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| **CRITICALLY APPRAISED TOPIC** |

**FOCUSED CLINICAL QUESTION**

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| In a 16-year-old child with cerebral palsy (P), is aquatic therapy (I) more effective than land-based therapy (C) in improving gross motor function (O)? |

**AUTHOR**

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**CLINICAL SCENARIO**

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| A 16-year-old male with spastic hemiplegia cerebral palsy (CP), classified at Gross Motor Function Classification System (GMFCS) level II, presents to outpatient physical therapy, accompanied by his parents, with mobility limitations. His physical examination reveals muscle weakness in his left extremities; abnormal muscle tone; impaired balance; and gait abnormalities, such as reduced step length on the left, decreased clearance of the left foot, and maintenance of knee flexion in a crouched gait pattern. The patient is ambulatory with the use of an articulating ankle-foot orthosis and supra-malleolar orthosis on his left and right feet, respectively. He plays basketball on a recreational league multiple times per week, and his goal for physical therapy is to improve his running abilities so that he can participate for the duration of his games.While children with CP are candidates for both land-based and aquatic therapy, knowing which intervention is preferred for improvements in gross motor function can aid physical therapists and other healthcare providers in coordinating care, thereby optimizing patient outcomes. In this case, choosing the proper therapeutic environment, whether on land or in water, will increase the patient’s functional mobility for participation in activities of his choosing, and thus aid him in meeting his therapy-related goals. |

**SUMMARY OF SEARCH**

[Best evidence appraised and key findings]

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| Eight studies met the inclusion and exclusion criteria, including 2 systematic reviews, 4 randomized controlled trials, 1 quasi-experimental study, and 1 case series.* Aquatic and land-based therapy of short duration, such as 6 weeks, equally improve gross motor function, as well as lower extremity spasticity, functional mobility, and severity of disability, in children with CP.
* Aquatic therapy that is longer in duration, lasting 10 weeks or more, is more effective than land-based therapy in improving gross motor function in children with spastic CP.
* Aquatic therapy yields greater improvements in health-related quality of life than land-based therapy, as determined by child self-reported and parent proxy-reported outcome measures.
* Aquatic therapy is feasible, and even effective, for children with CP at higher GMFCS levels, likely due to the buoyancy effect of water.
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**CLINICAL BOTTOM LINE**

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| Aquatic therapy is just as effective, if not more effective, than land-based therapy in improving gross motor function in children with CP. The unique properties of water allow for freedom of movement that cannot be obtained on land, especially for children who are less mobile at baseline. Despite its success, the evidence for aquatic intervention in children with CP is limited in terms of quality and quantity, and results are sometimes mixed. The safety and feasibility of aquatic therapy has been proven, but additional research is needed to add to the evidence base for its effectiveness, as well as its dosage. |

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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*** |

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

**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) |
| cerebral palsyCPchild | aquatic therapyaquatic exercisehydrotherapywater therapypool therapy | land-based therapyphysical therapyphysiotherapyrehabilitation | gross motor functionmotor functiongross motor developmentgross motor skills |

**Final search strategy (history):**

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

1. cerebral palsy OR cp
2. aquatic therap\*
3. aquatic exercise
4. hydrotherapy
5. physical therap\*
6. physiotherap\*
7. motor function
8. #1 AND (#2 OR #3 OR #4) AND (#5 OR #6) AND #7
9. #1 AND (#2 OR #3 OR #4) AND #7
10. **#1 AND (#2 OR #3 OR #4) AND (#5 OR #6)**

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

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| **Databases and Sites Searched** | **Number of results** | **Limits applied, revised number of results (if applicable)** |
| **PubMed****Cochrane Library****PEDro****CINAHL** | **51****18****18****71** | **28, Applied Filters: 2010 to 2020****15, Applied Filters: 2010 to 2020****15, Applied Filters: 2010 to 2020****43, Applied Filters: 2010 to 2020** |

## INCLUSION and EXCLUSION CRITERIA

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| **Inclusion Criteria** |
| * Patient population younger than 18 years of age with a diagnosis of cerebral palsy
* Patients underwent a type of aquatic intervention, with a description of functional status both before and after treatment
* The use of standardized outcome measures to assess gross motor function
* Studies with an experimental or observational design (i.e. systematic reviews, meta-analyses, randomized controlled trials, quasi-experimental studies, case series and reports)
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| **Exclusion Criteria** |
| * Published in a language other than English
* Published prior to 2010
* Abstracts, poster presentations, narrative reviews, meta-syntheses
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**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).*

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| **Author (Year)** | **Risk of bias (quality score)\*** | **Level of Evidence\*\*** | **Relevance** | **Study design** |
| **Adar (2017)1** | **PEDro scale: 9/11** | **Level 1b** | **High** | **Single-Blind RCT** |
| **Lai (2015)2** | **Downs and Black Checklist: 18/29** | **Level 2b** | **High** | **Single-Blind, Quasi-Experimental Prospective Study** |
| **Akinola (2019)3** | **PEDro scale: 5/11** | **Level 1b** | **High** | **Single-Blind RCT** |
| **Dimitrijević (2012)4** | **PEDro scale: 6/11** | **Level 1b** | **Moderate** | **RCT** |
| **Fragala-Pinkham (2014)5** | **Downs and Black Checklist: 18/29** | **Level 4** | **Moderate** | **Case Series** |
| **Declerck (2016)6** | **PEDro scale: 6/11** | **Level 1b** | **Low** | **Single-Blind RCT** |
| **Dolbow (2017)7** | **AMSTAR: 3/11** | **Level 1a** | **Low** | **Systematic Review** |
| **Roostaei (2017)8** | **AMSTAR: 6/11** | **Level 1a** | **Moderate** | **Systematic 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:

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| * Adar S, Dündar Ü, Demirdal ÜS, Ulaşlı AM, Toktaş H, Solak Ö. The effect of aquatic exercise on spasticity, quality of life, and motor function in cerebral palsy. *Turk J Phys Med Rehab*. 2017;63(3):239-248. doi:10.5606/tftrd.2017.280.
	+ As a study with high methodological quality (9/11 on the PEDro scale), a high level of evidence (1b), and relevance to the clinical scenario, it is an obvious choice for critical appraisal. The study design and associated level of evidence match that of other articles retrieved, but it is 1 of 3 studies that compares aquatic therapy and land-based therapy in children with CP, which addresses the clinical question in its entirety. The study’s subjects were between 4 and 18 years of age with a diagnosis of spastic diplegia or hemiplegia CP. These characteristics match those of the aforementioned patient, improving the generalizability of the results to his case.
* Akinola BI, Gbiri CA, Odebiyi DO. Effect of a 10-week aquatic exercise training program on gross motor function in children with spastic cerebral palsy. *Glob Pediatr Health*. 2019;6:2333794X19857378. doi:10.1177/2333794X19857378.
	+ This study provides top-tier evidence (1b) and fair methodological quality (5/11 on the PEDro scale) in comparison to the other articles retrieved. Even though its quality is similar to that of the study of Lai et al,2 the randomization in this study’s design makes it superior in terms of minimizing biased responses to treatment. Like the study of Adar et al1 and Lai et al,2 this study compares aquatic therapy and land-based therapy in a single sample of subjects, which again, address the clinical question in its entirety. While the study of Dimitrijević et al4 appears to score higher on the PEDro scale, its control group refrains from engaging in physical activity, making it unlikely to provide results that determine whether aquatic therapy is more effective than land-based therapy.
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**SUMMARY OF BEST EVIDENCE**

**(1) Description and appraisal of “The Effect of Aquatic Exercise on Spasticity, Quality of Life, and Motor Function in Cerebral Palsy” by Adar et al, 2017**

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| **Aim/Objective of the Study/Systematic Review:** |
| The primary aim of this study was to compare the effects of aquatic and land-based exercise interventions in children with CP, as determined by spasticity, quality of life, and gross motor function. The secondary aim of this study was to assess the morphology of spastic gastrocnemius muscle for morphological changes during the interventions using ultrasonography (USG). |
| **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 study is a single-blind randomized controlled trial in which 32 subjects were randomized into experimental and control groups, which were the aquatic and land-based exercise groups, respectively. Randomization was secured with numbered envelopes, assigning 17 subjects to the experimental group and 15 subjects to the control group. One physical therapist (PT) and 2 hydrotherapists led the aquatic exercise sessions, and 3 different PTs led the land-based exercise sessions. One physiatrist performed measurements at baseline, while another physiatrist performed measurements post-treatment, or after 6 weeks of either aquatic or land-based exercise. In regard to the secondary aim of this study, a single physiatrist with 4 years of experience in musculoskeletal USG performed ultrasonographic assessment of spastic gastrocnemius muscle both before and after treatment, while remaining blinded to both interventions.For statistical analysis, “numerical data with a normal distribution were analyzed with the independent sample t-test, while numerical data without a normal distribution and non-numerical data were analyzed with the Mann-Whitney U test” (page 242). The paired t-test and Wilcoxon rank sum test were used to compare pre- and post-treatment data for the experimental and control groups. The chi-square test was used to compare categorical variables, and relationships among them were assessed using the Spearman’s correlation test. Values were considered statistically significant with a two-tailed p-value of <0.05. |
| **Setting**[e.g., locations such as hospital, community; rural; metropolitan; country] |
| Subjects were recruited from the outpatient physical medicine and rehabilitation clinic of the Afyon Kocatepe University-affiliated hospital in the city of Afyonkarahisar, Turkey. Authors of this study were associated with the Department of Physical Medicine and Rehabilitation of that university and Katip Çelebi University in Izmir, Turkey.  |
| **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. |
| Thirty-two subjects with spastic diplegia or hemiplegia CP were recruited from the outpatient facility of the Afyon Kocatepe University-affiliated hospital between August 2012 and August 2013 for participation in this study. They were selected based on the following inclusion criteria: a diagnosis of CP, age between 4 and 18 years, spasticity in the lower extremities graded ≥1 per the modified Ashworth Scale (MAS), being able to follow directions and answer questions regarding their health status, being medically appropriate to participate in an exercise program, and adhering to the program. Children were excluded from this study if they had open wounds, any known cardiovascular disease, orthopedic surgery in the preceding 12 months, botulinum toxin A injection to the lower extremities in the preceding 6 months, or fear of water.There were 17 males and 15 females with a mean age of 9.7±2.7 years in this study. In the experimental group, there were 8 males and 9 females, of which 11 had spastic diplegia and 6 had spastic hemiplegia. Six subjects were classified at GMFCS level I, 6 subjects at level II, 3 subjects at level III, and 2 subjects at level IV. In the control group, there were 9 males and 6 females, of which 10 had spastic diplegia and 5 had spastic hemiplegia. Six subjects were classified at GMFCS level I, 2 subjects at level II, 4 subjects at level III, and 3 subjects at level IV. The experimental and control groups were not significantly different in regard to sex (p=0.502), age (p=0.627), diplegia/hemiplegia ratio (p=0.907), impairment level, functional measures, and health-related quality of life at baseline. All subjects completed the interventions as planned. |
| **Intervention Investigated**[Provide details of methods, who provided treatment, when and where, how many hours of treatment provided] |
| *Control* |
| The land-based exercise group served as the control group in this study. Subjects were under one-on-one supervision of a PT. The intervention consisted of 5 sessions per week for 6 weeks, totalling 30 sessions, on land. Sessions were 60 minutes in duration, with 10 minutes of active range of motion and stretching exercises; 30 minutes of aerobic exercise and strengthening exercise for the hip flexor, knee extensor, and ankle dorsiflexors; and 20 minutes of sitting, standing, and gait training. |
| *Experimental* |
| The aquatic exercise group served as the experimental group in this study. Subjects were under one-on-one supervision of a PT, with the option to receive additional assistance from 1 or 2 hydrotherapists. The intervention consisted of 5 sessions per week for 6 weeks, totalling 30 sessions, in a swimming pool at 33ºC. Sessions were 60 minutes in duration, with 10 minutes of poolside exercises, including warm-up, active range of motion exercises, and stretching, and 50 minutes of aquatic exercise in the pool. The pool session was divided into 25 minutes of aerobic exercise, such as swimming; 20 minutes of active range of motion, stretching, and strengthening exercises for the hip flexor, knee extensor, and ankle dorsiflexors; and 5 minutes of cool-down with slow-paced activity. The subjects’ exercises were adapted based on the number of repetitions and intensity level that they were capable of. Aquatic noodles, leg weights, and fins were utilized for this purpose. |
| **Outcome Measures**[Give details of each measure, maximum possible score and range for each measure, administered by whom, where] |
| One physiatrist administered outcome measures at baseline, and another physiatrist administered outcome measures post-treatment, or after 6 weeks of either aquatic or land-based exercise. A single physiatrist with 4 years of experience in musculoskeletal USG performed ultrasonographic evaluation of spastic gastrocnemius muscle both before and after treatment.* Pediatric Quality of Life Inventory (PedsQL)-CP Module: Subjects and their parents filled out the child self-report and parent proxy-report versions of the PedsQL-CP Module as an assessment of health-related quality of life, using 35 items across 7 dimensions: daily activities, school activities, movement and balance, pain and injury, fatigue, eating activities, and speech and communication. Items were reverse scored on a 5-point Likert scale, ranging from 0 being “Never” to 4 being “Almost always,” and transformed to a scale from 0 to 100 as follows: 0=100, 1=75, 2=50, 3=25, 4=0. A mean score of all items was calculated, with a maximum possible score of 100 indicating the best health-related quality of life.
* MAS: Subjects’ joints were passively moved with varying degrees of velocity to assess spasticity. Scores range from 0 to 4, with 1+ being a scoring category in the modified scale to indicate resistance through less than half of the movement. A score of 0 correlates with no increase in tone, while a score of 4 correlates with rigidity in flexion or extension as the maximum possible score.
* Timed Up and Go (TUG): Subjects were timed in a walking task as an assessment of functional mobility. The timer started when they rose from their chair, and it stopped after they walked 3 meters, turned around, walked back to the chair, and sat down. A longer time to complete the TUG indicates an increased risk of falls.
* Gross Motor Function Measure-88 (GMFM-88): Subjects performed gross motor activities as an assessment of gross motor function, using 88 items across 5 dimensions: lying and rolling; sitting; crawling and kneeling; standing; and walking, running, and jumping. Items were scored on a 4-point ordinal scale, ranging from 0 being “Does not initiate task” to 3 being “Completes task.” Scores were totalled for each dimension, and a total score was calculated, with a maximum possible score of 264 indicating the best gross motor function.
* Wee Functional Independence Measure (WeeFIM): Subjects performed 18 motor and cognitive tasks as an assessment of their disability and how much assistance they needed to carry out activities of daily living. Items were scored on a 7-point ordinal scale, ranging from 1 being “Total assistance” to 7 being “Complete independence.” A total score between 18 and 126 was calculated as a sum, with a higher score indicating a higher level of functioning.
* USG evaluation: The gastrocnemius medialis muscle thickness, fascicle length, pennation angle, and compressibility ratio were used to determine the effect of aquatic and land-based exercise interventions on spastic gastrocnemius muscle. The site of the measurements was standardized by taking the images “at proximal 30% of the tibial length as defined as the distance from the popliteal crease to the midpoint of the lateral malleolus” (page 241). The probe was positioned in the middle of each subject’s leg, being halfway between the muscle belly’s medial and lateral borders.
	+ Gastrocnemius medialis muscle thickness: Measured as the distance between the deep and superficial aponeuroses of the muscle.
	+ Fascicle length: Measured as the length between the intersections of the fascicle with the deep and superficial aponeuroses of the muscle.
	+ Pennation angle: Measured as the angle between the deep aponeurosis and the echoes of the interspaces among fascicles of the muscle.
	+ Compressibility ratio: Calculated by dividing the muscle thickness during minimal and maximal probe pressures.
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| **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.] |
| Table 1. The results and statistical comparisons of outcome measures, with the exception of the PedsQL-CP Module, at baseline and post-treatment for the land-based exercise group (page 244).

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|  | Baseline | Post-Treatment  |
|  | Mean±SD | Median | Min-Max | Mean±SD | Median | Min-Max | P-value |
| MAS: RKF |  | 1 | 0-3 |  | 0 | 0-2 | 0.008 |
| MAS: LKF |  | 1 | 0-3 |  | 0 | 0-2 | 0.003 |
| MAS: RAF  |  | 3 | 0-4 |  | 1 | 0-3 | 0.001 |
| MAS: LAF |  | 2 | 1-4 |  | 1 | 1-3 | 0.046 |
| MAS: RHA |  | 1 | 0-3 |  | 0 | 0-2 | 0.083 |
| MAS: LHA |  | 0 | 0-3 |  | 0 | 0-2 | 0.013 |
| TUG (sec) |  | 14 | 9.4-40 |  | 12 | 8.5-29 | 0.008 |
| GMFM-88 |  | 210 | 45-261 |  | 208 | 93-248 | <0.001 |
| WeeFIM: Motor |  | 78 | 15-90 |  | 85 | 59-90 | 0.001 |
| WeeFIM: Cognitive |  | 35 | 23-35 |  | 35 | 32-35 | 0.102 |
| WeeFIM: Total |  | 113 | 38-125 |  | 120 | 94-125 | 0.001 |
| Muscle Thickness (mm) | 11.3±1.7 |  |  | 11.4±2.1 |  |  | 0.698 |
| Fascicle Length (mm) | 31.8±9.7 |  |  | 31.0±10.1 |  |  | 0.516 |
| Pennation Angle (º) | 22.2±7.7 |  |  | 23.6±6.1 |  |  | 0.246 |
| Compressibility Ratio |  | 1.6 | 1.2-3.8 |  | 1.7 | 1.4-3 | 0.008 |

Note.SD: Standard deviation, Min: Minimum, Max: Maximum, RKF: Right knee flexors, LKF: Left knee flexors, RAF: Right ankle plantarflexors, LAF: Left ankle plantarflexors, RHA: Right hip adductors, LHA: Left hip adductorsIn the land-based exercise group, there were statistically significant improvements in post-treatment scores for the MAS, except for the right hip adductors; TUG; all dimensions and the total score of the GMFM-88; motor subscale and total score of the WeeFIM; and compressibility ratio of the spastic gastrocnemius muscle. There were also statistically significant improvements in the movement and balance subpart of the child-report PedsQL-CP Module and in the movement and balance and pain and injury subparts of the parent proxy-report PedsQL-CP Module.Table 2. The results and statistical comparisons of outcome measures, with the exception of the PedsQL-CP Module, at baseline and post-treatment for the aquatic exercise group (page 243).

|  |  |  |
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|  | Baseline | Post-Treatment  |
|  | Mean±SD | Median | Min-Max | Mean±SD | Median | Min-Max | P-value |
| MAS: RKF |  | 0 | 0-2 |  | 0 | 0-1 | 0.039 |
| MAS: LKF |  | 0 | 0-3 |  | 0 | 0-1 | 0.003 |
| MAS: RAF  |  | 2 | 1-3 |  | 1 | 0-3 | 0.005 |
| MAS: LAF |  | 3 | 1-3 |  | 2 | 0-3 | 0.046 |
| MAS: RHA |  | 1 | 0-1 |  | 0 | 0-1 | 0.025 |
| MAS: LHA |  | 1 | 0-1 |  | 0 | 0-1 | 0.003 |
| TUG (sec) | 13.9±5.6 |  |  | 12.2±5.8 |  |  | <0.001 |
| GMFM-88 |  | 210 | 45-261 | 202.1±63.3 |  |  | <0.001 |
| WeeFIM: Motor |  | 82 | 27-91 |  | 85 | 59-91 | 0.010 |
| WeeFIM: Cognitive |  | 34 | 22-35 |  | 34 | 29-35 | 0.083 |
| WeeFIM: Total |  | 115 | 53-126 |  | 120 | 92-126 | 0.010 |
| Muscle Thickness (mm) | 10.3±0.6 |  |  | 10.4±0.7 |  | 0.329 |  |
| Fascicle Length (mm) | 30.4±8.4 |  |  | 28.7±8.9 |  | 0.419 |  |
| Pennation Angle (º) | 20.5±4.1 |  |  | 19.8±6.1 |  | 0.019 |  |
| Compressibility Ratio |  | 1.5 | 1.2-2.5 | 1.8±0.3 | 1.8 | 1.2-2.4 | 0.041 |

Note*.* SD: Standard deviation, Min: Minimum, Max: Maximum, RKF: Right knee flexors, LKF: Left knee flexors, RAF: Right ankle plantarflexors, LAF: Left ankle plantarflexors, RHA: Right hip adductors, LHA: Left hip adductorsIn the aquatic exercise group, there were statistically significant improvements in post-treatment scores for the MAS, TUG, all dimensions and the total score of the GMFM-88, motor subscale and total score of the WeeFIM, and compressibility ratio of spastic gastrocnemius muscle. The MAS scores of spastic gastrocnemius muscle showed a negative and weak-to-moderate correlation with the compressibility ratio (r=-0.276, p<0.001), but there was no correlation with muscle thickness, fascicle length, or pennation angle. There were statistically significant improvements in the daily activities, school activities, movement and balance, pain and injury, and eating activities subparts of the child self-report PedsQL-CP Module and in the daily activities, school activities, movement and balance, pain and injury, and fatigue subparts of the parent proxy-report PedsQL-CP Module.There were no statistically significant differences in the improvements in post-treatment scores for the MAS, TUG, all dimensions and the total score of the GMFM-88, and motor subscale and total score of the WeeFIM between the aquatic and land-based exercise groups.  |
| **Original Authors’ Conclusions**[Paraphrase as required. If providing a direct quote, add page number] |
| The authors derived 3 conclusions from this study: (1) Both aquatic and land-based exercise interventions equally improved all scores for lower extremity MAS, TUG, all dimensions and the total score of the GMFM-88, and the motor subscale and total score of the WeeFIM in children with CP; (2) the aquatic exercise intervention yielded a higher improvement in post-treatment scores for the USG compressibility ratio and most subparts of the child self-report and parent proxy-report versions of the PedsQL-CP Module, as compared to the land-based exercise intervention; and (3) “the MAS scores of spastic gastrocnemius muscle of the patients with CP showed a negative and weak-to-moderate correlation with the compressibility ratio based on the USG findings” (page 245).The authors attributed the equal improvements in post-treatment scores to the short duration of the aquatic exercise intervention; the subjects’ lower GMFCS levels; and the blinded nature of the study, specifically in regard to the baseline and post-treatment assessments not being performed by a single physiatrist. The authors assumed that extending the intervention would encourage subjects’ motor learning, especially those at higher GMFCS levels, thereby producing a statistically significant difference between the aquatic and land-based exercise groups. Greater improvements in health-related quality of life in the aquatic exercise group were thought to stem from the optimal environment that the unique properties of water create, as well as the enjoyment that children with CP receive from activities in the water. While the success of the aquatic exercise intervention was demonstrated in the compressibility ratio obtained from USG evaluation, it might be more sensitive to small improvements in the spasticity of spastic gastrocnemius muscle since differences in post-treatment MAS scores were not noted from one group to the other. |
| **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.] |
| PEDro scale [Eligibility criteria: Yes; Random allocation: Yes; Concealed allocation: Yes; Baseline comparability: Yes; Blind subjects: No; Blind therapists: No; Blind assessors: Yes; Adequate follow-up: Yes;  |

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| Intention-to-treat analysis: Yes; Between-group comparison: Yes; Point estimates and variability: Yes]This study received 9 of 11 points on the PEDro scale, indicating high internal and external validity. Speaking to its internal validity, or the credibility of its results, this study implemented a random allocation process with allocation concealment and a single-blind strategy. Subjects were assigned to experimental and control groups with numbered envelopes, giving the groups equally distributed characteristics, as evidenced by their similarities at baseline regarding the most important prognostic indicators. The physiatrists who administered outcome measures were blinded to both interventions, reducing the likelihood of them introducing assessor bias, despite the subjects and therapists remaining unblinded. Subjects adhered to the aquatic and land-based exercise interventions without group reassignment or loss to follow-up, permitting data collection at baseline and post-treatment and their analysis by intention-to-treat. Results were reported with measures of variability within the aquatic and land-based exercise groups and between them, giving an idea of the size of the treatment effect and dispersion of the data set. The inclusion of these features reduces the risk of bias and increases the potential for causal inference, meaning this study is likely to be internally valid.Satisfaction of the first item on the PEDro scale is an indication of external validity. The inclusion and exclusion criteria in this study clearly defined the population of interest, helping to confirm that the results are valid for patients other than those in the original study population. Considering the loose eligibility criteria, the subjects’ demographic and clinical characteristics are relevant to a more general population of children with CP.The overall evidence quality of this study is high, and thus strongly supports the authors’ conclusion that the aquatic exercise intervention improved all scores for lower extremity MAS, TUG, all dimensions and the total score of the GMFM-88, and the motor subscale and total score of the WeeFIM in children with CP. While this study’s results can be trusted, based on the internal and external validity of the study design, their application is limited by a small sample size and the short duration of therapy. |
| **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.] |
| Both aquatic and land-based exercise interventions, as outlined by Adar et al,1 improved all scores for measures of lower extremity spasticity, functional mobility, gross motor function, and severity of disability; yet the aquatic exercise intervention proved to be superior in improving subjects’ health-related quality of life and compressibility ratio of spastic gastrocnemius muscle. This study’s results indicate that aquatic exercises are as effective as land-based exercises in children with CP under the age of 18, and for some variables, they are more effective. The associated p-values, when they are less than 0.05, increase the strength of the results; and the acts of random allocation, concealment, blinding, and within and between group comparison propose a cause-and-effect relationship between aquatic and land-based exercise interventions and their outcomes.This study’s findings are clinically significant, as they demonstrate the suitability of an aquatic exercise intervention for children with CP. Improvements in the above-mentioned areas of impairment, as well as health-related quality of life, are likely to have a noticeable effect on children’s lives, and even their parents’ lives. It can be assumed that children’s independence will increase as their mobility limitations decrease, making this type of intervention practical, whether it is on land or in water. Bottom line: With the freedom to choose between aquatic and land-based exercise interventions, children with CP should be evaluated on an individual basis so that they are referred to the proper therapeutic environment, one that they prefer to be in. This recommendation is evidenced by the results of this study, seeing as both interventions optimize patient 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.] |
| This study is highly relevant and applicable to the clinical question and scenario, as they share the same patient population in terms of age, diagnosis, and severity of disability; intervention and comparison; and outcome of interest. Gross motor function is the only outcome mentioned in the clinical question, but because the patient in the clinical scenario presents with a variety of impairments that are assessed by the other outcome measures in this study, they are increasingly relevant to his case. This study’s results suggest that aquatic and land-based exercise interventions are equally effective in improving gross motor function, which answers the clinical question. If the patient in the clinical scenario were to participate in either intervention, complete with identical parameters, it is plausible that he would experience similar improvements. Then, the choice of intervention would be a matter of preference and whether he and his family have access to a swimming pool equipped with therapy staff, considering that there is no decision to be made if both options are not available. But when given a choice, the minimal equipment and preparation for aquatic and land-based exercise interventions makes them both practical and feasible. |

**(2) Description and appraisal of “Effect of a 10-Week Aquatic Exercise Training Program on Gross Motor Function in Children with Spastic Cerebral Palsy” by Akinola et al, 2019**

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| **Aim/Objective of the Study/Systematic Review:** |
| The aim of this study was to determine the effect of an aquatic exercise training program, as compared with land-based exercise, on gross motor function in children with spastic CP. |
| **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 study is a single-blind randomized controlled trial in which 30 subjects were randomized into experimental and control groups, which were the water-based exercise group and land-based exercise group, respectively. The allocation concealment strategy was not specified, but through a random allocation sequence, 15 subjects were assigned to both the experimental and control groups. Two physiotherapists led the treatment of each session for each subject. Assessors who did not participate in either intervention were trained on the use of outcome measures. They performed measurements at baseline and at the end of the fourth week, eighth week, and tenth week of treatment, while remaining blinded to the study group assignments. For statistical analysis, the subjects’ ages were compared with the independent sample t-test. The Friedman test (*F*) was used to compare the baseline, fourth week, eighth week, and tenth week of data within the experimental and control groups, and the Mann-Whitney U test was used to compare data between both groups. Values were considered statistically significant with a p-value of <0.05. |
| **Setting**[e.g., locations such as hospital, community; rural; metropolitan; country] |
| Subjects were recruited from a developmental center in the megacity of Lagos, Nigeria, where they were receiving rehabilitation treatment for CP. |
| **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. |
| Thirty subjects with spastic CP were recruited in a convenience sample from a developmental center for participation in this study. They were younger than 12 years of age; however, the inclusion and exclusion criteria were not specified, except for children with associated neurodevelopmental conditions being excluded. The mean age of subjects in the experimental group was 4.93±1.98 years, the mean age of subjects in the control group was 5.41±2.85 years, and the mean age of all subjects was 5.20±2.43 years. In the experimental group, there was 1 subject classified at GMFCS level II, 5 subjects at level III, 7 subjects at level IV, and 2 subjects at level V. In the control group, there were 6 subjects classified at GMFCS level III and 9 subjects at level IV. The experimental and control groups were not statistically different in regard to age (p=0.105), mobility level (p=0.781), and various dimensions of gross motor function at baseline. All subjects completed the intervention as planned. |
| **Intervention Investigated**[Provide details of methods, who provided treatment, when and where, how many hours of treatment provided] |
| *Control* |
| The land-based exercise group served as the control group in this study. Subjects were under the supervision of 2 physiotherapists. The intervention consisted of 2 sessions per week for 10 weeks, totalling 20 sessions, on land. Sessions combined 2 types of exercises: manual passive stretching and functional training. Manual passive stretching involved passively moving the joints of spastic muscles away from the direction of primary function and holding the end position for 60 seconds. This process was repeated 5 times for a total duration of 5 minutes per joint. Subjects were functionally trained in 4 levels according to their gross motor function, with each level of training lasting 15 minutes. The levels were 2-point kneeling exercise training, sitting education/training, standing education/training, and walking education/training. |
| *Experimental* |
| The water-based exercise group served as the experimental group in this study. Subjects were under the supervision of 2 physiotherapists. The intervention consisted of 2 sessions per week for 10 weeks, totalling 20 sessions, in a swimming pool between 28ºC and 32ºC. Sessions combined 2 types of exercises, manual passive stretching and functional training, that fully immersed the exercised body parts in water. Manual passive stretching involved passively moving the joints of spastic muscles away from the direction of primary function and holding the end position for 60 seconds. This process was repeated 5 times for a total duration of 5 minutes per joint. Subjects were functionally trained in 4 levels according to their gross motor function, with each level of training lasting 15 minutes. The levels were 2-point kneeling exercise training, sitting education/training, standing education/training, and walking education/training. |
| **Outcome Measures**[Give details of each measure, maximum possible score and range for each measure, administered by whom, where] |
| Assessors who did not participate in either intervention administered outcome measures at baseline and at the end of the fourth week, eighth week, and tenth week of treatment.* GMFM-88: Subjects performed gross motor activities as an assessment of gross motor function, using 88 items across 5 dimensions: lying and rolling; sitting; crawling and kneeling; standing; and walking, running, and jumping. Items were scored on a 4-point ordinal scale, ranging from 0 being “Does not initiate task” to 3 being “Completes task.” Scores were totalled for each dimension, and a total score was calculated, with a maximum possible score of 264 indicating the best gross motor function.
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| **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.] |
| Table 1. The mean rank changes in the GMFM-88 at baseline and at the end of the fourth week, eighth week, and tenth week of treatment for the water-based exercise group (page 4).

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| --- | --- | --- | --- | --- | --- | --- |
|  | Baseline | 4th Week | 8th Week | 10th Week | *F* | P-value |
| A. Lying and Rolling | 1.97 | 2.30 | 2.97 | 3.00 | 16.019 | 0.001 |
| B. Sitting | 1.90 | 2.30 | 2.87 | 2.93 | 17.727 | 0.001 |
| C. Crawling and Kneeling | 2.17 | 2.30 | 2.57 | 2.97 | 12.600 | 0.006 |
| D. Standing | 2.23 | 2.50 | 2.50 | 2.77 | 8.000 | 0.046 |
| E. Walking, Running, and Jumping | 2.30 | 2.57 | 2.57 | 2.57 | 6.000 | 0.112 |
| Overall Gross Motor Function | 1.77 | 2.30 | 2.73 | 3.20 | 20.753 | 0.000 |

In the water-based exercise group, there were statistically significant improvements in post-treatment scores for all dimensions and the total score of the GMFM-88, with the exception of dimension E: walking, running, and jumping. Subjects were found to be predominantly female, older than 2 years, diagnosed with spastic quadriplegia CP, and mobile in congruence with GMFCS level IV. |
| **Original Authors’ Conclusions**[Paraphrase as required. If providing a direct quote, add page number] |
| The authors concluded “that aquatic exercise training program is a veritable tool for the improvement of gross motor function in children with spastic CP” (page 6). Ten weeks of participation in an aquatic exercise training program brought about statistically significant improvements in most dimensions of gross motor function, which the authors attributed to the buoyancy effect of water. They ruled that these improvements were significantly different from those in the land-based exercise group, ruling in favor of the aquatic exercise training program as a rehabilitative intervention for this patient population. |
| **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.] |
| PEDro scale [Eligibility criteria: No; Random allocation: Yes; Concealed allocation: No; Baseline comparability: Yes; Blind subjects: No; Blind therapists: No; Blind assessors: Yes; Adequate follow-up: No; Intention-to-treat analysis: Yes; Between-group comparison: Yes; Point estimates and variability: No]This study received 5 of 11 points on the PEDro scale, indicating medium internal and external validity. Speaking to its internal validity, or the credibility of its results, this study implemented a random allocation process with a single-blind strategy. Subjects were assigned to experimental and control groups, giving the groups equally distributed characteristics, as evidenced by their similarities in age and mobility level, as well as baseline parameters for gross motor function. The assessors who administered outcome measures were blinded to the study group assignments, reducing the likelihood of them introducing assessor bias, despite the subjects and physiotherapists remaining unblinded. As reflected in the PEDro scale score, this study lacks multiple factors that improve internal and external validity: eligibility criteria, concealed allocation, adequate follow-up, and point estimates and variability. The methods of this study state that subjects were screened for eligibility based on the inclusion and exclusion criteria, but these criteria were not specified. Without it, the population of interest is not clearly defined, although assumptions can be made regarding the demographic and clinical characteristics of the subjects that were recruited. Still, the generalizability of results to patients other than those in the original study population is questionable. Points were not awarded for allocation concealment or adequate follow-up because they were not explicitly mentioned in this study. It is unclear whether the randomization process was subject to selection bias, much less whether subjects remained in the water-based and land-based exercise groups without group reassignment or loss to follow-up. These unknowns, paired with the omission of measures of variability, threaten the internal validity of this study and cause hesitation in trusting that its results are free from bias.The overall evidence quality of this study is moderate to low, somewhat supporting the authors’ conclusion “that aquatic exercise training program is a veritable tool for the improvement of gross motor function in children with spastic CP” (page 6). While this study’s results can be trusted, based on the internal validity of the study design, their application is limited by the above-mentioned factors. |
| **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.] |
| Participation in the water-based exercise group was more effective, as compared to the land-based exercise group, in improving most dimensions of gross motor function in children with spastic CP under the age of 12. This study’s results indicate that an aquatic exercise training program should be pursued as a rehabilitative intervention instead of a land-based exercise training program in this patient population. The associated p-values, when they are less than 0.05, increase the strength of the results; and the acts of random allocation, blinding, and within and between group comparison propose a cause-and-effect relationship between the aquatic exercise training program and its outcomes. A point to note in this study is the concentration of children with CP who were classified at higher GMFCS levels, such as level III, IV, or V. Due to their mobility limitations that persist under the effects of gravity, water-based exercise seems to provide an alternative environment that allows for freedom of movement that cannot be obtained on land. Therefore, the results of this study also indicate that an aquatic exercise training program is feasible, and even effective, for children with CP at higher GMFCS levels, even though they are less mobile in the water. Despite this strength, this study neglects to mention its limitations. This downfall, along with the threats to its internal validity, prompt cautious interpretation of its results.This study’s findings are clinically significant, as they demonstrate the suitability of an aquatic exercise training program for children with CP of even the highest GMFCS levels. Improvements in gross motor function are likely to have a noticeable effect on children’s lives, and even their parents’ lives, in the areas that they are most dependent. The burden of care is assumed to decrease as a patient’s mobility increases, and in consequence, they require less assistance with daily tasks when they can operate at higher levels of functioning. For children with CP, this may translate to eating, communicating, transferring, or ambulating more independently. Considering these potential benefits, prescribing water-based exercise is worthy of consideration, particularly for those with severe disability.Bottom line: When provided in a longer duration, an aquatic exercise training program is preferable to a land-based exercise training program for the purpose of improving gross motor function in children with spastic CP.  |
| **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 study is moderately relevant and applicable to the clinical question and scenario, as they share the same patient population in terms of diagnosis and severity of disability, intervention and comparison, and outcome of interest. The subjects are younger than 12 years of age, with a mean age of 5.20±2.43 years. But the patient referenced in the clinical question and scenario is 16 years old, raising questions as to whether the results in this study would have a bearing on him. The difference in age, in addition to the vague eligibility criteria for subjects, interferes with the generalizability of the results to this case. However, this study’s results indicate that an aquatic exercise training program is more effective than a land-based exercise training program in improving gross motor function in a younger patient population. With this partial answer to the clinical question, it is plausible that the patient in the clinical scenario would experience similar improvements if he underwent the intervention, complete with identical parameters. As an already established treatment, aquatic exercise is known to be practical, but its feasibility is determined by patients’ access to a swimming pool equipped with therapy staff, which varies from person to person. |

**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.]

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| Both studies are applicable to the clinical question and scenario, based on the demographics and clinical characteristics of their patient population, their study designs, and the outcomes they measured. Yet, the study by Adar et al1 proved to be the most applicable due to the older ages of its subjects. Even with a mean age of 9.7±2.7 years, they are closer in age to the 16-year-old in the clinical scenario than the subjects in the study by Akinola et al.3 The eligibility criteria of the latter excludes subjects 12 years old or older, preventing recruitment of similarly aged youth. Moreover, the overall evidence quality presented in the study by Adar et al1 is superior to that of Akinola et al.3 With a PEDro scale score of 9/11, it has high internal and external validity that signify its methodological rigor and low risk of bias. The other study’s score of 5/11 lowers the trustworthiness of its results, and thus its quality.The results of these studies indicate that aquatic therapy is just as effective, if not more effective, than land-based therapy in improving gross motor function in children with CP. The study by Adar et al1 showed improvements in measures of gross motor function, as well as lower extremity spasticity, functional mobility, severity of disability, health-related quality of life, and compressibility ratio of spastic gastrocnemius muscle, with the provision of an aquatic exercise intervention; however, most of these improvements were equal to that of the land-based exercise intervention. In contrast, the study by Akinola et al3 showed that an aquatic exercise training program improved gross motor function significantly more than a land-based exercise training program. A successful outcome in this study may have been influenced by its concentration on children with CP who are classified at higher GMFCS levels and the longer duration of therapy. Higher GMFCS levels, such as levels III, IV, and V, provide subjects with more room to develop their gross motor function; and with gravity-induced restrictions, greater improvements might be expected once they are not as restricted in the water. Regardless of functional mobility, the extended length of the intervention, amounting to 10 weeks, could have caused a positive change in subjects’ gross motor function. In reflecting on the results of their 6-week intervention, Adar et al1 assumed that making it longer would encourage subjects’ motor learning, thereby producing the statistically significant difference between the aquatic and land-based exercise groups that they were lacking. Due to the fundamental differences in these studies, it is undetermined as to whether aquatic therapy is more effective than land-based therapy. But with promising results in gross motor function following activities in the water, they are equally effective, at the least. Despite its favor, the evidence for aquatic intervention in children with CP is limited in terms of quality and quantity, and as evidenced by this review, study results are sometimes mixed. This may be because of the small sample sizes of these studies, which decrease their statistical power and increase the risk of committing a type II error. On that account, longer large-scale studies are warranted to confirm or refute the trends observed in these studies and the relationship between gross motor function and the duration of intervention, in particular. |

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