THE USE OF AQUATIC CYCLING IN THE REHABILITATION OF PATIENTS WITH TOTAL HIP ARTHROPLASTY: A PILOT STUDY

Veronika Kramperová[1]*, Martin Švec[2]

[1]Charles University, Faculty of Physical Education and Sport, Prague, Czech Republic, [2]Charles University, Faculty of Physical Education and Sport, Prague, Czech Republic

ABSTRACT

INTRODUCTION: Aquatic cycling has emerged as a promising low-impact aerobic activity suitable for post-surgical rehabilitation. This pilot study aimed to assess its effectiveness in improving mobility and reducing joint stiffness in patients after total hip arthroplasty (THA). **METHODS:** Sixteen participants (9 women, 7 men; mean age 70.6 ± 6 years) were randomly assigned to either an experimental group, which engaged in an 8-week aquatic cycling program, or a control group receiving standard land-based physiotherapy. Functional performance was evaluated pre- and post-intervention using the Timed Up and Go (TUG) test, Ten-Meter Walk Test (10MWT), Six-Minute Walk Test (6MWT), and the WOMAC stiffness subscale. Heart rate during the main intervention phase was monitored using a ThinkRider chest strap and the mySasy app to maintain a target of 40–60% heart rate reserve (115–125 BPM). Motivational music (120 BPM) was used to facilitate rhythm and maintain consistent pacing during exercise. **RESULTS:** The experimental group demonstrated clinically meaningful improvements across all measured parameters. Although none of the changes reached statistical significance (all $p > 0.05$), between-group differences indicated the largest effect of the intervention in the Timed Up and Go test (Δ Cliff's delta = 0.32), followed by WOMAC Physical Function ($\Delta\delta = 0.32$) and WOMAC Pain ($\Delta\delta = 0.31$). Moderate effects were also seen in the 10-Meter Walk Test ($\Delta\delta = 0.22$) and the Six-Minute Walk Test ($\Delta\delta = 0.17$). These results suggest meaningful functional benefits of aquatic cycling over standard rehabilitation. **DISCUSSION:** These results suggest that aquatic cycling is a safe and effective complementary therapy for enhancing mobility and reducing joint stiffness in patients after THA. Improvements observed are consistent with findings from prior studies highlighting the benefits of aquatic rehabilitation. Aquatic cycling offers a gentler alternative to high-intensity training formats, rendering it especially appropriate for elderly or individuals with limited mobility. **CONCLUSIONS:** Aquatic cycling appears to be a viable addition to rehabilitation programs for patients following THA. Further larger-scale studies are recommended.

Keywords: rehabilitation, aquatic exercise, walking test, joint stiffness, functional recovery

INTRODUCTION

Total hip arthroplasty (THA) is a widely performed surgical procedure to relieve pain and restore mobility in patients with degenerative joint diseases, especially osteoarthritis. With the growing aging population, the demand for effective and safe rehabilitation protocols post-THA is increasing (Ferguson et al., 2018).

Optimal postoperative rehabilitation is crucial for restoring functional independence and ensuring long-term surgical outcomes. Traditional land-based rehabilitation can be demanding for elderly individuals or those with significant joint discomfort. Therefore, alternative approaches such as aquatic therapy are gaining popularity due to their favorable physical and psychological properties (Bartels et al., 2016; Wang et al., 2021).

Aquatic therapy has been shown to reduce joint loading due to buoyancy, provide thermal and hydrostatic benefits for circulation, and improve psychological confidence by minimizing the risk of falls.

The aquatic environment allows for early mobilization with reduced pain and resistance, which can positively affect recovery dynamics. Aquatic cycling represents a specific modality of aquatic therapy that involves pedaling on submerged stationary bikes, enabling repetitive, controlled lower limb movement with minimal joint stress (Garzon et al., 2015; Rewald et al., 2017).

Recent scoping reviews and experimental studies have indicated cardiovascular and muscular benefits of aquatic cycling in general populations. However, its potential in orthopedic rehabilitation remains underexplored. There is a clear gap in the literature regarding the use of aquatic cycling as a structured rehabilitation modality for patients in the early post-operative phase following THA. Most existing studies have focused on general aquatic exercise or hydrotherapy without examining the specific impacts of cyclical underwater movement on joint stiffness and mobility in orthopedic patients.

The present pilot study addresses this gap by investigating the effects of aquatic cycling on functional mobility and joint stiffness in patients after THA, offering insights into its feasibility and clinical relevance.

METHODS

Sixteen participants (9 women, 7 men; mean age 70.6 ± 6 years) were randomly allocated to an experimental group (aquatic cycling) or control group (land-based rehabilitation). The inclusion criteria were: primary unilateral THA, age >60 years, medical clearance for aquatic therapy. Exclusion criteria included infection, open wounds, or other contraindications.

The experimental group received standard land-based physiotherapy, supplemented with 45-minute aquatic cycling sessions conducted at a rehabilitation center twice weekly for eight weeks in a therapeutic pool at 32°C. Each session included: a 5-minute warm-up at self-selected pace on the Aquarider® submerged stationary bike, a 15-minute main phase at a target intensity of 40–60% heart rate reserve (115–125 BPM), and a cool-down phase. Heart rate was continuously monitored using a ThinkRider chest strap and the mySasy application. Motivational background music (Spotify, 120 BPM) was used to support pacing and engagement. The control group followed standard land-based physiotherapy, consisting of individually prescribed therapeutic exercises guided by a physiotherapist.

Outcome measures assessed pre/post intervention included:

- Timed Up and Go test (TUG),
- 10-Meter Walk Test (10MWT),
- Six-Minute Walk Test (6MWT),
- Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), which includes three subscales: Pain (W-A), Stiffness (W-B), and Physical Function (W-C).

Data were analyzed using the Wilcoxon signed-rank test and Mann-Whitney U test. Effect sizes were calculated with Cliff's delta, and between-group effect size was assessed using the difference in Cliff's delta (Δ Cliff's delta). Significance was set at $p < 0.05$.

RESULTS

Table 1 summarizes the baseline anthropometric characteristics of participants. There were no statistically significant differences between the experimental and control groups in age, height, weight, or BMI.

Table 1: Baseline Characteristics of Study Participants

Variable	*Experimental Group (n = 8)*	*Control Group (n = 8)*	*p-value*
Age (years)	*70.0 ± 6.9*	*71.1 ± 5.1*	*0.63*
Height (cm)	*169.6 ± 8.7*	*168.0 ± 6.2*	*0.73*
Weight (kg)	*82.1 ± 13.2*	*83.3 ± 11.3*	*0.81*
BMI (kg/m²)	*28.5 ± 3.2*	*29.5 ± 2.9*	*0.42*

Note: Data are presented as mean ± standard deviation. No statistically significant differences were found between the groups in age, height, weight, or BMI at baseline (p > 0.05).

Table 2 summarizes pre- and post-intervention results for both groups. As shown in Table 2, the experimental group demonstrated clinically relevant improvements across all measured outcomes. The most notable between-group differences (Δ Cliff's delta) were observed in the Timed Up and Go test (Δδ = 0.32), WOMAC-Physical Function (Δδ = 0.32), and WOMAC-Pain (Δδ = 0.31). Moderate effects were also observed for the 10-Meter Walk Test (Δδ = 0.22) and Six-Minute Walk Test (Δδ = 0.17). Although these changes did not reach statistical significance (p > 0.05), their magnitude suggests potential clinical benefit of aquatic cycling. The control group showed only minimal improvements without clinical relevance.

Table 2: Functional Performance Outcomes and Patient-Reported Measures

Test (Outcome)	***EG Pre (M±SD)***	***EG Post (M±SD)***	***p (EG)***	***δ (EG)***	***CG Pre (M±SD)***	***CG Post (M±SD)***	***p (CG)***	***δ (CG)***	***Δδ (EG–CG)***
TUG (s)	*12.8 ± 4.3*	*9.1 ± 2.5*	*0.141*	*0.66*	*11.4 ± 1.2*	*11.3 ± 1.4*	*0.201*	*0.34*	*0.32*
10MWT (s)	*11.8 ± 4.6*	*8.8 ± 2.2*	*0.834*	*0.66*	*10.5 ± 1.5*	*8.8 ± 1.6*	*0.078*	*0.44*	*0.22*
6MWT (m)	*283.8 ± 69.3*	*400.6 ± 79.2*	*0.527*	*0.56*	*304.4 ± 70.2*	*402.5 ± 57.8*	*0.527*	*0.39*	*0.17*
WOMAC-Pain	*4.8 ± 4.1*	*2.9 ± 2.6*	*0.553*	*0.50*	*6.9 ± 3.2*	*5.5 ± 3.3*	*0.055*	*0.19*	*0.31*
WOMAC-Stiffness	*3.4 ± 2.3*	*2.1 ± 1.7*	*0.275*	*0.47*	*2.9 ± 2.0*	*2.4 ± 1.2*	*0.093*	*0.29*	*0.18*
WOMAC-Function	*20.6 ± 6.4*	*12.8 ± 7.0*	*0.673*	*0.56*	*22.9 ± 9.0*	*16.4 ± 8.3*	*0.109*	*0.24*	*0.32*

Note: EG = Experimental Group, CG = Control Group; p = p-value (Wilcoxon test); δ = Cliff's delta; Δδ = between-group difference in Cliff's delta. None of the between-group differences reached statistical significance (all p > 0.05).

DISCUSSION

The results of this pilot study indicate that aquatic cycling may positively influence postoperative rehabilitation following THA. Although none of the measured outcomes reached statistical significance (all p > 0.05), moderate to large effect sizes – particularly in the TUG (Δδ = 0.32), WOMAC Physical Function (Δδ = 0.32), and WOMAC Pain (Δδ = 0.31) – suggest clinically meaningful improvements in mobility and perceived function. These functional gains were more pronounced in the experimental group than in the control group, as evidenced by the between-group differences in Cliff's delta.

These findings align with existing literature. Rewald et al. (2017) highlighted the potential of aquatic cycling for improving cardiovascular and musculoskeletal fitness while reducing joint stress, findings echoed in our study through improvements in walking and balance assessments. Garzon et al. (2015) also confirmed that aquatic cycling at moderate cadence provides effective cardiovascular loading with minimal joint impact. Luo et al. (2019) and Hinman et al. (2007) demonstrated the benefits of aquatic rehabilitation on pain and stiffness in joint replacement populations, in line with the positive WOMAC results observed in our experimental group. Similarly, Rahmann et al. (2009) emphasized the effectiveness of early aquatic intervention in post-THA recovery, supporting our focus on early postoperative application. Weston et al. (2014) discussed the role of high-intensity interval training, but aquatic cycling offers a more accessible and safer option for elderly individuals. Finally, Tovin et al. (1994)

compared water and land-based rehabilitation and found aquatic exercise equally or more effective in orthopedic recovery –resonating with our findings.

Nonetheless, several limitations must be acknowledged. First, the small sample size (n = 16) limits statistical power and generalizability. Second, the intervention period was relatively short (8 weeks), restricting insight into long-term sustainability. Third, some outcome measures relied on self-reported data (WOMAC), introducing potential subjectivity. Fourth, due to the nature of the intervention, neither participants nor evaluators could be blinded, possibly affecting assessment objectivity. Lastly, no follow-up was conducted to assess persistence of effects beyond the intervention.

Future studies should address these limitations by incorporating larger, randomized controlled trials with extended follow-up periods and objective biomarkers of recovery. Additionally, comparisons with other aquatic modalities (e.g., treadmill walking or resistance exercises) could provide further clinical guidance.

CONCLUSION

Aquatic cycling appears to be a safe and feasible complement to standard rehabilitation after total hip arthroplasty. Despite the absence of statistical significance, the observed moderate to large effect sizes suggest clinically meaningful benefits in mobility and joint function. Further research with larger cohorts is recommended to confirm these preliminary findings.

REFERENCES

1. Ferguson, R. J., Palmer, A. J., Taylor, A., Porter, M. L., Malchau, H., & Glyn-Jones, S. (2018). Hip replacement. *The Lancet, 392*(10158), 1662–1671. https://doi.org/10.1016/S0140-6736(18)31771-5
2. Garzon, M., Juneau, M., Dupuy, O., Nigam, A., & Bosquet, L. (2015). Cardiovascular responses to aquatic cycling at increasing pedaling cadences. *Journal of Science and Medicine in Sport, 18*(5), 610–614. https://doi.org/10.1016/j.jsams.2014.08.002
3. Hinman, R. S., Heywood, S. E., & Day, A. R. (2007). Aquatic physical therapy for hip and knee osteoarthritis: Results of a single-blind randomized controlled trial. *Physical Therapy, 87*(1), 32–43. https://doi.org/10.2522/ptj.20060040
4. Luo, Y., Wang, L., Wang, X., Wang, W., & Wang, Y. (2019). Effects of rehabilitation therapy on total hip replacement outcomes in elderly patients with hip osteoarthritis: A systematic review and meta-analysis. *Aging Clinical and Experimental Research, 31*(7), 919–927. https://doi.org/10.1007/s40520-018-1046-3
5. Rahmann, A. E., Brauer, S. G., & Nitz, J. C. (2009). A specific inpatient aquatic physiotherapy program improves strength after total hip or knee replacement surgery: A randomized controlled trial. *Archives of Physical Medicine and Rehabilitation, 90*(5), 745–755. https://doi.org/10.1016/j.apmr.2008.10.032
6. Rewald, S., Mesters, I., Lenssen, A. F., Bansi, J., Lambeck, J., de Bie, R. A., & Waller, B. (2017). Aquatic cycling—What do we know? A scoping review on head-out aquatic cycling. *PLOS ONE, 12*(5), e0177704. https://doi.org/10.1371/journal.pone.0177704
7. Tovin, B. J., Wolf, S. L., Greenfield, B. H., Crouse, J., & Woodfin, B. A. (1994). Comparison of the effects of exercise in water and on land on the rehabilitation of patients with intra-articular anterior cruciate ligament reconstructions. *Physical Therapy, 74*(8), 710–719. https://doi.org/10.1093/ptj/74.8.710
8. Weston, M., Taylor, K. L., Batterham, A. M., & Hopkins, W. G. (2014). Effects of low-volume high-intensity interval training (HIT) on fitness in adults: A meta-analysis of controlled and non-controlled trials. *Sports Medicine, 44*(7), 1005–1017. https://doi.org/10.1007/s40279-014-0180-z