height:*** Body Mass—BWB-800 AS scale
* Height—HR-200 stadiometer

**Strength:*** Grip Strength—Hand-grip dynamometry
* Isokinetic (KET) and isometric knee-extension (KEM)—dynamometric load cell applied to a knee joint device

**Dynamic Balance:*** 8-foot-up-and-go (UGT) [lower time = decreased falls risk]
	+ Stand from chair, walk 8ft and around a cone then return back to chair

**Flexibility:*** Upper body Flexibility—Back-scratch test (BS)
	+ Measures the distance between middle finger when attempting to touch hands behind one’s back
* Lower body Flexibility—Sit-and-reach test (SR)
	+ Individuals are seated in the long sitting position with the soles of their feet against a box then reach forward as far as possible. The distance between the starting and ending position is measured.

**Body Composition:** * DXA; QDR 4500 W—measures fat mass, fat free mass, and appendicular skeletal mass
* Peripheral quantitative computed tomography (pQCT; Norland/Stratex XCT-3000)—Total cross-sectional area, cross-sectional muscle area, cross-sectional fat area on forearm and calf, and muscular density.
	+ Forearm—cross sectional 2.5mm scan at 66% from the distal end of the radius
	+ Calf—cross sectional 2.5mm scan at 66% from the distal end of the tibia.

\*\*The same experienced technician performed all DXA and pQCT scans.\*\* |
| **Main Findings** |
| Aquatic and land-based exercises performed at the same RPE have the possibility of being beneficial for maintaining strength and increasing lower extremity flexibility. Aquatic exercise appears to improve calf muscular strength, both shoulder range of motion and lower body flexibility, and dynamic balance while decreasing trunkal fat mass and dominant forearm fat. Land-based exercise appears to increase both trunk and total fat free mass when compared the two other groups. In the land-based group, grip strength increase by 26% and there was also an increase in forearm muscle density while the AG had no significant increases. Throughout the entire study, there were no adverse events, the drop out rate was low, and the weekly participation was high (81.25%), all of which indicate that the intervention were well tolerated. The authors sum their findings by supporting the use of aquatic exercises in warm water for elderly adults. The following data represent the statistically significant findings:* Average max HR during exercise component of session: AG= 60.1% ± 4.6% and LG= 59.5% ± 6.6%
* Statistically significant ANOVA (main effects) results for before and after differences among the 3 groups and post-hoc analyses:
	+ Dynamic Balance: P <0.001
		- AG has a larger improvement in the UGT than the LG (P=0.012) and the CG (P<0.001) after the program ended. The LG improvement was statistically greater than the CG (LG<CG; P=0.003).
	+ Leg Strength
		- The control group significantly decreased their isotonic (KET) and isometric knee extension (KEM) and there were no differences found between the AG and LG.
		- Isotonic leg strength: P<0.001
			* KET CG<AG, P <0.001 and CG<LG, P=0.007
		- Isometric leg strength: P=0.007
			* KEM CG<AG, P=0.002 and CG<LG, P=0.005
	+ Fat Mass
		- When compared to the CG, the AG statistically decreased their total FM (P<0.001) and trunk FFM (p=0.005).
		- Trunk FM: P=0.007
		- Total FM: P<0.001
	+ Fat Free Mass
		- The LG statically increased their trunk FFM and total FFM when compared to both AG and CG.
		- Trunk FFM: P=0.007
			* Trunk FFM: LG>AG, P=0.006 and LG>CG, P=0.012
		- Total FFM: P=0.013
			* Total FFM: LG>AG, P=0.005 and LG>CG, P=0.011

\*\*The results of this study should be interpreted with caution secondary to the small number of participants in this study. |
| **Original Authors’ Conclusions** |
| Warm-water aquatic exercise and the use of RPE to monitor exercise should be considered viable tools to increase physical fitness in healthy elderly subjects. Both aquatic and land-based exercises were beneficial for maintaining strength and improving lower body flexibility when performing at the same RPE. While further data is needed to confirm these findings, aquatic exercise appears to be a superior activity to increase dynamic balance and to promote weight loss.  |
| **Critical Appraisal** |
| **Validity:****Strengths**:* First study to analyse body composition and physical performance in a warm water exercise program for healthy elderly adults.
* The study compared the same protocol in land and water using the same intensity (RPEs).
* The results were clearly presented in a chart with the exception of the ANOVA and post hoc analysis.
* Program adherence was high, 81.25%

**Weaknesses:** * Exercises did not target specific outcome measures. Ex- Grip strength was measured but there were no exercises performed to increase grip strength throughout the program.
* Energy and Food intake were never mentioned throughout the study
* Small sample size.
* Subjects may have underlying pathologies even though they met the author’s inclusion/exclusion criteria.
* Exercise intensity was subjective (RPEs) instead of objective (HR).
* Subjects and exercise instructors were not blinded to the interventions.
* Authors did not include power, effect size, or standard mean differences.

**Potential Sources of Bias*** There was no discussion or assessment of publication bias that may have been present.
* The authors establish that there were no statistically significant differences for baseline characteristics and thus decrease the possibility of selection bias.

**Methodological Quality: Moderate to High*** PEDro = 7/11
* Level of Evidence= 1b
 |
| **Interpretation of Results** |
| The results of this study indicate that warm-water aquatic exercise is a useful tool for increasing physical fitness, maintaining strength, and improving lower body flexibility through exercises for healthy older adults. Each of these mentioned findings is statistically significant, but should be interpreted with caution because it is based on very few studies with limited participants and ultimately has small clinical significance. One fortunate aspect of this study is that the authors explained the entire intervention program in great detail, outlining exercises, intensities, and frequencies of the intervention program. With the great amount of detail, it is possible for a clinician to replicate this program for healthy older adults.It is difficult to analyse and understand the clinical significance and effects because only the pre (T0)/ post (T1) tests, change percentages, and P values were reported for the groups as a whole. The ANOVA and post-hoc analysis discussed in the results sections detailed the significant findings, but this data was unavailable and only P values were provided for the reader. While this is the case, the authors conclusions of their own results, including statically significant results, lend insight into using warm water aquatic exercise as a medium for successful treatment of healthy older adults.  |

**EVIDENCE SYNTHESIS AND IMPLICATIONS**

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| *Implications for practice:*All evidence reviewed in this critical appraisal indicate that the use of aquatic therapy is appropriate in many situations and that outcomes will vary based on the patient’s pathology and their individual aquatic interventions. Current research focuses on aquatic therapy improving specific aspects of varying diseases and pathologies such as osteoarthritis, strokes, Parkinson’s disease, cerebral palsy, multiple sclerosis, fibromyalgia, etc. Furthermore, each study has a unique design making it difficult to compare interventions with one another. When first searching for evidence to answer the above stated PICO question, I was confronted with limited evidence that addressed using an aquatic program to improve gait and balance in older adults. These two measures were often considered secondary outcomes and limited information was readily available.8 For this reason, one randomized controlled trial of moderate methodological quality addressing body composition and physical performance and two high quality systematic reviews that discussed aquatic therapy interventions for individuals with OA and post-stroke were used in this critical appraisal.6,8,13 The small statistical and clinically significant effects reported in each of these studies can be applied to patients who have similar pathologies and to people of similar ages, but should be interpreted with caution considering the limited number of participants in the randomized controlled trials and in the systematic reviews. Each study can be related to functional gait and balance by means of improving strength, flexibility, self-reported functioning, and decreasing pain. For patients who have lower extremity osteoarthritis, aquatic exercise has been found to decrease pain and stiffness, increase self-reported functioning, increase objectively measured physical functioning, such as range of motion or activity level, and increase quality of life. While OA was not specifically stated as a problem the patient had in the PICO question, OA affects half of all people 65 years of age and older, thus putting this 70 year old patient into this category.14 An aquatic intervention that focuses on managing OA symptoms of the lower extremity has the ability to improve gait and balance as measured by increase in range of motion, activity level, and self-reported functioning. In this study, activity level was measured through the TUG, the 6MWT, and the 30sec chair rise test. Shumway-Cook et al. found that a TUG score over 13.5 seconds in community dwelling older adults increased falls risk and that lower scores decrease one’s fall risk.15 While the specific results of the TUG were not provided, the clinically significant activity finding provide support that there was a decrease in the TUG and therefore most likely a decrease in the participant’s falls risks. The second systematic review found limited evidence regarding aquatic interventions for individuals who have had a stroke. This study found that the individuals who participated in an aquatic intervention improved muscular strength and ADL, though the evidence is based on limited data secondary to the limited number of participants and randomized controlled trials available. In September 2015, a systematic review was published to characterize balance and lower extremity power and strength.16 The authors found that throughout the lifespan (child 🡪 older adult), lower extremity strength and power had a small-sized association with balance for every age group. Therefore, as the patient’s in the Mehrholz et al. study gained lower extremity strength through aquatic exercises, their balance very well may have increased as well. It would be beneficial for the reviewer of the Mehrholz article to read the per/post intervention ADL scores to see where the subject’s improvements were and to thus draw conclusions about function. Lastly, the randomized controlled trial by Bergamin et al. supports the use of aquatic exercise in older adults for numerous reasons.6 This aquatic exercise program improved muscular strength and lower extremity flexibility, and appeared to increase dynamic balance. As just reported, increased muscular strength leads to increased balance and increases in dynamic balance lead to fewer falls and improved gait.16,17 By participating in an aquatic exercise program, individuals are able to increase their physical fitness and prolong functional independence without adverse effects. Each of these mentioned studies supports the use of aquatic therapy for older adults and claim that the interventions were appropriate and well tolerated because were few drop outs, very few adverse effects, and attendance/participation rates were high. Overall the data show support for aquatic therapy and exercise as one type of physical activity to improve balance and gait. *Future Research:*In the future, there needs to be a increase in the number of randomized controlled trials addressing aquatic interventions for all populations. Many studies that have been performed lack high methodological rigor and quality, have small effect sizes, and have a limited number of participants. Research should focus on creating studies that have high methodological quality while also increasing the number of participants in the randomized controlled studies. There is limited evidence for supporting/refuting aquatic exercise for many populations such as individuals post-stroke and healthy older adults who want to use aquatic exercises as their mode of daily physical activity. An increase of aquatic therapy evidence will guide therapists in their decision making process when planning an exercise program that will facilitate increases in functional balance and gait.  |

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