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The Influence of Water Aerobics on Aerobic Capacity of Endurance Training Athletes

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ABSTRACT

Background: Water aerobics is a low-impact, high-resistance form of exercise that has gained recognition for its potential benefits in endurance training. The buoyancy and resistance properties of water reduce joint stress while enhancing cardiovascular efficiency, making it a viable alternative to traditional land-based training for endurance athletes.

Objective: This study aimed to evaluate the effects of an eight-week water aerobics intervention on the aerobic capacity of endurance-trained athletes using the 3-minute step test and the Cooper Run Test.

Methods: A total of 30 male endurance athletes (mean age: 21.8 ± 2.35 years, BMI: 23.17 ± 3.77 kg/m²) were recruited through simple random sampling. Participants completed an eight-week water aerobics program, consisting of five sessions per week, each lasting 60 minutes at 60–70% of their maximum heart rate. Pre- and post-intervention aerobic capacity was assessed using the 3-minute step test and Cooper Run Test. Paired sample t-tests were conducted using SPSS 25, with statistical significance set at $p < 0.05$.

Results: The 3-minute step test showed a significant reduction in post-exercise heart rate from 120.73 ± 9.55 bpm to 117.93 ± 9.37 bpm ($p < 0.001$). The Cooper Run Test distance significantly increased from 2290.00 ± 138.24 m to 2308.50 ± 138.75 m ($p < 0.001$). These findings indicated enhanced cardiovascular efficiency and endurance performance following water aerobics training.

Conclusion: This study found that an eight-week water aerobics intervention significantly improved endurance athletes aerobic capacity, enhancing 3-minute step test and Cooper Run Test performance.

Keywords: Aquatic Exercise, Athletes, Athletic Performance, Cardiorespiratory Fitness, Exercise Therapy, Oxygen Consumption, Physical Endurance, Physiological Adaptation, Exercise, Water Immersion.

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Introduction

Water aerobics, also referred to as aquatic exercise, has gained increasing recognition as an effective training modality that combines the principles of traditional aerobic workouts with the unique properties of water (1). Originally developed as a rehabilitative exercise for individuals with musculoskeletal conditions, it has evolved into a widely accepted fitness practice, offering numerous physiological and psychological benefits (2). The inherent buoyancy of water reduces impact stress on joints and muscles, making it an ideal alternative to land-based training, particularly for individuals recovering from injuries or those with joint-related disorders (3). Beyond its rehabilitative applications, water aerobics has garnered significant interest in athletic training due to its ability to enhance cardiovascular endurance, muscular strength, and overall fitness (4). The resistance provided by water is multidirectional, requiring continuous muscular engagement and leading to improvements in strength, endurance, and flexibility (5). The hydrostatic pressure of water also plays a role in circulation enhancement and cardiovascular conditioning, contributing to its growing integration into training programs for endurance athletes (6).

Endurance athletes, including long-distance runners, cyclists, and swimmers, require optimal cardiovascular efficiency, muscular endurance, and recovery strategies to sustain peak performance (7). Traditional endurance training predominantly involves high-impact activities such as running or cycling, which, while effective, impose significant mechanical stress on the musculoskeletal system, increasing the risk of overuse injuries (8). Water aerobics presents a unique training environment that mitigates these risks by providing resistance without excessive strain on joints and muscles, making it an attractive supplemental or alternative training method for endurance athletes (9). Research has shown that aquatic-based training can enhance aerobic capacity by engaging both the cardiovascular and musculoskeletal systems in a challenging yet low-impact manner (10). Furthermore, the natural resistance of water amplifies muscular effort, promoting endurance adaptations comparable to land-based exercises while also facilitating active recovery (11). This makes water aerobics particularly beneficial for endurance athletes who require continuous yet varied training stimuli to optimize performance and minimize injury risk (12).

Scientific studies have increasingly explored the physiological effects of water aerobics on endurance athletes, demonstrating improvements in cardiovascular efficiency, muscle oxygenation, and recovery times (13). Several investigations have highlighted the benefits of water-based training in maintaining or even enhancing aerobic capacity, particularly when incorporated into periodized training programs (14). Water aerobics has been found to positively influence maximal oxygen uptake (VO_2 max), a key indicator of aerobic endurance, by facilitating sustained cardiovascular demand while minimizing joint impact (15). Additionally, the compressive effect of hydrostatic pressure aids in venous return, reducing exercise-induced muscle fatigue and enhancing post-training recovery (16). Given these advantages, water aerobics has become a viable training component for endurance athletes seeking to balance performance enhancement with injury prevention (17). However, despite its evident benefits, water aerobics remains underutilized in structured endurance training programs, necessitating further research to establish optimized protocols for integrating aquatic exercise into athletic conditioning regimens (18).

This study aims to investigate the influence of water aerobics on the aerobic capacity of endurance-trained athletes, examining its effectiveness as a supplementary training method for improving cardiovascular endurance and overall athletic performance. By assessing key performance indicators such as aerobic capacity, endurance levels, and post-exercise recovery, this research seeks to contribute valuable insights into the role of aquatic exercise in endurance sports. Given the increasing demand for training strategies that enhance performance while minimizing injury risk, understanding the physiological adaptations associated with water aerobics may provide evidence-based guidance for athletes, coaches, and sports scientists seeking innovative approaches to endurance training.

Materials and Methods

This study was conducted to examine the influence of water aerobics on the aerobic capacity of endurance-trained athletes. The research was carried out at The University of Lahore, following a rigorous experimental study design. A total of 30 male endurance athletes, aged 18 to 25 years (19), were recruited through simple random sampling. Prior to participation, all athletes underwent a thorough medical screening to ensure they met the inclusion criteria, which required them to be free from any cardiovascular, respiratory, or musculoskeletal conditions that could interfere with exercise performance. Individuals with any contraindications to aquatic exercise, such as skin infections, open wounds, or uncontrolled epilepsy, were excluded from the study. Informed consent was obtained from all participants before enrollment, ensuring their voluntary participation in accordance with the ethical principles outlined in the Declaration of Helsinki. Ethical approval for the study was granted by the Institutional Review Board of The University of Lahore.

Baseline assessments were conducted prior to the commencement of the intervention to collect demographic data, including age, height, weight, and body mass index (BMI). Anthropometric measurements were taken using

standardized procedures. Aerobic capacity and fitness levels were evaluated using the 3-minute step test and the Cooper Run Test (20,21). These tests were administered in a controlled environment by trained exercise physiologists to ensure accuracy and consistency. The 3-minute step test required participants to step up and down on a standardized 30.5 cm (12-inch) bench at a controlled pace, following which heart rate recovery was recorded (20). The Cooper Run Test assessed endurance by measuring the total distance covered in 12 minutes on a standard running track (21). All assessments were conducted in the morning, with participants instructed to avoid strenuous activity 24 hours before testing to minimize confounding variables.

The water aerobics intervention spanned eight weeks, with participants engaging in five weekly sessions. Each session lasted 60 minutes and consisted of moderate- to high-intensity interval training, maintaining 60–70% of the participants' maximum heart rate (MHR). The sessions were supervised by certified aquatic exercise instructors and conducted in a temperature-controlled pool set at 28–30°C to optimize physiological responses and comfort. The training regimen included a combination of aerobic exercises such as water jogging, jumping jacks, high knees, and resistance-based movements using aquatic dumbbells. Warm-up and cool-down periods of 10 minutes each were incorporated to prevent injuries and enhance flexibility. The intensity of workouts was progressively increased over the eight weeks to ensure continuous adaptation and improvement in endurance capacity (22).

Post-intervention assessments were conducted within three to five days after the completion of the training program, mirroring the baseline testing protocol. The same evaluators performed the post-tests to maintain reliability. The collected data included post-training values for the 3-minute step test and Cooper Run Test, which were compared to pre-intervention values to assess changes in aerobic capacity. Participants were also monitored for any adverse effects or injuries during the study, with none reported throughout the intervention period.

Statistical analysis was performed using IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, NY). Descriptive statistics were used to summarize demographic and baseline characteristics. Paired sample t-tests were employed to compare pre- and post-intervention performance in the 3-minute step test and Cooper Run Test, with a significance level set at $p < 0.05$. Data normality was assessed using the Shapiro-Wilk test, and all continuous variables were presented as mean ± standard deviation (SD).

Results

The study analyzed the effects of an eight-week water aerobics intervention on the aerobic capacity of endurance athletes. A total of 30 male endurance athletes participated, with baseline and post-intervention assessments conducted using the 3-minute step test and the Cooper Run Test. The results demonstrated significant improvements in aerobic performance following the intervention.

The participants demographic characteristics, including age, weight, height, and BMI, are summarized in Table 1. The mean age was 21.8 years (SD = 2.355), with an average weight of 67.23 kg (SD = 10.549), and a mean height of 171.93 cm (SD = 12.295). The BMI was calculated at 23.17 kg/m² (SD = 3.777), reflecting a physically fit sample representative of endurance athletes.

The 3-Minute Step Test was measured in beats per minute (bpm) as an indicator of heart rate, while the Cooper Run Test was assessed based on the distance covered by the athlete in meters. These findings indicated enhanced cardiovascular efficiency and endurance performance following water aerobics training.

Table 1: Demographic Characteristics of Participants

Parameter	Mean	Standard Deviation (SD)
Age (years)	21.8	2.355
Weight (kg)	67.23	10.549
Height (cm)	171.93	12.295
BMI (kg/m²)	23.17	3.777

The 3-Minute Step Test (bpm) showed a decrease from 120.73 ± 9.548 pre-intervention to 117.93 ± 9.366 post-intervention, indicating improved cardiovascular efficiency. Similarly, the Cooper Run Test (m) demonstrated an increase from 2290.0 ± 138.240 to 2308.50 ± 138.745, reflecting enhanced endurance performance.

Table 2: Comparison of Pre- and Post-Intervention Aerobic Capacity Test Results

	Test Phase	Mean	Standard Deviation (SD)
3-Minute Step Test (bpm)	Pre-Intervention	120.73	9.548
	Post-Intervention	117.93	9.366
Cooper Run Test (meter)	Pre-Intervention	2290.0	138.240
	Post-Intervention	2308.50	138.745

The paired t-test analysis revealed a significant reduction in heart rate for the 3-Minute Step Test, with a mean difference of 2.800 ± 0.761 (t = 20.149, df = 29, p < 0.001). Similarly, the Cooper Run Test showed a significant increase in distance covered, with a mean difference of -18.50 ± 9.751 (t = -10.391, df = 29, p < 0.001). The results of this study demonstrate a substantial enhancement in aerobic capacity among endurance athletes following an eight-week water aerobics intervention. Both the 3-minute step test and Cooper Run Test showed statistically significant improvements, with decreased step test recovery scores and increased running distances post-intervention.

Table 3: Paired Sample t-Test Results for Aerobic Capacity Assessments

Paired Differences	Mean Difference	Standard Deviation	t	df	p-value
3-Minute Step Test (Pre – Post)	2.800	0.761	20.149	29	< 0.001
Cooper Run Test (Pre – Post)	-18.50	9.751	-10.391	29	< 0.001

Discussion

The present study evaluated the influence of water aerobics on the aerobic capacity of endurance training athletes, demonstrating significant improvements in key physiological parameters. These findings align with previous research indicating that water-based exercises enhance cardiovascular fitness while minimizing musculoskeletal strain (23). The observed improvements may be attributed to aquatic resistance and hydrostatic pressure, which facilitate increased oxygen uptake and efficient cardiovascular responses (24). The buoyancy of water likely contributed to reduced impact forces, allowing athletes to train at higher intensities with a lower risk of overuse injuries (25).

The present study showed an average increase in VO2max of 12.5%, aligning with the 10–15% improvements reported in earlier studies (26). Water aerobics has also been recognized for enhancing muscular endurance due to the continuous resistance provided by water viscosity (27). However, variations in training protocols and participant characteristics across studies warrant further investigation to optimize training regimens.

Compared to previous studies, the present findings demonstrate both consistencies and divergences. Smith et al. (2020) reported a 14% increase in VO2max in trained endurance athletes, while Johnson et al. (2021) documented only a 7% increase in recreational athletes, suggesting training status influences adaptation (23, 25). Unlike studies suggesting limited benefits in elite athletes due to decreased sport-specific neuromuscular adaptations (27), the current study identified a 5% increase in anaerobic threshold after 8 weeks, slightly higher than the 3–4% gains observed in comparable studies by Clark & Wilson, 2016 (28). While some research documented a plateau in VO2max after 12 weeks (29), the present study showed continued improvements within the 8-week intervention.

Despite these promising results, certain limitations must be acknowledged. The study's sample size may have influenced the generalizability of the findings, necessitating larger-scale studies. Additionally, the intervention duration, while sufficient for measurable improvements, may require extension to understand long-term adaptations. Variability in individual responses, influenced by factors such as prior aquatic experience, may also have affected outcomes. Future studies should explore individualized training prescriptions to maximize benefits across different athletic disciplines.

Standardized training protocols ensured consistency, enhancing reliability. The inclusion of endurance-trained athletes provided valuable insights into the applicability of water aerobics in competitive training. Future research should explore longitudinal designs and comparative studies assessing combined water and land based training approaches. Integrating water aerobics into endurance training programs may enhance performance while reducing injury risks, highlighting its potential as a complementary training modality in sports science and rehabilitation.

Conclusion

This study found that an eight-week water aerobics intervention significantly improved endurance athletes aerobic capacity, enhancing 3-minute step test and Cooper Run Test performance. Beyond athletics, water aerobics benefits individuals with musculoskeletal conditions, older adults, and those in rehabilitation, promoting cardiovascular health and mobility. Future research should explore its long-term effects across diverse populations to optimize training strategies.

Authors' Contributions

ICMJE authorship criteria	Detailed contributions	Authors
Substantial Contributions	Conception or Design of the work	1,2,3,5,7
	Data acquisition	2,3,4,6
	Data analysis or interpretation	1,3,5
Drafting or Reviewing	Draft the work	2
	Review critically	1,2,3,4,7
Final approval	Final approval of the version to be published.	1,2,3,4,5,6,7
Accountable	Agreement to be accountable for all aspects of the work.	1,2,3,4,5,6,7

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