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ORIGINAL PAPER

EVALUATING THE EFFECTIVENESS OF THE AQUATIC THERAPY APPROACH ON KICK VELOCITY, VERTICAL JUMP TEST, AGILITY, SPEED, AND CORE STRENGTH IN FOOTBALL PLAYERS

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Summary

Background. Football is ball-based sport. Aquatic therapy has the benefit of buoyancy and hydrostatic pressure. It has gained recognition for its therapeutic benefits, particularly in strength and conditioning training. This study aims to investigate the effects of the aquatic therapy approach on kick velocity, vertical jump test, agility, speed, power, and core strength in football players.

Material and methods. A randomized controlled trial was conducted on 120 male professional football players assigned to experiment and control groups. Informed consent was obtained from all participants, and various outcome measures, including kick velocity, vertical jump test, 5 m sprint test, T-test, and plank test, were recorded. After pre-assessment, Group A underwent 45 minutes of aquatic therapy training, while Group B underwent 60 minutes of conventional land training 3 times a week for 4 weeks.

Results. There was statistical improvement seen within groups in all outcome measures; however, significant improvement was seen in the aquatic therapy group in kick velocity, vertical jump test, and core strength when both groups.

Conclusions. The findings of this study are significant, as they provide strong evidence to support the integration of aquatic therapy into football training. This offers a safer and more effective

method for enhancing performance, potentially revolutionizing how we approach sports training and rehabilitation.

Keywords: kick velocity, core strength, aquatic therapy, sports, performance

Introduction

With its unique benefits of buoyancy and hydrostatic pressure, aquatic therapy has gained recognition for its therapeutic benefits and adaptability, particularly in strength and conditioning training for athletes. By leveraging these unique characteristics, aquatic therapy provides an ideal setting for exercise therapy that minimizes joint strain while offering increased resistance [1]. In the competitive landscape of sports, especially in disciplines like football, where physical prowess is crucial, the integration of aquatic therapy presents a compelling avenue for optimizing athlete performance and recovery. With its demands for dynamic movements, explosive power, and swift recovery, football necessitates innovative strength and conditioning training approaches. Heightening the intensity of volume-loading training exercises has demonstrated a propensity to amplify bone density and enhance performance outcomes. Thus, the integration of aquatic therapy emerges as an excellent modality for achieving these objectives. We conducted a systematic review which showed a need for more literature on structured aquatic therapy protocols targeting all the sport's key components [2].

Aim of the work

This paper explores the synergy between aquatic therapy and football, investigating how advanced-level exercise therapy can enhance footballers' performance in aquatic environments. Through a clinically informed examination, this study examines the effects of the aquatic therapy approach on kick velocity, vertical jump test, agility, speed, power, and core strength in football players.

Material and methods

After the participant briefing and informed consent was obtained, demographic data was collected, including age, BMI, dominant side, years of training, and club name. Pre-assessment involved various football sport outcome measures: kick velocity (measured with a Bushnell Radar gun), vertical jump test (for lower limb power), 5-meter sprint test (for speed), T-test (for agility), and plank test (for core strength).

Study design and methodology

This research utilized an experimental pre-test and post-test randomized control trial design to examine the effects of aquatic training on various athletic performance measures in professional football players. Participants were stratified into two groups – experimental (aquatic therapy) and control (conventional football training) – following a random allocation process using a random number generator to reduce allocation bias. Each group underwent a four-week training protocol,

with pre- and post-intervention assessments of the outcome variables: kick velocity, vertical jump test, 5-meter sprint test, agility t-test, and plank hold time for core strength.

Setting and participants

This study was conducted in Mumbai, India, with participants drawn from football teams participating in the Indian Super League, I-League, and Mumbai Division League, where 120 healthy male adult professional football players (aged 18-30 years) with a minimum of 1 year of professional coaching experience were enrolled. Intervention sessions for aquatic therapy were held at the Andheri Recreation Club, made possible by the generous cooperation of the club authorities. Eligibility criteria included healthy male footballers aged 18 years and above with a minimum of one year of professional coaching experience. Players with recent lower limb injuries or recent hospitalizations were excluded.

Training experience and participant level

All participants were professional-level male football players with an average of 4.8±1.2 years of structured training under licensed football coaches. Professional status was defined by active participation in national-level football leagues (Indian Super League and I-League) and regular engagement in competitive matches and coaching for at least one year.

The data was collected from January 2022 to December 2023. This single-blinded, randomized controlled trial allocated participants into the experiment group (n=60, mean age:

23.25±3.66 years) and the control group (n=60, mean age: 23.30±3.67 years) via convenience sampling.

Sample size and recruitment

A priori power analysis using G*Power software determined the required sample size, estimating a minimum of 54 participants per group for adequate statistical power (α=0.05, power=0.95). A total of 120 players were enrolled using convenience and purposive sampling methods.

Outcome measures and testing

Outcome assessments were conducted both pre- and post-training using standardized tools and protocols.

Instrumentation and testing procedures:

- kick velocity: measured with Bushnell Velocity Radar Gun (Model 101911, Bushnell Corp., USA). Placed 0.5 m behind the goalpost. Accuracy: ±1.6 km/h [3] (Figure 1);
- 5-meter sprint test: marked with cones; timing by stopwatch. Stopwatch triggered by precise foot contact at start and finish lines [4];
- vertical jump test. Jump height = difference between standing and jump reach. Measured by measuring tape. Average of 3 trials recorded [5];

- agility T-test: conducted using a 4-cone setup. A player sprints forward 5 m, laterally 2.5 m, and back. Timing with dual observers using stopwatch to reduce human error [6];
- core strength (plank hold time): prone plank duration recorded to nearest second using stopwatch.

Figure 1. Participant performing kick velocity test

Training protocols:

- control group: engaged in land-based football training focused on speed, agility, strength, plyometrics, and balance;
- experimental group: underwent aquatic therapy 3 times weekly, structured into 3 types of sessions per week – lower limb strengthening, cardio conditioning, and core strengthening – spanning 4 weeks [7]. Exercises progressed in volume and intensity across weeks, and certified aquatic physiotherapists supervised sessions (Figure 2).

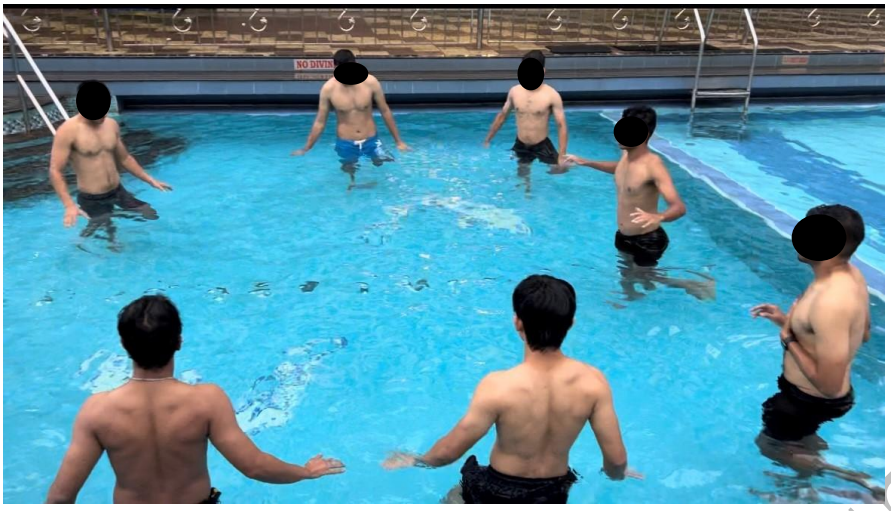

Figure 2. Participants performing exercises in water

The control group went through conventional football training, whereas the experimental group only underwent the aquatic therapy training protocol for these 4 weeks.

Training regimen specificity:

- frequency: 3 sessions per week;
- duration: 45 minutes per session for 4 weeks;
- volume: each session included 6-10 exercises, increasing in intensity each week;
- warm-up protocol: dynamic warm-up in water (8 minutes), including forward, backward, and lateral jogging, arm swings, leg swings, and shoulder rolls;
- cool-down protocol: static water-based stretches (7 minutes) focusing on hamstrings, quadriceps, calves, and trunk muscles.

Cardio session intensity and monitoring:

- target heart rate was 65-75% of the estimated max HR (using the formula: 220 – age);
- participants wore waterproof smart watches;

– intensity was monitored in real time to ensure all participants stayed within the target HR zone.

Procedure

The study participants were divided into two groups:

– control group: this group underwent conventional land-based football training 3 times a week for 60 minutes per session over 4 weeks as prescribed by their coach. The training regimen included agility and speed cone drills, running exercises, strengthening exercises, plyometrics training, and balance exercises;
– experiment group: this group participated in aquatic therapy 3 times a week for 45 minutes, each lasting 4 weeks.

The protocol comprised various exercises targeting different aspects of fitness and strength.

1st session – focus on lower limb strength:

– warm-up: jogging drills in water – forward, side-ways, and backward, free leg and arm movements;
– exercise sets: free squats, deep squats with toe raise, adductor squats, static lunges, unilateral stance - superman/squat to kneeling, lateral lunges, unilateral calf raises;
– cool down: gentle stretches.

2nd session – cardio session:

– warm-up: jogging drills in water – forward, side-ways, and backward;
– exercise sets: jumping jacks, high knee march, forward and backward jumps, butt kicks, forward and reverse lunges, fast feet, vertical jumps, alt toe touch;

- cool down: gentle stretches.

3rd session – focus on core strength:

- warm-up: jogging drills in water – forward, side-ways, and backward, free leg and arm movements;
- exercise sets: tuck jumps, toe squats, skiing, squat jumps, lateral jumps, elbow to the knee, squat and punches, squat, and sidekicks;
- cool down: gentle stretches.

Each exercise was performed for 20 repetitions and 3 sets, while the cardio session exercises were performed for 1 minute each, also for 3 sets. These exercises were conducted in a swimming pool under the guidance of an aquatic physiotherapist.

Statistical analysis

Statistical analysis using IBM SPSS version 21.0 included assessing parameter normality by Skewness, Kurtosis, Shapiro-Wilk test, and graphical methods like histograms, box plots, and Q-Q plots. The data exhibited visual normality in the histogram, box plot, and Q-Q plot graphs, supported by Skewness = 0.427, Kurtosis = 1.7, and Shapiro-Wilk = 0.003 values, warranting parametric tests. Descriptive statistics were presented as mean ± standard deviation (SD), median (min-max), or frequency. At the same time, inter-group analysis employed an independent T-test, and intra-group analysis used a paired T-test due to data normality. Significance was determined with a p-value <0.05.

Figure 3 provides a visual representation of the flow of participants throughout the trial in the form of CONSORT. This flowchart depicts an understanding of participant recruitment, allocation, follow-up, and analysis.

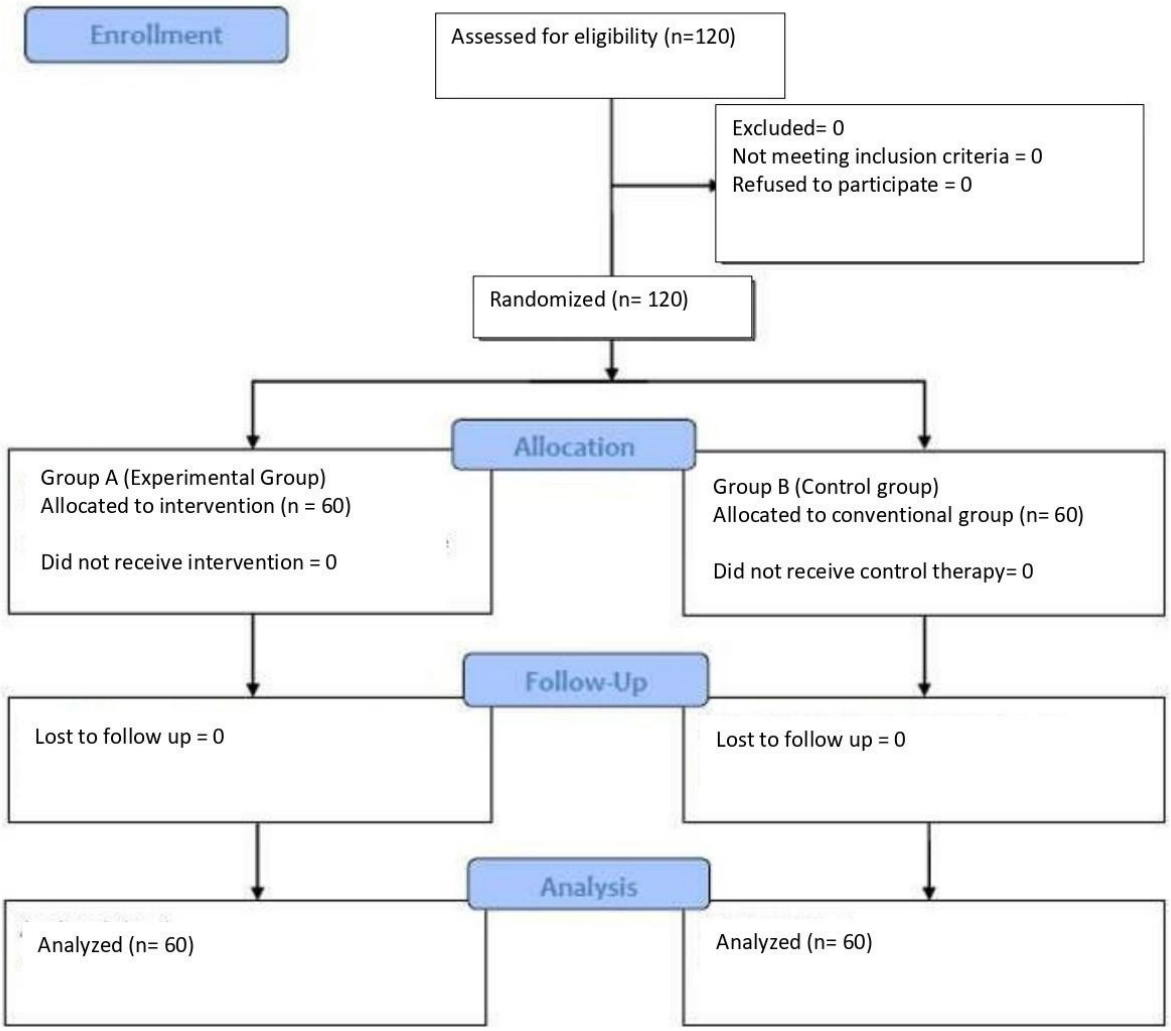

Figure 3. CONSORT

Results

Within-group analysis

Intragroup analysis of the control group revealed significant improvements, as the *p*-value was 0.00 for all outcome measures. Intragroup analysis of the experimental group also demonstrated significant enhancements, as the *p*-value was 0.00 for all outcome measures (Table 1).

Table 1. Within group analysis

Group A	Mean±SD	*p*-value	Group B	Mean±SD	*p*-value
Kick velocity					
Pre	40.6±3.65	0.00	**Pre**	40.13±3.81	0.00
Post	44.9±3.54	0.00	**Post**	41.17±4.04	0.00
Vertical jump test					
Pre	19.77±1.54	0.00	**Pre**	19.88±1.56	0.00
Post	23.05±1.68	0.00	**Post**	20.73±1.68	0.00
Speed					
Pre	1.70±0.30	0.00	**Pre**	1.72±0.30	0.00
Post	1.15±0.28	0.00	**Post**	1.47±0.29	0.00
Agility					
Pre	7.38±0.59	0.00	**Pre**	7.45±0.55	0.00
Post	6.50±0.60	0.00	**Post**	6.97±0.56	0.00
Core strength					
Pre	1.80±0.39	0.00	**Pre**	1.84±0.35	0.00
Post	2.82±0.38	0.00	**Post**	2.18±0.35	0.00

Between-group analysis

Intergroup analysis comparing the experiment and control groups revealed that the experimental group exhibited superior improvements in all outcome measures – kick velocity (p=0.00), vertical jump test (p=0.00), speed (p=0.00), agility (p=0.00), and core strength (p=0.00), with a p-value <0.05 (Table 2).

Table 2. Between group comparison of group A and group B

Outcome difference	Group	Mean	Std. Deviation	*p*-value
Kick velocity	**Experimental**	4.33	1.130	0.00
	Control	1.07	0.899	
Vertical jump test	**Experimental**	3.32	0.930	0.00
	Control	0.85	0.799	
Speed test	**Experimental**	0.545	0.1141	0.00
	Control	0.238	0.0904	
Agility test	**Experimental**	0.878	0.2256	0.00
	Control	0.473	0.1572	
Core strength	**Experimental**	1.032	0.2752	0.00
	Control	0.333	0.2862	

Clinical assessment

Statistically significant enhancements were observed in kick velocity, vertical jump test, core strength, speed, and agility within the aquatic therapy group, as depicted in Figures 4-8.

However, Figures 4-6 show a notable clinical improvement in kick velocity, vertical jump test, and core strength in the experimental group compared to the control group.

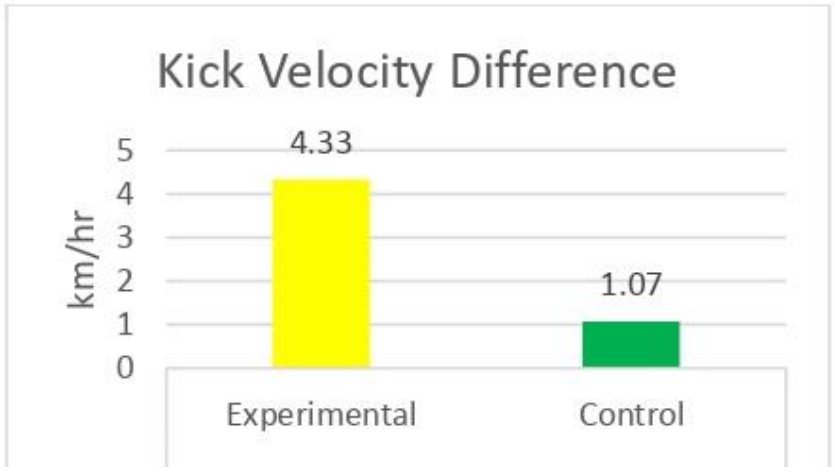

Figure 4. Graphical representation suggesting between group comparison changes in kick velocity

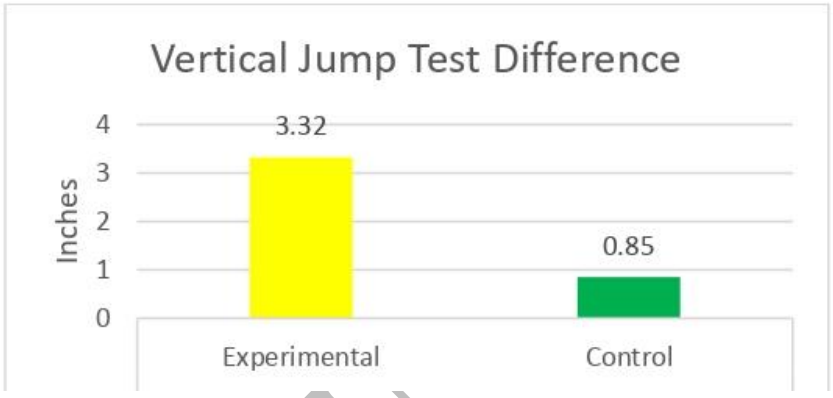

Figure 5. Graphical representation suggesting between group comparison changes in vertical jump test

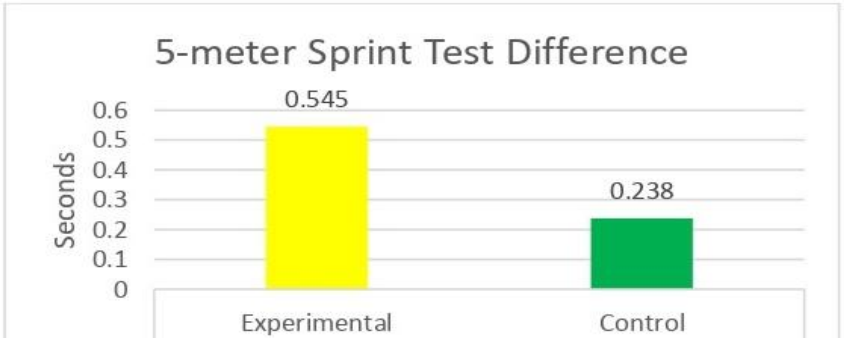

Figure 6. Graphical representation suggesting between group comparison changes in 5-meter sprint test

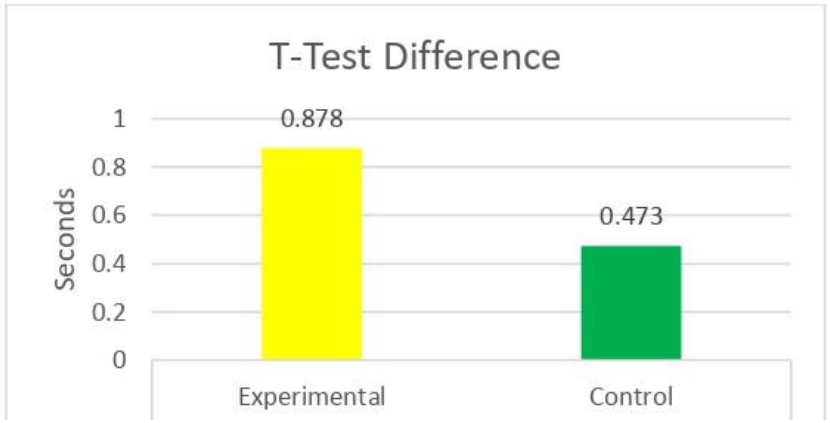

Figure 7. Graphical representation suggesting between group comparison changes in agility T-test

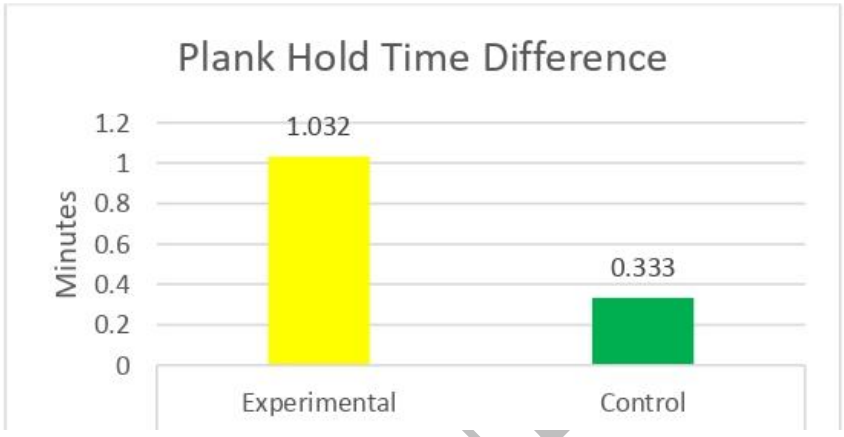

Figure 8. Graphical representation suggesting between group comparison changes in plank test

Discussion

In light of the results observed, both the control and experimental groups demonstrated statistical improvement across various outcome measures. However, the experimental group undergoing aquatic therapy exhibited more significant enhancements in kick velocity, vertical jump test, speed, agility, and core strength among football players.

The control group's improvement stemmed from incorporating fundamental exercises such as agility drills, which honed players' ability to maneuver swiftly and adapt to the game's dynamic nature. Additionally, strength training exercises targeted specific muscle groups, enhancing power for actions like tackling and shooting, while plyometric exercises cultivated explosive power [8], crucial for dynamic movements on the pitch.

Conversely, following this tailored aquatic therapy protocol, the experimental group witnessed statistical and clinical improvements. The protocol's first session focused on lower limb strengthening exercises, vital for overcoming water resistance and requiring significantly more power than air. Aquatic training has improved kick velocity as water is eight times denser than air, thus exercises done in water are eight times more effective in strengthening [9]. Consequently, kick velocity saw a notable improvement, a pivotal factor in creating goal-scoring opportunities.

The second session incorporated aquatic plyometric exercises, leveraging water resistance to enhance players' vertical jump, speed, and agility [10]. Aquatic training has improved agility as high-intensity cardio and plyometric exercises were incorporated. Due to buoyancy, water exercises were performed efficiently and with minimal fall risk. Increased vertical jump capability aids defensive scenarios and enhances offensive capabilities, particularly in scoring goals from set-piece situations.

Barefoot exercises in the therapeutic aquatic setting are a burgeoning trend that offers many advantages. This approach facilitates enhanced foot and ankle strength, bolstering balance and stability within the aquatic environment and enhancing agility and core strength in the participants [11].

Core strength, addressed in the third session, is crucial for transferring energy to the upper and lower limbs during movements like kicking [12]. Due to hydrostatic pressure, any exercises

done in water activate and strengthen core and oblique muscles, improving players' stability, agility, and resilience.

These findings underscore the manifold benefits of aquatic training in refining critical athletic attributes essential for success in football. Integrating structured aquatic training protocols into football programs holds significant promise for optimizing player performance and team success on the pitch.

Conclusions

The substantial global demand for football and the intensely competitive nature of the sport require optimal physical and cardiovascular health, which are imperative for enhancing players' performance. Aquatic therapy training is a promising avenue to augment the performance of professional footballers and budding athletes in their formative years. This tailor-made aquatic therapy protocol stands out as a pivotal aspect, as it addresses the specific needs of athletes in football and beyond. This personalized approach holds promise for enhancing performance among professional footballers and presents a viable option for emerging athletes. Its customizability and effectiveness make it a valuable adjunctive method to conventional training. They can be used across various sports, such as hockey, basketball, and volleyball, where individualized interventions are paramount for optimizing athletic potential.

Disclosures and acknowledgements

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The study protocol received approval from the R.K. University Ethics Committee (dated December 1, 2021, no. RKU/SPT/2021/11/23), registered and approved by the Central Drugs Standard Control Organization (CDSCO), under the Directorate General of Health Services, Ministry of Health and Family Welfare, Government of India. The study is registered with the Clinical Trials Registry of India (CTRI), with the registration number CTRI/2022/01/039759 (registered on 27/01/2022). Intellectual Property of India: L-139423/2023. Written informed consent was obtained from all the participants before their inclusion in the study, including consent for the use of any images.

Artificial intelligence (AI) was used initially by the authors to correct the English grammar.

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