CRITICALLY APPRAISED TOPIC

FOCUSED CLINICAL QUESTION

In patients with lower extremity amputation, how does aquatic therapy intervention affect functional and psychosocial outcome measures compared to land-based resistance training exercise?

AUTHOR

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CLINICAL SCENARIO

It is known that patients with a variety of impairments, chief complaints, and levels of independence can experience improved functional and psychosocial outcomes over the course of aquatic therapy-based plans of care. Aquatic therapy is especially beneficial when the patient has difficulty performing weight bearing exercise and activities of daily living, or when their symptoms are highly sensitive and irritable. Amputees often experience challenges with weight bearing exercise, ambulation with a prosthesis, strength imbalances, and other functional activities, especially as they return to "normal" function following the amputation. Aquatic therapy may be a useful tool to target strength, functional mobility, and other PT goals for these patients, while also providing the patient with a recreational physical activity outlet. In the Durham, NC community, there is a high interest, yet moderately high level of difficulty and/or fear associated with aquatic activities among amputees—as noted at the Amputee Swim Night in Durham in August 2019. Evidence that supports aquatic therapy as a productive intervention for amputee rehabilitation would be help to improve access to and implementation of aquatic therapy in this population.

SUMMARY OF SEARCH

[Best evidence appraised and key findings]

Eight studies were selected as best evidence and fitting the inclusion and exclusion criteria. These consisted of 4 systematic reviews, 2 narrative reviews, 1 literature review, and 1 case study.

- Aquatic exercise may result in more significant improvements in functional and psychosocial outcomes when compared with no exercise and land-based exercise.[1]
- Land-based exercise results in better functional and psychosocial outcomes than no exercise in individuals with a variety of musculoskeletal conditions, but aquatic exercise may result in better outcomes than land-based exercise.[1]
- Individuals with transfemoral amputation may demonstrate improved functional mobility and psychosocial outcomes following participation in an underwater treadmill training program.[2]
- There is no evidence to suggest a specific protocol or activity guidelines for individuals with lower extremity amputation and aquatic exercise participation.[1-8]
- An individualized and salient exercise program may promote positive outcomes for pain, physical function, and quality of life among individuals with a variety of musculoskeletal conditions.[1]

CLINICAL BOTTOM LINE

Individuals with lower extremity amputation may benefit from implementation of an aquatic exercise program for improvements in functional and psychosocial outcomes. There is limited evidence to suggest ideal parameters for such interventions and the long-term carryover of these benefits. However, individuals with a variety of musculoskeletal conditions have demonstrated improvements in pain levels, physical function, and quality of life during and after participation in aquatic exercise programs. Individuals with transfemoral amputation have demonstrated improved functional mobility, fatigue, and quality of life following participation in an underwater treadmill training program. The evidence, although limited, supports the implementation of aquatic exercise in individuals with lower extremity amputation.

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

The above information should fit onto the first page of your CAT

SEARCH STRATEGY

Terms used to guide the search strategy			
Patient/Client Group	**I**ntervention (or Assessment)	**C**omparison	**O**utcome(s)
Amputation Amputee Amput* Lower extremity amput*	Aquatic therapy Hydrotherapy Aquatic intervention Aquatic exercise Pool therapy Underwater treadmill training	Resistance training Resistance exercise Land-based therapy	Functional mobility Functional outcomes Performance outcomes Psychosocial outcomes

Final search strategy (history):

Show your final search strategy (full history) from PubMed. Indicate which "line" you chose as the final search strategy.

Pubmed Search Strategy

Search #	Query	Results
1	(transfemoral amput*) AND ((((aquatic therapy) OR (aquatic intervention)) OR (aquatic exercise)) OR (hydrotherapy))	3
2	(amput*) AND ((((aquatic therapy) OR (aquatic intervention)) OR (aquatic exercise)) OR (hydrotherapy))	160
3	((amput*) AND ((((aquatic therapy) OR (aquatic intervention)) OR (aquatic exercise)) OR (hydrotherapy))) NOT ((zebrafish) OR (organism))	143
4	(((amput*) AND ((((aquatic therapy) OR (aquatic intervention)) OR (aquatic exercise)) OR (hydrotherapy))) NOT ((zebrafish) OR (organism))) AND (((lower extremity) OR (lower body)) OR (leg))	35
5	(((amput*) AND (((aquatic therapy) OR (aquatic exercise)) NOT ((zebrafish) OR (organism))) AND (((lower extremity) OR (lower body)) OR (leg))	2
6	(((underwater treadmill training) OR ((((aquatic therapy)) OR (aquatic exercise)) OR (hydrotherapy))) AND (amput*)) NOT ((zebrafish) OR (organism))	139
7	((underwater treadmill training) OR ((((aquatic therapy)) OR (aquatic exercise))) AND (amput*)) NOT ((zebrafish) OR (organism))	6
8	(underwater treadmill training) AND (amput*)	0
9	((underwater treadmill training) OR ((((aquatic therapy)) OR (aquatic exercise)) OR (hydrotherapy))) AND (amput*)	154
10	((((amput*[Title/Abstract]) AND ((((underwater treadmill training) OR (aquatic therapy)) OR (aquatic exercise)) OR (hydrotherapy))) NOT (organism)) NOT (zebrafish)) AND (((lower extremity) OR (lower body)) OR (leg))	31

CINAHL Search Strategy

Search #	Query	Results
1	(Amput*) AND (aquatic therapy or hydrotherapy or aquatic exercise or water exercise)	15
2	(Amput*) AND (aquatic therapy or hydrotherapy or aquatic exercise or water exercise) AND (land-based therapy)	0
3	(Amput*) AND (aquatic therapy or hydrotherapy or aquatic exercise or water exercise) AND (resistance training)	1
4	(aquatic therapy or hydrotherapy or aquatic exercise or water exercise) AND (land-based therapy)	36
5	(underwater treadmill training or aquatic therapy or hydrotherapy or aquatic exercise or water	36

	exercise) AND (land-based therapy)	
6	(underwater treadmill training) AND (land-based therapy)	0
7	(aquatic therapy or hydrotherapy or aquatic exercise or water exercise) AND (land-based therapy) AND (functional outcome measures)	3
8	aquatic therapy or hydrotherapy or aquatic exercise or water exercise) AND (land-based therapy) AND (performance outcome measures)	0
9	aquatic therapy or hydrotherapy or aquatic exercise or water exercise) AND (land-based therapy) AND (functional mobility)	6

*highlighted lines indicate final search strategy for articles included in the present review.

In the table below, show how many results you got from your search from each database you searched.

Databases and Sites Searched	Number of results	Limits applied, revised number of results (if applicable)
• Pubmed • Google Scholar • CINAHL	3 3 4 (relevant sources noted that were considered in working list of articles, see tables above for total numbers of results)	• Expanded population and interventions • Utilized "cited by" feature in Google Scholar to find more recent literature • Removed population to compare interventions to one another

INCLUSION and EXCLUSION CRITERIA

Inclusion Criteria
• Traumatic and nontraumatic amputee patient population • Case study and case report articles • Crossover studies • Standardized outcome measures utilized for functional and performance assessment • Study clearly describes aquatic interventions components • Outpatient or inpatient setting of study • Narrative review articles
Exclusion Criteria
• Articles published before 2000 • Articles not published in English

RESULTS OF SEARCH

Summary of articles retrieved that met inclusion and exclusion criteria

For each article being considered for inclusion in the CAT, score for methodological quality on an appropriate scale, categorize the level of evidence, indicate whether the relevance of the study PICO to your PICO is high/mod/low, and note the study design (e.g., RCT, systematic review, case study).

Author (Year)	Risk of bias (quality score)*	Level of Evidence**	Relevance	Study design
Barker et al (2014)[1]	AMSTAR – 9/11	2a (includes quasi-RCTs)	Moderate(+)	Systematic Review and Meta-Analysis
Cutler (2017) (AAO&P)[2]	SANRA – 6/12	5 (expert opinion)	High	Narrative Review (conference paper presentation)
Villalta et al (2013)[3]	AMSTAR –6/11	1a	Moderate(-)	Systematic Review and Meta-Analysis
Culter (2017) (JPO)[4]	Downs & Black – 10/29	3b (individual case study)	Moderate	Case Study
Heywood et al (2017)[5]	AMSTAR – 8/11	1a	Moderate	Systematic Review & Meta-Analysis
Severin et al (2016)[6]	AMSTAR 2– Critically low SANRA –5/12	3a (includes cohort and case-control studies)	Moderate	Literature Review
Heywood et al (2016)[7]	AMSTAR – 8/11	3a (includes case control studies)	Moderate	Systematic Review
Van Silfhout et al (2020)[8]	SANRA – 8/12	5 (expert opinion)	Moderate(+)	Narrative Review

*Indicate tool name and score

**Use Portney & Watkins Table 16.1 (2009); if downgraded, indicate reason why

BEST EVIDENCE

The following 2 studies were identified as the 'best' evidence and selected for critical appraisal. Rationale for selecting these studies were:

- **Barker et al (2014)[1]:** this is the highest quality of evidence found from the literature search, and lends itself to a variety of patient populations for both functional and psychosocial outcomes. Severin et al (2017) was close in quality, but this paper specifically reviewed strength as an outcome for patients with lower limb musculoskeletal conditions. Barker et al reviewed more functional and psychosocial outcomes for a variety of musculoskeletal patients, indicating that results can be generalized more appropriately to the population and outcomes of this PICO question.
- **Cutler (2017) (AAO&P)[2]:** while this paper is not the greatest quality, it is the most specific paper from the performed literature search with regard to the patient population and interventions base. Coupled with the high quality of the review paper listed above, I think this will allow for better extrapolation of the generalized results to the amputee population.

SUMMARY OF BEST EVIDENCE

(1) Description and appraisal of *Effectiveness of Aquatic Exercise for Musculoskeletal Conditions: A Meta-Analysis* by Barker et al (2014)[1].

Aim/Objective of the Study/Systematic Review:
The aim of this study was to review and summarize the effectiveness of aquatic intervention on functionality, pain levels, and quality of life for individuals with a variety of common musculoskeletal conditions. Aquatic therapy was compared with land-based exercise and no exercise intervention to clearly examine the benefits and outcomes associated with aquatic therapy. The study also focused specifically on the effects of aquatic therapy in individuals with osteoporosis (OP), osteoarthritis (OA), rheumatoid arthritis (RA), fibromyalgia, and low back pain (LBP).
Study Design [e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant] Note: For systematic review, use headings 'search strategy', 'selection criteria', 'methods' etc. For qualitative studies, identify data collection/analyses methods.
This article is a systematic review and meta-analysis. A review of the Cochrane Central Register of Controlled Trials (Cochrane), Cumulative Index to Nursing and Allied Health Literature (CINAHL), and Ovid MEDLINE was conducted until May 2013 using key terms including: hydrotherapy, aquatic therapy, aquatic exercise, arthritis, rheumatoid arthritis, osteoarthritis, fibromyalgia, low back pain, osteoporosis, musculoskeletal diseases, and combinations of the above terms. Two reviewers screened abstracts for exclusion, and full texts were reviewed according to the inclusion criteria, which included randomized control trial (RCT) design, participants with at least 1 musculoskeletal condition, participants over the age of 18, and no recent surgery. Studies were required to have one group of participants who received aquatic therapy, and a control group that received land-based exercise or no exercise. "Exercise" was considered any physical activity that focused on endurance, strength, aerobic pool exercise, flexibility, or resistance training. Aquatic interventions that included balneotherapy or turbulent spa therapy were not included due to the non-exercise nature of these therapies. Specific outcomes for the included studies varied, but were generally categorized by pain, quality of life, and physical function. Generic outcome measures that are known to respond to improvements in the aforementioned categories were utilized in the meta-analysis. The included studies were reviewed and assessed for quality according to the Physiotherapy Evidence Database Scale (PEDro).
Setting [e.g., locations such as hospital, community; rural; metropolitan; country]
The authors of the present paper are based out of the Monash University and University of Melbourne in Melbourne, Australia, University of Queensland in St. Lucia, Australia, and the Metro North Hospital and Health Services in Brisbane, Australia. The settings of the studies included in the review were not specified other than all taking place in an outpatient environment.
Participants [N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up] Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article.
Twenty-six (26) studies were included, consisting of 24 RCTs and 2 quasi-RCTs that focused on individuals with osteoporosis, osteoarthritis, rheumatoid arthritis, low back pain, and fibromyalgia. Sixteen of the included studies had an average participant age of <60 years old, and the youngest mean age of a study was 34.8 years old. Male and female participants were included in all studies. Further description of patient demographics,

duration of disease/musculoskeletal condition, and baseline levels of comparison were left out of the present study. However, all included studies were evaluated for methodologic quality and heterogeneity, and low-quality studies were excluded from the meta-analysis.

Intervention Investigated

[Provide details of methods, who provided treatment, when and where, how many hours of treatment provided]

Control

Control groups consisted of land-based exercise in equal dosage to that of the experimental groups who received aquatic exercise intervention. Some studies also included control groups who received no exercise intervention. Protocols ranged from 30-minute sessions once per week for 6 weeks to 60-minute sessions twice per week for 52 weeks.

Experimental

Experimental groups received aquatic exercise interventions in the same dosage as control groups, ranging in duration from 3 weeks to 52 weeks, time per session of 30 to 60 minutes, and 1 to 7 sessions per week. Exact details regarding the dosage, intensity, and individual exercises were not included in the present paper. This was discussed as a limitation of the present study, as this information was generally left out of the included studies as well. Most programs included a warm-up period, strengthening exercises, stretching, range of motion activities, aerobic exercise, and a cool down period.

Outcome Measures

[Give details of each measure, maximum possible score and range for each measure, administered by whom, where]

Three categories of outcome measures were included for analysis in this review: pain, physical function, and quality of life. Pain measures included: Visual Analog Scale (VAS)-pain, Health Assessment Questionnaire (HAQ)-pain, Short Form-36 (SF-36)-pain, Short Form-12 (SF-12)-pain, European Quality of Life-5 Dimension Scale(EQ-5D)-pain, Brief Pain Inventory (BPI), Functional Capacity Evaluation-pain, Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)-pain, Arthritis Impact Measurement Scale 2(AIMS-2)-pain, Knee Injury and Osteoarthritis Outcome Score (KOOS)-pain, and Fibromyalgia Impact Questionnaire (FIQ)-pain.

Physical function outcomes included: HAQ-function, Disability Rating Index (DRI), SF-36-function, EQ-5D-mobility, Functional Capacity Evaluation (FCE)-ADL, Functional Ambulation Performance (FAP), Summary Physical Function scale (SPF), Adelaide Activities Profile (AAP), WOMAC-function, AIMS-2-physical activity, KOOS-ADL, Arthritis Self Efficacy Questionnaire (ASEQ)-function, Osteoporosis Functional Disability Questionnaire (OFDQ)-functional abilities domain, and FIQ-function.

Quality of life outcomes included: EQ-5D, SF-36, SF-12-physical health, Arthritis Quality of Life Scale (AQoL)-total score, Perceived Quality of Life Scale (PQOL), Quality of Well-Being Scale (QWBS), Global Self-Rating Index (GSRI), AIMS-2-affect, and KOOS-quality of life.

Outcome data provided included mean scores, standard deviations, and sample sizes for baseline prior to intervention and follow-up after the completion of the intervention.

Main Findings

[Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided; you may calculate your own values if necessary/applicable. You may summarize results in a table but you must explain the results with some narrative.]

The authors of this systematic review and meta-analysis report findings according to comparison (aquatic exercise vs.no exercise and aquatic exercise vs. land-based exercise), outcomes (pain, physical function, and quality of life), and musculoskeletal condition (osteoarthritis, rheumatoid arthritis, fibromyalgia, low back pain, and osteoporosis). Main findings for each condition can be found in the tables below. Higher effect sizes were noted for a variety of musculoskeletal conditions when comparing aquatic exercise to no exercise across outcomes. Moderate effect sizes were noted for a variety of musculoskeletal conditions when comparing aquatic exercise to land-based exercise for pain, physical function, and quality of life outcomes.

Table 1: Meta-analysis of pain outcomes: aquatic exercise vs. no exercise

Population	# Aquatic Exercise Participants	# No Exercise Participants	Weight	Std. Mean Difference, 95% CI	Overall Effect
Osteoarthritis	510	586	80.6%	-0.31 (-0.50, -0.13)	Z = 3.28 (p=0.001)
Rheumatoid Arthritis	35	35	7.6%	0.00 (-0.47, 0.47)	Z = 0.00 (p=1.00)
Fibromyalgia	32	32	8.7%	-1.02 (-1.65, -0.38)	Z = 3.15 (p = 0.002)
Low Back Pain	9	10	3.1%	-0.74 (-1.68, 0.20)	Z = 1.54 (p = 0.12)
Total	586	663	100%	-0.37 (-0.56, -0.18)	Z = 3.89 (p < 0.0001)

Compared with no exercise, aquatic exercise groups demonstrated a significant improvement in pain outcomes for a variety of musculoskeletal conditions, as demonstrated by a large effect size and great statistical significance. Smaller effect sizes were seen for individuals with rheumatoid arthritis and low back pain.

Table 2: Meta-analysis of pain outcomes: aquatic exercise vs. land-based exercise

Population	# Aquatic Exercise Participants	# No Exercise Participants	Weight	Std. Mean Difference, 95% CI	Overall Effect
Osteoarthritis	158	157	47.5%	-0.23 (-0.46, -0.01)	Z = 2.04 (p = 0.04)
Rheumatoid Arthritis	78	76	23.4%	0.14 (-0.18, 0.46)	Z = 0.86 (p = 0.39)
Osteoarthritis and Rheumatoid Arthritis	32	34	10.1%	0.27 (-0.22, 0.75)	Z = 1.08 (p = 0.28)
Fibromyalgia	31	30	9.1%	-0.51 (-1.02, 0.00)	Z = 1.94 (p = 0.05)
Low Back Pain	32	33	10.0%	-0.18 (-0.66, -0.31)	Z = 0.71 (p = 0.48)
Total	331	330	100%	-0.11 (-0.27, 0.04)	Z = 1.46 (p = 0.14]

Compared with land-based exercise, aquatic exercise groups demonstrated moderate improvements in pain for osteoarthritis and fibromyalgia populations. Whereas individuals with rheumatoid arthritis and low back pain had less significant improvements in pain outcomes.

Table 3: Meta-analysis of physical function outcomes: aquatic exercise vs. no exercise

Population	# Aquatic Exercise Participants	# No Exercise Participants	Weight	Std. Mean Difference, 95% CI	Overall Effect
Osteoarthritis	452	454	68.5%	0.32 (1.10, 0.54)	Z = 2.86 (p = 0.004)
Rheumatoid Arthritis	35	35	7.9%	0.22 (-0.25, 0.69)	Z = 0.93 (p = 0.35)
Fibromyalgia	63	57	16.5%	0.63 (0.27, 1.00)	Z = 3.37 (p = 0.0008)
Osteoporosis	31	27	7.1%	-0.36 (-0.88, 0.16)	Z = 1.35 (p = 0.18)
Total	581	573	100%	0.32 (0.13, 0.51)	Z = 3.33 (p = 0.0009)

Physical function outcomes were greatly improved in individuals with a variety of musculoskeletal conditions following participation in aquatic exercise compared with those who did not exercise. This is demonstrated by a large effect size and statistical significance.

Table 4: Meta-analysis of physical function outcomes: aquatic exercise vs. land-based exercise

Population	# Aquatic Exercise Participants	# No Exercise Participants	Weight	Std. Mean Difference, 95% CI	Overall Effect
Osteoarthritis	107	102	33.3%	-0.18 (-0.46, 0.09)	Z = 1.31 (p = 0.19)
Rheumatoid Arthritis	79	76	25.0%	-0.01 (-0.33, 0.30)	Z = 0.09 (p = 0.93)
Osteoarthritis and Rheumatoid Arthritis	42	44	13.8%	-0.18 (-0.61, 0.24)	Z = 0.84 (p = 0.40)
Fibromyalgia	24	23	7.5%	0.40 (-0.18, 0.98)	Z = 1.36 (p = 0.17)
Low Back Pain	32	33	10.2%	0.51 (0.02, 1.01)	Z = 2.03 (p = 0.04)
Osteoporosis	31	33	10.3%	-0.26 (-0.75, 0.23)	Z = 1.04 (p = 0.30)
Total	314	311	100%	-0.30 (-0.19, 0.12)	Z = 0.42 (p = 0.67)

A small to moderate effect size was noted for physical function outcomes in aquatic exercise groups compared to land-based exercise groups for individuals with a variety of musculoskeletal conditions. The greatest effects were noted in those with low back pain, fibromyalgia, and osteoarthritis.

Table 5: Meta-analysis of quality-of-life outcomes: aquatic exercise vs. no exercise

Population	# Aquatic Exercise Participants	# No Exercise Participants	Weight	Std. Mean Difference, 95% CI	Overall Effect
Osteoarthritis	267	410	80.7%	0.53 (0.17, 0.88)	Z = 2.90 (p = 0.004)
Rheumatoid Arthritis	35	35	9.8%	-0.27 (-0.74, 0.20)	Z = 1.13 (p = 0.26)
Osteoporosis	31	27	9.5%	-0.06 (-0.58, .045)	Z = 0.24 (p = 0.81)
Total	333	472	100%	0.39 (0.06, 0.73)	Z = 2.32 (p = 0.02)

Quality of life was significantly improved in those with osteoarthritis and rheumatoid arthritis following participation in aquatic exercise compared to no exercise, as demonstrated by large effect sizes and statistical significance.

Table 6: Meta-analysis of quality-of-life outcomes: aquatic exercise vs. land-based exercise

Population	# Aquatic Exercise Participants	# No Exercise Participants	Weight	Std. Mean Difference, 95% CI	Overall Effect
Osteoarthritis	111	103	49.3%	0.01 (-0.26, 0.28)	Z = 0.08 (p = 0.94
Rheumatoid Arthritis	78	76	35.7%	-0.25 (-0.57, 0.07)	Z = 1.54 (p=0.12)
Osteoporosis	31	33	15.0%	-0.10 (-0.59, 0.39)	Z = 0.30 (p = 0.70)
Total	220	212	100%	-0.10 (-0.29, 0.09)	Z = 1.02 (p = 0.31)

Quality of life was inconsistently improved in patients with a variety of musculoskeletal conditions following aquatic exercise compared with land-based exercise, as demonstrated by varying effect sizes and lack of statistical significance.

Original Authors' Conclusions

[Paraphrase as required. If providing a direct quote, add page number]

Overall, aquatic exercise resulted in similar pain, physical function, and quality of life outcomes to land-based exercise intervention. Aquatic intervention was well-tolerated and accepted by the populations included in the studies, and patient participation and adherence to a physical activity plan may be increased if the exercise is enjoyed by the participant. While a variety of musculoskeletal conditions were reviewed in this paper, benefits of aquatic therapy was noted across all patient groups. Improvements in pain levels were lowest in individuals with LBP and RA, but were consistent in other populations. Aquatic therapy resulted in improved physical function for individuals with OA, RA, and fibromyalgia when compared with no exercise. There was no difference between aquatic exercise and land-based exercise for individuals with OA and fibromyalgia, and physical function was not improved for participants with OP in the aquatic group compared with either control scenario. Limited data regarding quality of life were reported, as only 16 of the 26 included studies focused on quality of life. However, this limited data demonstrated improved patient reported outcomes and well-being for individuals with OA, RA, OP following aquatic exercise. Positive effects were also noted in the land-based exercise group for those with OA. Given these results, it is reasonable to conclude that aquatic exercise can be beneficial for individuals with a variety of musculoskeletal disorders in terms of pain, physical function, and quality of life.

Critical Appraisal

Validity

[Summarize the internal and external validity of the study. Highlight key strengths and weaknesses. Comment on the overall evidence quality provided by this study.]

According to the AMSTAR risk of bias assessment tool, this article scored a 9/11, indicating relative high quality and low risk of bias. The review paper included several high-quality articles (randomized control trials) and reported on a variety of musculoskeletal conditions and outcome measures for the intervention of interest and controls. One limitation of this article is that the included studies ranged in publishing time from 1996-2012, so the newest data is 8 years old at this point in time, and the oldest data is 24 years old. Since these articles were published advances in rehabilitation technologies and resources have undoubtedly occurred, which may reduce the validity and outdate the results of this paper. Additionally, there is a lack of large-scale, long-term follow up studies on this topic in the literature, which reduces the validity of this review paper. The existing literature is also quite vague regarding parameters (frequency, intensity, duration, specific interventions) for aquatic exercise, which makes it difficult to make specific activity recommendations.

Interpretation of Results

[This is YOUR interpretation of the results taking into consideration the strengths and limitations as you discussed above. Please comment on clinical significance of effect size / study findings. Describe in your own words what the results mean.]

While this review paper has several limitations, it is still a high-quality article with moderate to high relevance to the clinical scenario at hand. Because the results of the study are based on high quality randomized control trials, and generally large effect sizes were noted, it is reasonable to conclude that the results of the study are reliable, valid, and can be applied to a variety of musculoskeletal conditions. Higher effect sizes were noted in the aquatic exercise compared to no exercise studies, and moderate effect sizes were noted in aquatic exercise compared to land-based exercise studies. This indicates that combination of low-load exercise and the therapeutic nature of water may contribute to positive outcomes when compared to a sedentary lifestyle, but it may not necessarily matter if the individual is participating in aquatic exercise compared to land-based exercise. *Some* form of exercise is better than no exercise when it comes to pain, physical function, and quality of life, and the selected exercise program must be salient to the patient for greater adherence and long-term outcomes.

Applicability of Study Results

[Describe the relevance and applicability of the study to your clinical question and scenario. Consider the practicality and feasibility of the intervention in your discussion of the evidence applicability.]

Given the limited literature about aquatic exercise in general, and further limited literature about aquatic exercise specific to the amputee population, it is difficult to make strong recommendations about the implementation of aquatic intervention in this population. Because of the general nature of the study, the results can be only loosely applied to amputees, indicating the use of aquatic exercise for amputees with pain, impaired physical function, and reduced quality of life. The lack of specific interventions and protocols reduces the study’s validity and applicability, so the results must be applied with caution and in a generalized fashion. The application of aquatic exercise is realistic for amputees if they have access to resources, such as transportation, a PT clinic with a pool, and a community pool for long-term maintenance, and if the activity is of interest and enjoyment to them. If these conditions are not able to be met, land-based exercise would likely suffice in place of aquatic exercise to address a variety of functional impairments.

(2) Description and appraisal of *Transfemoral Aquatic Rehabilitation* by Cutler, 2017[2].

Aim/Objective of the Study/Systematic Review:
The aim of this paper is to discuss the general benefits of aquatic rehabilitation due to the therapeutic, gravity-reduced conditions of the aquatic setting for the transfemoral amputee population. The author's goal is to educate healthcare professionals about interventions to be utilized and their benefits, based on case studies and clinical practice.
Study Design [e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant] Note: For systematic review, use headings 'search strategy', 'selection criteria', 'methods' etc. For qualitative studies, identify data collection/analyses methods.
This paper is a narrative review or expert opinion, as the author presented the discussion to colleagues at the American Academy of Orthotists & Prosthetists Annual Meeting and Scientific Symposium. Three patient case studies were briefly described according to their level of mobility and demographics. No randomization or specific protocol was utilized, as the author retrospectively presented his findings of this case series.
Setting [e.g., locations such as hospital, community; rural; metropolitan; country]
This paper does not specify the exact setting of the intervention; however, it is reasonable to assume that the interventions take place through the author's clinical organization, Limbitlness LLC, in an outpatient setting in a small city in California.
Participants [N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up] Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article.
There are 3 participants described in this study. One is a geriatric unilateral transfemoral amputee, another is a young K4 level unilateral transfemoral amputee, and the third is a mature female adult with bilateral transfemoral traumatic amputee. Information about time since amputation, prior and current level of function, other comorbidities, and other demographic information were not provided in the paper. Inclusions criteria were not specified, nor was randomization or referral source.
Intervention Investigated [Provide details of methods, who provided treatment, when and where, how many hours of treatment provided]
Control
No control was described in the present study.
Experimental
No specific protocol existed prior to the study in order to guide interventions. Patients participated in underwater treadmill training at an unspecified dosage—frequency, intensity, and time—for at least 30 days. Follow up occurred 4-months post-initiation of aquatic rehabilitation program. Additional components of the intervention, such as warm up, additional exercises, and assessment methods were not included. The

intervention was directed by the author or another therapist, and was supported by a physician.

Outcome Measures

[Give details of each measure, maximum possible score and range for each measure, administered by whom, where]

Ambulation time, distance, degree of muscle contracture, fatigue, and disability ratings were assessed. Specific outcome measures were not named. Assessment was done at baseline and completion of the intervention to assess for functional improvement. It is unclear who administered these assessments and where they took place.

Main Findings

[Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided; you may calculate your own values if necessary/applicable. Use a table to summarize results if possible.]

Exact data and tables were not provided in this narrative review. Below is a table with generalized results from the study. In general, patients demonstrated improved functional mobility, range of motion, fatigue, and quality of life based on author reports in the paper. Because exact data and standard deviations are not provided, it is difficult to establish an effect size and/or statistical significance.

Outcome	Baseline	Post-Intervention
Ambulation time	5 minutes	45 minutes
Ambulation range (distance)*	100 feet	400 feet
Hip flexion contracture	45 degrees	20 degrees
Patient fatigue	Not reported	50% reduction
Disability rating**	78%	48%

*= after 30 days of intervention

**=after 4 months of aquatic rehabilitation, 3 years post amputation

Original Authors' Conclusions

[Paraphrase as required. If providing a direct quote, add page number]

The author noted significant carryover from the aquatic therapy environment to that of functional land-based ambulation. Fear associated with ambulation was reduced, and balance, confidence, and functional ambulation parameters were improved. Specifically, walking distance and speed were improved following aquatic ambulation, which is attributed to the effects of the water resistance that is removed when ambulating on land. The motorized component of the treadmill is credited for the extension moment created at the trunk, which aided in postural improvements and increased step length. The properties of the water are credited for improved sympathetic neural response, which provided a relaxing environment and allowed for reduction of the hip flexion contracture and reduction in risk and fear of falling among participants. The author suggests that aquatic rehabilitation, specifically underwater treadmill training should be further explored for amputees who are at greater risk of falls or who have poor functional mobility mechanics and may be placing other tissues at risk of injury with improper ambulation.

Critical Appraisal

Validity

[Summarize the internal and external validity of the study. Highlight key strengths and weaknesses. Comment on the overall evidence quality provided by this study.]

The primary benefit of this paper and main reason for its inclusion in this CAT is its relevance to the clinical scenario, patient population, and intervention. This paper is the most relevant piece of literature to the topic at hand, and ought to be considered when making aquatic exercise recommendations for patients with amputation. Unfortunately, there are several limitations to this paper regarding validity and reliability. This paper is level 5 evidence (expert opinion) and scored a 6/12 on the SANRA scale for quality and risk of bias, indicating that it is of moderate quality. Because this study did not include any randomization, patient/subject information (time since amputation, other comorbidities, demographics, etc) clear data and results, or standardized methods of assessment and intervention, the results must be interpreted with high caution. The author does acknowledge limitations in the literature surrounding this subject given professional concerns about the aquatic environment, potential compromise of equipment utilized, and unclear transfer of training and skill from the aquatic environment to functional on-land activities. He describes the quality of waterproofed equipment, improved psychosocial status in patients (specifically reduced fear of falling), and carryover of skills noted from the aquatic environment to land-based ambulation conditions. It is also important to note that the author's expert opinion may be biased given his relationship to *Limbitless, LLC*, the prosthetics and orthotics company that sponsored this study.

Interpretation of Results

[This is YOUR interpretation of the results taking into consideration the strengths and limitations as you discussed above. Please comment on clinical significance of effect size / study findings. Describe in your own words what the results mean.]

The results of this paper are difficult to interpret, as it is a narrative review with no concrete description of interventions, outcomes, results, or patient population. Given its low level of evidence, moderate to quality and risk of bias, it is difficult to lean on this article when making strong recommendations for the use of aquatic exercise for individuals with lower extremity amputation. However, the general reports of significant improvements in gait speed, ambulation distance, and quality of life are quite encouraging—even if on a case-by-case basis—especially considering the relative diversity in age and functional mobility level. This paper scratches the surface of the topic at hand, which provides support to further explore this as a treatment option for individuals with lower extremity amputation who are risk of falls or with poor gait mechanics.

Applicability of Study Results

[Describe the relevance and applicability of the study to your clinical question and scenario. Consider the practicality and feasibility of the intervention in your discussion of the evidence applicability.]

This narrative review is of moderate quality, low level of evidence, but high relevance to the clinical population and scenario at hand. Of the studies reviewed in the literature search for this CAT, this paper had the greatest relevance to the patient population, interventions, and outcomes. The limitations of the study, described previously, establish a significant barrier to applying these results to clinical practice, and therefore the general results may be only loosely applied to patients with lower extremity amputations. However, the subjective results provide enough positive evidence to suggest the use of aquatic ambulation/underwater treadmill training in this patient population.

SYNTHESIS AND CLINICAL IMPLICATIONS

[Synthesize the results, quality/validity, and applicability of the two studies reviewed for the CAT. Future implications for research should be addressed briefly. Limit: 1 page.]

Overall, there is limited high-quality evidence to support the implementation of aquatic exercise in individuals with lower extremity amputation. The Barker et al (2014) paper is high level evidence of moderate to high quality, but general applicability to the patient population at hand. In this study, positive effects on pain, physical function, and quality of life were noted when individuals with a variety of musculoskeletal conditions participated in aquatic exercise compared to no exercise. The effects were not as significant when comparing aquatic exercise to land-based exercise in the same patient populations, indicating that aquatic exercise *may* be the better option, but ultimately it may depend upon what is most realistic and valuable to the patient. However, the therapeutic properties of the aquatic environment are often well-tolerated and preferred in patients with high sensitivity, impaired physical function, and risk of falls, which likely contributes to the benefits of aquatic therapy compared with land-based therapy in these populations.

When specifically considering the amputee population, there is no high quality evidence to support or negate the implementation of aquatic exercise. The Cutler (2017) paper provides a hazy look at the intervention and patient population at hand, but its poor quality and validity inhibit the ability to make strong recommendations based on the results and discussion. However, when combined with the results of the Barker et al (2014) article, all results can be extrapolated and applied generally to patients with lower extremity amputation. It is reasonable to conclude that individuals with lower extremity amputation may experience improved physical function and quality of life following an aquatic exercise program. Future research should focus on specific outcomes related to physical function and psychosocial/quality of life following aquatic exercise in individuals with lower extremity amputation. For general musculoskeletal populations, future research should focus on exploring specific parameters of aquatic exercise (frequency, duration, intensity, type) for optimal functional and psychosocial benefit. These explorations are difficult to standardize because of the variability in patient presentation, comorbidities, and tolerance to activity, but more well-designed research studies with randomization and specific outcome measures would improve the understanding and awareness of the benefits of aquatic exercise in all populations.

REFERENCES
[List all references cited in the CAT]

1. Barker AL, Talevski J, Morello RT, Brand CA, Rahmann AE, Urquhart DM. Effectiveness of aquatic exercise for musculoskeletal conditions: a meta-analysis. Arch Phys Med Rehabil, 95: 1776-1786, 2014.

2. Cutler TJ. TRANSFEMORAL AQUATIC REHABILITATION. In: American Academy of Orthotists & Prosthetists, 2017.

3. Villalta EM, Peiris CL. Early aquatic physical therapy improves function and does not increase risk of wound-related adverse events for adults after orthopedic surgery: a systematic review and meta-analysis. Arch Phys Med Rehabil, 94: 138-148, 2013.

4. Cutler TJ. Rehabilitation of an Individual with Transfemoral Amputation Combining Aquatic Ambulation With Prosthetic Socket Incorporating High-Fidelity Skeletal Capture. Journal of Prosthetics and Orthotics, 29: 206-212, 2017.

5. Heywood S, McClelland J, Mentiplay B, Geigle P, Rahmann A, Clark R. Effectiveness of Aquatic Exercise in Improving Lower Limb Strength in Musculoskeletal Conditions: A Systematic Review and Meta-Analysis. Arch Phys Med Rehabil, 98: 173-186, 2017.

6. Severin AC, Burkett BJ, McKean MR, Sayers MGL. BIOMECHANICAL ASPECTS OF AQUATIC THERAPY: A LITERATURE REVIEW ON APPLICATION AND METHODOLOGICAL CHALLENGES. Journal of Fitness Research, 5: 48-62, 2016.

7. Heywood S, McClelland J, Geigle P, Rahmann A, Clark R. Spatiotemporal, kinematic, force and muscle activation outcomes during gait and functional exercise in water compared to on land: A systematic review. Gait Posture, 48: 120-130, 2016.

8. van Silfhout L, Edwards MJ. Mobilising the patient: With emphasis on innovative technologies. Injury, 51 Suppl 2: S15-S17, 2020.