

Warm-up in water-polo: report from usual practices of high-level Portuguese coaches

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ABSTRACT

Recent studies have shown that warm-ups positively impact performance across various swimming disciplines; however, research on warm-ups in team sports such as water polo is limited. This study investigated the pre-game warm-up routines of water polo players from different Portuguese National Teams. Coaches from 22 national and international teams provided data through an online questionnaire. Results indicated strong consensus on the importance of warm-ups: 67% of coaches acknowledged mental benefits, and 83% recognised physical benefits. The most common dry-land warm-up exercises included bodyweight movements, stretch cords, and medicine balls, while in-water warm-ups lasted approximately 30 minutes and covered 300 to 800 meters, progressing through structured phases of varying intensity. The in-water warm-up started with a general warm-up, followed by techniques and positional skills, with and without the ball, and concluded with specific game scenarios, including substitute rotations. These findings suggest that elite water polo coaches favour a combined dry-land and in-water warm-up strategy to optimise physical preparation, mental readiness, and tactical execution before a competition.

KEYWORDS: pre-exercise; warm-up exercise; aquatic sports; rewarm-up; performance.

INTRODUCTION

The impact of warm-up routines in sports has been the subject of extensive research over the past few years, highlighting their critical role in enhancing athletic performance across various disciplines (Neiva et al., 2014; Silva et al., 2018). Engaging in a warm-up is widely recognised as essential before undertaking any physical activity, whether in training or competitive contexts (Gil et al., 2019; McGowan et al., 2016). The benefits of warm-up routines are attributed to several physiological changes, including increased muscle temperature, improved muscle function, enhanced blood flow, and reduced muscle and joint stiffness (Bishop, 2003; McGowan et al., 2015). These effects contribute to optimising metabolic processes that are crucial during exercise and minimise fatigue (Andrade et al., 2015; Balilionis et al., 2012; Bishop, 2003).

Particularly in sports characterised by explosive, intermittent efforts, such as water polo, the significance of effective warm-up practices becomes even more marked (Andrade et al., 2015; McGowan et al., 2015, 2016). Recent studies in swimming have led to valuable insights regarding optimal warm-up strategies (Neiva et al., 2014, 2017), while contemporary research has emphasised the physiological effects of warm-up routines, in injury prevention and performance enhancement in aquatic sports (Crowley et al., 2018; McGowan et al., 2016; Neiva et al., 2017).

Moreover, warm-up is crucial for elevating heart rate and oxygen consumption, facilitating improved oxygen delivery to muscles and thereby boosting aerobic energy capacity (Balilionis et al., 2012). An effective warm-up should not only optimise performance (Platanou & Geladas, 2006) but also ensure that its benefits are sustained throughout the entirety of the game (Botonis et al., 2016).

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Coaches and players alike emphasise the critical nature of pre-competition warm-up exercises for achieving optimal performance (McGowan et al., 2015). They also agree that programming warm-up routines is as vital as any other training component (Botonis et al., 2016). However, there is a notable lack of research supporting this perspective, which calls for a deeper investigation into the reasoning behind the diverse warm-up routines utilised by coaches.

To date, research on professional coaches' perspectives regarding warm-up typologies across various sports remains limited, and no studies have specifically examined this topic in the context of water polo. Therefore, this study aims to elucidate the warm-up practices commonly employed by water polo coaches and to uncover any methodological differences in their warm-up approaches, thereby filling a significant research gap and contributing to the enhancement of training strategies within the sport of water polo.

METHODS

Participants

Twenty-two subjects ($n = 20$ men, 33.4 ± 8.5 years; $n = 2$ women, 36.0 ± 7.1) of eighty-four eligible Portuguese elite water polo coaches based in Portugal, participated in this study. To participate in the study, the inclusion criteria defined were: 1) all the recruited coaches were required to hold at least level II of coach certification; 2) have at least 3 years of experience; and 3) be affiliated with and coach a team in the second or first Portuguese national division. All participants provided written informed consent to participate in the study, and the study was approved by the Research Ethics Committee at the University of Beira Interior.

Measures and procedures

This exploratory and descriptive study was designed to provide comprehensive information regarding elite water polo coaches' current pre-competition warm-up practices. The research team developed a self-administered questionnaire comprising 26 questions, including 17 multiple-choice and 9 closed-ended items. The questionnaire aimed to gather insights into current warm-up practices in both dryland and water settings, as well as challenges faced by coaches and athletes during matches. The first part included questions about characterisation (e.g., competitive experience, qualifications, training level) and the second part included specific questions about the warm-up routines they use (e.g., volume, intensity, recovery, dry-land activities, in-water activities).

To ensure content validity, the questionnaire was developed based on prior research (McGowan et al., 2016; Paton, 2014) and refined with input from two international-level expert coaches. Additionally, a pilot test was conducted with three experienced water polo coaches, who provided feedback on the clarity, relevance, and structure of the questions. Adjustments were made based on their suggestions before finalising the questionnaire.

Coaches were contacted via email, phone, and other channels to assess their eligibility for the study. A total of 84 coaches met the initial eligibility criteria; however, after applying the inclusion criteria, only 22 participants were selected for the final sample. Before participation, all selected coaches provided written informed consent to ensure ethical compliance. The final questionnaire was distributed electronically via Google Forms, allowing participants to complete it independently. They were given a two-week period to submit their responses.

Statistical analysis

All collected data were analysed using descriptive statistics, including mean values ($\pm$ standard deviation), frequencies, and percentages (%), to summarise responses for all relevant variables. The statistical analysis was performed using IBM Statistical Package for Social Sciences (SPSS, version 29.0.1.0) for Microsoft Windows (Armonk, NY, EU: IBM Corp.), and Microsoft Excel (Microsoft Corporation, 2018) for data organisation and visualisation. Answers to open questions (for example, "If you have other benefits, in addition to those described above, give examples and explain the importance you give when designing the warm-up") were analysed following established qualitative research protocols (Patton, 2014). The author and main researcher identified general themes with different orders of applicability and/or importance.

RESULTS

The average experience as competitive coaches was 8.6 ± 3.8 years (mean $\pm$ SD), and the age of the swimmers they trained ranged from 15 to 30 years. Most of the coaches surveyed (86.4%) were currently training the younger age groups (under 12, under 14 and under 16). The main objectives of the warm-up routines identified are described in Table 1, along with some representative responses. Coaches prioritised the following objectives: (i) physiological preparation, (ii) tactical preparation, (iii) mental preparation, and (iv) kinesthetics/tactile preparation.

Table 2 presents an example warm-up routine that water polo coaches use with their players. The typical pre-competition swimming volume for a water polo game is 536.4 ± 173.3 m. During the in-water warm-up, coaches incorporate tasks using various training materials, including kickboards (14%), medicine balls (4%), resistance bands (9%), and hand paddles (14%). However, it was more common not to use any specific training material (59%). To monitor the intensity during the warm-up, most used the perceived effort (64%), heart rate (18%), exercise duration (split times) (18%), and combinations of these measures (82%). Most coaches (68%) prescribe a dry warm-up for their players before the in-water warm-up.

Table 3 presents examples of dry-land warm-up activities, including the number of repetitions, duration, and descriptions of the exercises. The coaches presented similar routines, including the number of repetitions and rest for each exercise. Most coaches (81%) indicated that the team presentation before the start of the game is the external factor that most affects this transition phase, between the end of the in-water warm-up and the start of the game. Therefore, during this transition phase, coaches report that their players usually sit (36.4%) and listen to music (36.4%) until they are called for the team presentation. Players spend about 10–15 minutes in transition, taking into account that it takes about 11.73 ± 4.84 minutes to be called for presentation.

Table 1. Main objectives of the warm-up identified by the water polo coaches ($n = 22$).

Higher-order themes	Number of responses	Selected responses
Physiological preparation	20	- To stimulate the relevant energy systems - Heart Rate preparedness for the game - Muscles warm-up
Tactical preparation	18	- To prepare all players for each position - For specific movements and space occupation
Mental preparation	14	- To focus on the plan - To focus on the demand of the team - To be mentally alert and conscious of the problems and solutions in the water and with the referee's team
Tactile/Kinesthetics preparation	16	- For different movements in water (awareness of what the player needs) - To get comfortable in water, an environment like lights, crowd, water conditions, and ball grip

Table 2. Example of a typical in-water warm-up prescribed by coaches before a match, in terms of intensity, exercises, examples of tasks, type of materials used, and total distance swam (m).

Warm-up Stage	Example of specific tasks completed	Additional devices used	Type of effort	Intensity (% PME)
Initial stage	400-600m swim or 16X25m (With variance in style - Freestyle/backstroke/breaststroke)		Continuous	60–70
	200-300m swim		Continuous/Build	65–85
	12X25m (Swim/RB/KB/MDB)	RB; MDB; KB	Sprint/Build	75–100/60
Fundamental stage	Starting Team: 3 x 2 strong widths / Slide pole legs + alternative pole crol with spin / 2 x Front pole legs 5" 2 to 2 + sprint crol / 2x; Center/point 2 to 2 5" + sprint to 2nd post / 2x 4 jumps + sprint to 2nd post; Goalies "Walk" fingers touching cross bar; Steady position; Side to side high/low corner face the goal; Lunging left/right high/low corner	MDB; WPB	Sprint/Build	85–100/60
	4x25 Sprint freestyle + 4x25 Drill (Eggbeater kicks; Slide side to side with 1 breast kick; Jump with one arm and with two arms; Butterfly stroke with breaststroke kick		Continuous/Build	70–90/60
	1vs1 (arms in shoulders) + face to face (horizontal position, hands on colleague's shoulders; pushes across colleague's shoulder, with breaststroke kick/eggbeater; back-to-back; Side by side (hand/arm hand on the colleague's shoulder/back)		Sprint/Build	80–95/50
Final stage	Passing (Short/Long) – 2 or more players	WPB		
	Steals and "middle Steals"			
	Shots (Specific positions; After a pass from the 2m line; free – head shot; lob shot)			

RB: resistance band; WPB: water polo ball; KB: kickboard; MDB: medicine ball; PME: perceived maximal exertion; ": seconds.

Most coaches believe that the phase between the end of the warm-up and the start of the game should be 20 minutes or less (64%), while others state that 10 minutes (27%) or 5 minutes (9%) would be ideal. During the game, none of the coaches reported prescribing any type of activation or re-warm-up for their players when they needed to substitute in-game or during time-outs. The majority of coaches (82%) integrate the pre-competition warm-up into training sessions to help players internalise the routine. However, their approaches vary: 22% implement it at the beginning of the week, 33% use it only during practice games, 17% reserve it for important matches, and 28% introduce it primarily at the start of the season. Notably, 18% of coaches do not follow a structured warm-up routine during actual games.

DISCUSSION

To our knowledge, this is the first study to investigate the warm-up practices commonly used by water polo coaches in Portugal. The results revealed wide variation in warm-up practices, including duration, intensity, types of exercises, materials used, and distances covered. Despite this variability, most coaches recognise the importance of warm-up and systematically incorporate it into training sessions, ensuring players are familiar with the routine before the competition.

Currently, no studies have specifically explored pre-competition warm-ups in water polo, particularly those that cover both dry-land and in-water phases or address re-warming strategies for bench players. The existing literature on the physiological demands of water polo is also limited (Hohmann, 1992). Findings from this study suggest that warm-up objectives should include physiological preparation (raising body temperature), mental readiness (enhancing focus on strategy), tactical awareness (preparing for specific game demands), and kinesthetic activation (improving ball handling and positioning). These elements align with broader sports-related practices but have not yet been thoroughly examined in the context of water polo.

In our study, dry-land warm-ups primarily consisted of mobility exercises for the arms, trunk, and legs, often performed without additional equipment or, in some cases, incorporating simple tools. These warm-ups consistently preceded in-water sessions, a practice supported by previous research (Andrade et al., 2015; Crowley et al., 2018; Sáez de Villarreal, 2015). However, it is notable that coaches tend to follow traditional methodologies based on experience rather than scientifically validated protocols. This highlights the gap between research and coaching practices, reinforcing the need for evidence-based guidelines to optimise warm-up strategies.

The limitations of this study include a small number of coaches surveyed and a lack of differentiation in age or skill

Table 3. Example of a typical dryland warm-up prescribed by coaches before a match and before the in-water warm-up, in terms of Intensity, exercises, example of a task, and type of material used in each task.

Warm-up stage	Type	Example of specific exercises	Additional devices used	Number of Reps (Time)/ Rest
Initial stage	Mobility	Arm Rotations Short and big		1 set of 30"/15" rest (Change after 15")
		Dynamic Chest + Back		1 set of 30"/15" rest (Change after 15")
		"Bent-Over windmill"		1 set of 30"
		Handles (Shoulder and Chest)/ YWTL		1 set of 30" for each exercise
		Hip Circles/Rotations/Adductor Rock back		1 set of 30" for each exercise, no rest between
		"Pumps (Arnold)"/90/90's (Arms 90°)		1 set of 30" for each exercise, no rest between
Fundamental stage	Specific workout	External Rotation/Internal Rotation/Reverse Fly	Resistance Band	1 set of 30" for each exercise 15" rest between
		Normal Squat/Side to Side Squat		2 sets 30" for each exercise 15" rest between
		Jumping Jacks		2 sets 30" and 15" rest
		Lunge Walk+Reverse/Lunge with trunk rotation	Medicine Ball	2 sets 30" for each exercise 15" rest between
		Plank/Side Bridge		2 sets 30" for each exercise, 15" rest between / right and left arm on the floor
		Mountain climbers		2 sets 30" and 15" rest
Final stage	Dynamic stretching	Spinal Rotations		1 set of 30"/15" rest
		Hand Walk		1 set of 30"/15" rest
		Knee+arm		1 set of 30"/15" rest

level among players, with a focus mainly on older athletes. Future research should explore individualised warm-up protocols that account for seasonal training loads, player positions, and competition schedules to enhance player preparation and performance.

CONCLUSIONS

This study provides a comprehensive insight into the warm-up practices of elite water polo coaches, marking the first such investigation in Portugal. While warm-up routines vary in duration, intensity, and exercise selection, coaches generally agree on the importance of structured pre-competition warm-ups and incorporate them regularly into training. The findings highlight the dominance of dry-land warm-ups using body-weight exercises, with minimal reliance on specialised equipment before transitioning to in-water warm-ups. Additionally, in-water warm-ups are often structured into phases, ensuring players optimise their physical and tactical readiness. The findings will serve as a valuable resource for coaches, strength and conditioning professionals, and researchers, enhancing coach education and offering practical insights into the challenges of competitive water polo. Additionally, this study highlights the situational factors that both coaches and players encounter in high-performance environments, helping to inform strategic decision-making and training adaptations.

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