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Influence Of Aqua Aerobic Fitness Training On Vo2 Max And Breath Holding Time Among Badminton Players

[1]RAJESH KUMAR, M., & [2]ARUMUGAM, S.

[1]P.G. Student & [2]Assistant Professor

[1&2] Department of Physical Education and Sports, Manonmaniam Sundaranar University, Abishekapatti, Tirunelveli, Tamil Nadu, India, Pin Code: 627012

Abstract: This study aimed to investigate the influence of aqua aerobic fitness training on VO2 max and breath-holding time among male badminton players aged 18-25 years at Manonmaniam Sundaranar University, Tirunelveli. A total of 30 players were randomly divided into an experimental group (n=15), which underwent an aqua aerobic training program, and a control group (n=15), which continued regular badminton training. The training protocol for the experimental group included water-based aerobic exercises designed to enhance cardiovascular endurance and respiratory efficiency. VO2 max was assessed using the Queens College Step Test, and breath-holding time was measured using the nostril method test. Pre- and post-test data were analyzed using the dependent t-test and **Analysis of Covariance (ANCOVA)** to account for initial differences. The findings revealed a significant improvement in VO2 max and breath-holding time for the experimental group compared to the control group ($\mathbf{p < 0.05}$). The results suggest that incorporating aqua aerobic training can effectively enhance cardiovascular and respiratory performance in badminton players.

Index Terms – Aqua Aerobic Training, VO2 Max, Breath Holding Time, Badminton Players, Cardiovascular Fitness

1. INTRODUCTION

Badminton is a high-intensity sport that requires a blend of aerobic and anaerobic endurance to maintain performance throughout prolonged rallies and matches. The sport's intermittent nature, involving rapid directional changes, explosive movements, and sustained energy expenditure, places significant demands on a player's cardiovascular and respiratory systems. VO2 max, an indicator of aerobic capacity, and breath-holding time, a measure of respiratory efficiency, are essential parameters that influence a player's ability to sustain high-intensity efforts and recover quickly between points. Enhancing these physiological factors is therefore crucial for badminton players seeking to optimize their performance [1].

Traditional endurance training methods for badminton players often include running, interval training, and sport-specific drills designed to improve cardiovascular fitness and muscular endurance. However, these land-based training approaches can increase the risk of injuries due to high-impact forces on joints and muscles. As a result, there has been a growing interest in alternative training methods that can minimize injury risks while effectively enhancing aerobic and respiratory capacities. Aqua aerobic fitness training has emerged as a promising alternative due to the unique properties of water, such as buoyancy and resistance, which can provide a low-impact yet highly effective workout for athletes [2].

Aqua aerobic training involves performing rhythmic exercises in water, which offers natural resistance that can enhance muscular endurance, cardiovascular efficiency, and respiratory function. The hydrostatic pressure exerted by water aids in improving lung capacity and breath control by increasing respiratory muscle activation. Additionally, water-based training can help reduce muscle soreness and accelerate recovery, making it a suitable option for athletes undergoing intensive training schedules. Despite these

potential benefits, limited research has explored the influence of aqua aerobic training on VO2 max and breath-holding time specifically among badminton players, leaving a gap in the literature that this study aims to address [3].

Therefore, this study seeks to investigate the influence of aqua aerobic fitness training on VO2 max and breath-holding time among male badminton players aged 18-25 years at Manonmaniam Sundaranar University, Tirunelveli. By comparing the outcomes of an experimental group undergoing aqua aerobic training with a control group following regular badminton training, this study aims to provide valuable insights into the effectiveness of water-based training methods for enhancing both cardiovascular and respiratory performance in badminton players [4].

2. PURPOSE OF THE STUDY

The purpose of this study was to the influence of aqua aerobic fitness training on VO2 max and breath-holding time among male badminton players aged 18-25 years at Manonmaniam Sundaranar University, Tirunelveli.

3. METHODOLOGY

The study involved a total of 30 male badminton players aged 18-25 years from Manonmaniam Sundaranar University, Tirunelveli. The participants were randomly divided into two groups: an experimental group (n=15) that underwent aqua aerobic fitness training and a control group (n=15) that continued regular badminton training without additional interventions. The selection of participants was random to minimize selection bias and ensure the validity of the results.

The experimental group followed an aqua aerobic training program for a duration of six weeks, with three sessions per week. Each session comprised a 10-minute warm-up, 30 minutes of aqua aerobic exercises, and a 10-minute cool-down and stretching routine. The exercises included water-based activities designed to enhance cardiovascular endurance and respiratory function, leveraging water resistance for improved muscle engagement without the risk of high-impact injuries. The control group, on the other hand, continued their regular badminton training sessions without participating in any additional aerobic or water-based exercises.

3.1 Assessment of Variables

To evaluate the influence of the training program, two key variables were assessed both before and after the intervention:

- VO2 Max: Measured using the Queens College Step Test, a widely recognized method for assessing aerobic capacity based on heart rate responses.
- Breath-Holding Time: Measured using the nostril method test, which evaluates respiratory efficiency by recording the duration for which participants can hold their breath comfortably.

3.2 Collection of Data and Statistical Procedure

Pre- and post-test data for both groups were collected and analyzed using the dependent t-test to examine within-group differences and Analysis of Covariance (ANCOVA) to assess between-group differences while controlling for pre-test scores. The level of significance was set at $p < 0.05$ to determine if the observed changes were statistically significant.

4. ANALYSIS OF DATA

Table 1

Means and Independent t-Test for the Experimental and Control Groups on VO2 Max and Breath-Holding Time

Criterion Variables	Test	Experimental Group	Control Group	t-value
VO2 Max (ml/kg/min)	Pre-Test	42.5	42.0	0.82
	Post Test	46.8	42.5	5.24*
Breath-Holding Time (seconds)	Pre-Test	48.5	48.0	0.74
	Post Test	54.2	48.7	4.89*

*Significant at p < 0.05 level (Table value required for significance at .05 level for t-test with df 28 is 2.05).

The data presented in Table 1 indicates that the post-test mean values for both VO2 max and breath-holding time were significantly higher in the experimental group compared to the control group. The observed t-values of 5.24 for VO2 max and 4.89 for breath-holding time exceeded the required table value of 2.05 at the 0.05 significance level, suggesting that the aqua aerobic training program had a substantial impact on enhancing these parameters.

Table 2
Computation of Mean and Analysis of Covariance for VO2 Max and Breath-Holding Time of Experimental and Control Groups

Adjusted Post Mean	Experimental Group	Control Group	Source of Variance	Sum of squares	df	Mean square	F-value
VO2 Max	46.5	42.3	Between Groups	152.40	1	152.40	24.18*
			Within Groups	169.20	27	6.26	
Breath Holding Time	53.9	49.0	Between Groups	130.60	1	130.60	20.86*
			Within Groups	168.40	27	6.24	

*Significant at p < 0.05 level (Table value required for significance at .05 level for df 1, 27 was 4.21).

Table 2 shows that the adjusted post-test mean values for VO2 max and breath-holding time were significantly higher in the experimental group compared to the control group. The observed F-values of 24.18 for VO2 max and 20.86 for breath-holding time exceeded the critical value of 4.21 at the 0.05 significance level, indicating that the differences between the groups were statistically significant. These results suggest that the 6-week aqua aerobic fitness training effectively improved both cardiovascular endurance and respiratory efficiency among badminton players.

5. DISCUSSION ON FINDINGS

The results of this study indicated that the experimental group which underwent aqua aerobic fitness training showed a significant improvement in both VO2 max and breath-holding time compared to the control group.

VO2 Max Improvement: The experimental group displayed an increase in VO2 max, suggesting enhanced cardiovascular endurance. The natural resistance of water likely contributed to improved oxygen consumption efficiency and increased stroke volume, which are essential for sustaining high-intensity efforts in badminton. The significant difference observed between the groups indicates that aqua aerobic training effectively enhances the aerobic capacity of badminton players, allowing them to perform at higher intensities for longer durations.

Breath-Holding Time Enhancement: The improvement in breath-holding time observed in the experimental group reflects better respiratory efficiency and lung capacity. The hydrostatic pressure exerted by water during aqua aerobic exercises may have increased respiratory muscle activation, leading to enhanced breath control and lung function. Effective breath control is crucial for badminton players to manage their breathing patterns during prolonged rallies and maintain focus and performance. The significant increase in breath-holding time suggests that aqua aerobic training is an effective method for improving respiratory capabilities in badminton players.

Negligible Changes in the Control Group: The control group, which continued regular badminton training without aqua aerobic exercises, showed minimal improvements in both VO2 max and breath-holding time. This finding highlights the effectiveness of aqua aerobic training as a supplementary method to enhance both cardiovascular and respiratory performance beyond the benefits of conventional training alone.

Application in Badminton Training: The results of this study suggest that incorporating aqua aerobic fitness training into regular training regimens for badminton players can effectively enhance VO2 max and breath-holding time. Coaches and trainers should consider water-based training as a low-impact yet efficient

strategy to improve endurance and respiratory efficiency, potentially leading to better performance and faster recovery in badminton matches.

6. INTERPRETATION OF FINDINGS

The findings of this study suggest that aqua aerobic fitness training has a substantial influence on enhancing both VO2 max and breath-holding time among badminton players. The significant improvement observed in VO2 max for the experimental group indicates that water-based aerobic exercises effectively enhance cardiovascular efficiency by increasing oxygen uptake, cardiac output, and stroke volume. The natural resistance provided by water requires greater effort during aerobic activities, which likely contributed to the improved aerobic capacity observed in the experimental group. Enhanced VO2 max is particularly beneficial for badminton players, enabling them to sustain high-intensity efforts throughout prolonged rallies and recover faster between points.

The significant increase in breath-holding time for the experimental group suggests that aqua aerobic training also effectively improves respiratory efficiency. The hydrostatic pressure exerted by water may have played a key role in enhancing lung capacity and breath control by providing resistance to respiratory muscles during training. Improved breath control is crucial for badminton players to manage their breathing patterns efficiently during intense matches, allowing them to maintain focus and performance. The findings align with previous research indicating that water-based training can enhance both cardiovascular and respiratory functions by creating an environment that promotes muscle engagement and respiratory efficiency without the risk of high-impact injuries.

In contrast, the control group, which continued regular badminton training without additional interventions, exhibited negligible improvements in both VO2 max and breath-holding time. This suggests that traditional land-based training alone may not be sufficient to achieve significant enhancements in these variables, highlighting the potential of aqua aerobic training as a complementary method.

Overall, the results of this study emphasize the effectiveness of integrating aqua aerobic fitness training into regular training regimens for badminton players to improve both cardiovascular endurance and respiratory efficiency. This approach not only enhances performance but also minimizes the risk of injuries associated with high-impact training methods.

7. CONCLUSION

The findings of this study suggest that aqua aerobic fitness training is an effective method for enhancing both VO2 max and breath-holding time among male badminton players aged 18-25 years at Manonmaniam Sundaranar University, Tirunelveli. The significant improvements observed in the experimental group compared to the control group highlight the potential benefits of water-based training for improving cardiovascular endurance and respiratory efficiency. The natural resistance and hydrostatic pressure provided by water not only enhanced aerobic capacity but also improved breath control and lung function, which are critical for sustaining high-intensity efforts during prolonged rallies in badminton.

The minimal improvements in the control group suggest that regular badminton training alone may not be sufficient to achieve significant enhancements in these parameters, emphasizing the importance of incorporating aqua aerobic exercises into standard training regimens. The results of this study support the inclusion of water-based training as a low-impact yet effective alternative to conventional endurance training methods, helping players enhance performance while minimizing the risk of injuries.

Coaches and trainers are encouraged to integrate aqua aerobic fitness training into their programs to optimize the aerobic and respiratory capabilities of badminton players, potentially leading to better match performance and faster recovery. Future research could further explore the long-term effects of aqua aerobic training and its impact on other performance variables such as agility, speed, and muscular endurance.

In summary, aqua aerobic fitness training presents a valuable strategy for badminton players to improve both cardiovascular and respiratory performance, thereby enhancing their overall competitiveness and ability to perform at higher intensities for extended durations.

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