Nutritional Recommendations for Water Polo

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Water polo is an aquatic team sport that requires endurance, strength, power, swimming speed, agility, tactical awareness, and specific technical skills, including ball control. Unlike other team sports, few researchers have examined the nutritional habits of water polo athletes or potential dietary strategies that improve performance in water polo match play. Water polo players are typically well muscled, taller athletes; female players display higher levels of adiposity compared with their male counterparts. Positional differences exist: Center players are heavier and have higher body fat levels compared with perimeter players. Knowledge of the physical differences that exist among water polo players offers the advantage of player identification as well as individualizing nutrition strategies to optimize desired physique goals. Individual dietary counseling is warranted to ensure dietary adequacy, and in cases of physique manipulation. Performance in games and during quality workouts is likely to improve by adopting strategies that promote high carbohydrate availability, although research specific to water polo is lacking. A planned approach incorporating strategies to facilitate muscle glycogen refueling and muscle protein synthesis should be implemented following intensified training sessions and matches, particularly when short recovery times are scheduled. Although sweat losses of water polo players are less than what is reported for land-based athletes, specific knowledge allows for appropriate planning of carbohydrate intake strategies for match play and training. Postgame strategies to manage alcohol intake should be developed with input from the senior player group to minimize the negative consequences on recovery and player welfare.

Keywords: swimming, team sport, diet, body composition

Water polo is unique compared with other aquatic sports, because it is the only team sport sanctioned by the Fédération Internationale de Natation (FINA). This article provides an overview of water polo and highlights the physiological and nutritional demands associated with daily training and water polo match play. The nutritional intake and nutrition-related issues specific to this population are discussed, as well as nutritional interventions likely to enhance the response to daily training and performance during training and match play.

The origin of water polo came from the more commonly known game of polo played on horses. In 1870 the London Swimming Club developed rules for football played in swimming pools. Early games were generally exhibitions of brute strength as each player aimed to score goals irrespective of position. In 1880 the rules were modified in Scotland, in the way they are now widely adopted. Outside of Europe, the United States started playing the sport in 1888. It developed as a rough game centered on scrimmages, with the ball commonly dunked below the water surface. The game was about survival of the fittest.

In 1908, the sport entered the Olympic Games in London, adopting the more sophisticated rules set by the British. FINA adopted these rules, which were universally accepted, resulting in 12 competing nations at the Antwerp Olympic Games of 1920. From 1928, Hungary emerged as the leading water polo nation, a position they held until the 1980s. Countries such as Serbia, Montenegro, the United States, Russia, Italy, Croatia and Spain are all considered powerhouse nations in water polo. At the Sydney 2000 Olympics, women's water polo was introduced, and Australia won the first ever Olympic Gold medal. The United States has dominated international women's water polo, winning all but one FINA Women's Water Polo World League Championship since its inception in 2004. Today, water polo exists in all FINA International competitions and of course every 4 years in the Olympics.

Water polo is played in the pool within an area of 30 × 20 m with a minimum pool depth of 2 m. Teams consist of 13 players, and a goalkeeper and 6 field players participate at any one time. The duration of the game is four quarters of 8 min real time, not including time out for penalties, requested time-outs, or goals. Overall game time is typically 60–70 min with the exception of games in which overtime is required. The goalkeeper is the only...
player allowed to touch the ball with both hands simultaneously. A team has only 30 s of ball possession before a goal attempt has to be made, at which point the team is required to relinquish possession. Only players with clear ball possession may be attacked by the opposition, and the ball may not be dunked below the water surface during the encounter. Severe fouls lead to exclusion for 25 s, and after three exclusions, a player may not return to the game. After a successful goal attempt and during the 2-min break between quarters, the coach is able to substitute players.

**Physiological Demands of Water Polo**

Water polo is a sport that places high physical and physiological demands on players, who require well-trained capabilities to cope with such intense demands (Smith, 1998). Like most team sports, water polo is characterized by a high intensity, intermittent activity pattern coupled with aggressive physical contact with opposing players.

**Time-motion analysis**

Players perform numerous activities throughout a game including swimming of various intensities; treading water; wrestling with opponents; lunging in offense and defense; and passing, receiving, and shooting the ball (Tumilty et al., 2000). During men’s water polo match play, players usually perform around 100 high intensity activities and sprint swimming efforts, with durations ranging from 7 to 14 s. These bursts of intense exercise are usually performed in cumulative sequences of longer duration, interspersed with activities of lower intensity (Smith, 1998). Observation of players during international level competition shows a total playing time of 34 min, with a work-to-rest ratio during play (i.e., not including rest time between quarters) of 5:2. A player swims for transportation 60 times on average per game (about 12 min), each swim lasting 10–12 s, and swimming movements to gain an offensive or defensive advantage are of similar duration. Total distance swum in a game may range between 500 and 800 m. Field players spend 45%–55% of match time in a horizontal position and the remainder of the time in a vertical position. High intensity activities represent about half of match play time (Smith, 1998). This activity profile suggests that all aerobic and anaerobic metabolic pathways are heavily taxed during men’s water polo match play.

Video-based time-motion and notation analyses have also been used to assess the demands of elite women’s water polo. A study conducted during a major World Cup tournament investigated predefined activity durations and frequencies, finding average exercise bout durations of 7 s and a work-to-rest ratio within play of 1:1.6 (D’Auria and Gabbett, 2008). On average, swimming represented 64% of the exercise; contested swimming, 13%; wrestling, 14%; and holding position, 9%. There were however large differences between outside players and center forwards: high intensity swimming was of greater significance to perimeter players, whereas the activity pattern of center players had a larger emphasis on wrestling (D’Auria and Gabbett, 2008). A separate study of elite women’s water polo reported that mean match duration was 70 min, 33 min of which were playing time. Players were reported to perform on average 330 discrete movements per match, changing movements every 6 s. Mean distance swum per match was 700 m, and the differential predominance between perimeter players and center forwards in sprint swimming (over 2 min and under 1 min, respectively) and wrestling (less than 2 min and more than 4 min, respectively) was confirmed. In addition, the importance of repeated sprint ability for water polo players was emphasized, because players were required to perform seven repeated high intensity activity bouts per match (Tan et al., 2009a).

The specific activity pattern of water polo goalkeepers differs markedly from that of field players, because they usually spend more than 30 min easy-sculling (i.e., performing “eggbeater” kick and sculling to sustain eye contact with match play when the ball is away from their team’s defensive zone); about 12 min ready-sculling to sustain a high vertical position in preparation for hands-up blocking, jumping, or stealing the ball; and approximately 3 min swimming and passing. Although goalkeepers also perform high intensity and explosive movements such as maintaining a hands-up position and jumping frequently, such movements are often required following 10–15 s of relatively intense exercise and are repeated over 40 times per match (Smith, 1998).

The analysis of the activity pattern of men’s and women’s water polo, including perimeter, center forward, and goalkeeping positions, clearly reflects the high intensity, intermittent nature of the game. Coaches regularly rotate players in and out of the game during stops in play, as unlimited substitutions are allowed throughout the match. Individual playing time can thus vary among players, and so will physiological and nutritional needs. Training and nutritional interventions should address the specific physiological demands of the game for each player to delay the occurrence of fatigue and maximize performance.

**Physiological Demands and Fatigue During Competition**

Insight into the cardiovascular and metabolic demands of the sport provided by simple physiological measurements such as heart rate and blood lactate also indicate that high demands are placed on both aerobic and oxygen-independent metabolic pathways during match play. Male water polo players spend most of their play time at heart rates exceeding 80% of their maximum heart rate (Smith, 1998). Female players’ mean heart-rate reserve is 80% over the duration of a match (including the warm up and the rest periods between quarters). They spend nearly 40 min at heart rates above that mean value.
of 80%. These results indicate that despite the intermittent activity patterns of water polo, aerobic metabolism is severely taxed during match play (Hollander et al., 1994). Similar conclusions highlighting the importance of aerobic metabolism were reached in studies investigating the swimming profiles of elite male players during major national and international competition (Hohmann & Frase, 1992; Platanou and Geladas, 2006).

Mean capillary blood lactate concentrations of elite Spanish players studied during the rest breaks of the final play-off matches of the national league were 7.1–9.5 mmol/L (range = 5.0–12.0 mmol/L) for field players, whereas goaltenders’ values were consistently 5.1–5.7 mmol/L. On the basis of these observations, it was concluded that the glycolytic demands of water polo match play are high as a result of the sustained exercise intensity (Rodríguez et al., 1994). A similar conclusion was reached in an investigation of female players studied during a single match of the top level league in the Netherlands, although the mean blood lactate values reported were somewhat lower than those reported above: 4.9–5.8 mmol/L (range = 1.5–9.8 mmol/L; Hollander et al., 1994). Similar blood lactate values have been observed during match play in male and female players (Konstantaki et al., 1998; Platanou and Geladas, 2006; Platanou and Nikolopoulos, 2003).

In a study analyzing the physiological demands of eight elite goaltenders during competition, players were reported to spend 86% of match play time at heart rates representing 82% of their peak heart rate, below the intensity corresponding to their individual lactate threshold (3.5 mmol/L). However, the remaining 14% of match play time contained activities requiring sudden elevations of their heart rate above their lactate threshold, and mean blood lactate concentration at the end of each quarter was 3.9 mmol/L (range = 2.0–8.3 mmol/L). Goaltenders exercised at highest intensities during situations of numerical inferiority because of the temporary exclusion of a team mate (Platanou, 2009).

Although teams are allowed to constantly rotate players throughout a match, the overall exercise intensity of water polo match play usually decreases as a match progresses, suggesting the likelihood of fatigue occurring during the latter stages of match play (Pinnington et al., 1998; Platanou and Geladas, 2006; Tan et al., 2009a). This finding is important, because in addition to diminishing players’ engagement in intensive match play, fatigue may also have a negative impact on a player’s skill proficiency. A study analyzing the effects of fatigue on decision making and shooting skill performance of junior elite water polo players found that shooting proficiency deteriorated as exertion level increased. A systematic increase in heart rate and blood lactate responses during a water-polo-specific simulation task induced increased fatigue levels, which suggests that these factors contributed to the observed decline in skill proficiency (Royal et al., 2006). In contrast with the previous findings, no fatigue was detected among elite goaltenders in an analysis of their activity profile from quarter to quarter (Platanou, 2009).

### Implications for Training

Water polo training sessions should be planned to maximize the physical and physiological adaptations allowing players to best meet the demands of match play. However, a marked discrepancy has been reported between the heart rate and blood lactate concentration values during training and match play in female players. The overall intensity during training sessions seemed to be insufficient to elicit the necessary overload to increase the players’ capacity to cope with the demands of competitive matches (Hollander et al., 1994). Various authors have emphasized that elite players should engage in conditioning programs that prepare them for the expected demands of match play, including match-specific swimming loads and position-specific game skills and team scrimmages (Hohmann and Frase, 1992; Pinnington et al., 1998; Platanou and Geladas, 2006). In this respect, notational analyses of elite men’s and women’s water polo match play can add to the knowledge gained from time-motion analyses and the assessment of the physiological demands of competition, helping coaches and fitness staff to integrate technical and tactical aspects of the game in their training activities (Lupo et al., 2012, 2014).

It appears that dry-land strength training should also be an integral part of water polo players’ training programs. Eighteen weeks of lower body strength and high-intensity training (including bench press, full squat, military press, pull-ups, loaded countermovement jumps, and abdominal exercises) induced gains not only in dry-land strength measures, but also in performance qualities that could be important for water-polo-specific match play, such as throwing velocity and 20-m sprint swimming (Veliz et al., 2014).

### Dietary Intake of Water Polo Players

Little has been reported regarding the dietary intake of male and female water polo players independent to that of other athletes. Dietary intake of Greek national swimming (n = 31) and water polo athletes (n = 27) was reported using a 24-hr dietary recall assessment and food-frequency questionnaire (Farajian et al., 2004). No differences were reported in energy or macronutrient intake between athletes involved in the different aquatic sports; however, male aquatic athletes reported consuming more energy, carbohydrates, protein, and fat than female aquatic athletes (Farajian et al., 2004). Reported daily energy intake for male and female aquatic sport athletes were 14.3 and 8.5 MJ ⋅ day−1, respectively. This is remarkably similar to that reported by Holway and Spriet (2011) in a recent review including 819 male and 283 female team sport athletes (15.3 and 8.6 MJ ⋅ day−1, respectively). Surprisingly, Greek male water polo players had a lower carbohydrate intake (3.6 ± 1.3...
g · kg body mass–1) compared with male swimmers (5.0 ± 1.5 g · kg body mass–1) and with the weighted mean intake of team sport athletes reported by Holway and Spriet (2011). In a study of elite Dutch athletes, male water polo players consumed a diet high in energy compared with other team sport athletes (van Erp-Baart et al., 1989). However, carbohydrate intake of team sport athletes in this study, expressed as a percentage of total energy, was below recommendations at the time (46% of energy derived from carbohydrate) and similar to that of the general Dutch population (van Erp-Baart et al., 1989).

Daily protein intake of male water polo athletes (1.8 g · kg body mass–1) is higher than that reported for female players (1.4 g · kg body mass–1; Farajian et al., 2004). However, both fall within suggested daily protein intake for athletes (Phillips & Van Loon, 2011). There is some evidence to suggest the dietary quality of team sport athletes is less than what is reported for athletes involved in individual sports. Alcohol intake of team sport athletes appears higher than that of other athlete groups (Burke et al., 1991; van Erp-Baart et al., 1989), although contemporary dietary surveys are lacking to verify these earlier reports. Furthermore, assessed against the recommendations of the Mediterranean diet pyramid, Greek male aquatic athletes failed to consume the recommended amounts of vegetables, and approximately half the athletes consuming less than the recommended amounts of fruit (Farajian et al., 2004). These issues are noteworthy for sports nutrition professionals consulting with water polo athletes and highlight the need for a thorough dietary review when initially engaged with a team.

### Size, Physique, and Body Composition

Water polo is a physically demanding sport in which strength, power, and physical contact are critical elements for success. Contemporary studies describing the physical characteristics of elite male, female, and junior elite water polo players are outlined in Table 1. Male players can be described as balanced mesomorphs, and female players display higher levels of endomorphy (Ferragut et al., 2011; Platanou & Varamenti, 2011). Compared with elite swimmers, water polo players are heavier and have higher body fat levels (Pyne et al., 2006).

Data describing the physical attributes of water polo players at the 1991 FINA World Championships found no positional differences among either male or female players (Drinkwater & Mazza, 1994). However, more contemporary data demonstrate positional differences in the physical characteristics of male and female water polo players; center players are heavier and have higher body fat levels compared with perimeter players (Kondrič et al., 2012; Tan et al., 2009b). This probably offers an advantage to the center players because they are required to hold position close to goal while grappling and wrestling aggressively with opposition players. Furthermore, additional body fat levels may offer a physical advantage in terms of buoyancy for the center player positions (Tan et al., 2009a).

<table>
<thead>
<tr>
<th>Study</th>
<th>Athletes</th>
<th>Anthropometric Data</th>
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<tbody>
<tr>
<td>Tsekouras et al., 2005</td>
<td>n = 19; 25.5 ± 5.0 years; professional male players</td>
<td>Ht: 184.5 ± 4.3 cm; BM: 90.7 ± 6.4 kg. Body composition assessed via DXA—lean mass: 75.1 ± 4.9 kg; fat mass: 15.3 ± 4.3; BMD 1.37 ± 0.07 g.cm–2</td>
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<td>Lozovina et al., 2009</td>
<td>n = 121; 17–27 years; male players recruited from eight First Division Croatian water polo clubs</td>
<td>Ht: 192.3 ± 6.4 cm; BM: 93.6 ± 10.8 kg. center and back players were heavier than other player positions</td>
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<tr>
<td>Tan et al., 2009b</td>
<td>n = 12; 20.8 ± 4.7 years; female National League players; n = 14, 23.3 ± 2.9 female National Squad players within Australian League</td>
<td>Ht: 173.7 ± 5.5 cm; BM: 74.6 ± 8.0 kg. National Squad players were taller and heavier than National League players; National Squad center players were taller, heavier and had higher body fat levels compared with perimeter players</td>
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<tr>
<td>Alcaraz et al., 2011</td>
<td>n = 10; 23.5 ± 2.1 years; female players recruited from the Spanish National team</td>
<td>Ht: 171.0 ± 6.5 cm; BM: 64.2 ± 5.2 kg</td>
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<tr>
<td>Ferragut et al., 2011</td>
<td>n = 13; 26.1 ± 4.8 years; male players recruited from the Spanish National team</td>
<td>Ht: 188.2 ± 6.1 cm; BM: 91.5 ± 12.0 kg; Arm span: 195.5 ± 6.1 cm; Somatotypes—endomorphic: 2.99 ± 0.9; mesomorphic: 5.6 ± 1.4; ectomorphic: 2.0 ± 1.0. Center players heavier than field players with higher selected skinfolds</td>
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<tr>
<td>Platanou and Varamenti., 2011</td>
<td>n = 33; 21.7 ± 5.4 years; female water polo players recruited from Greek A women league clubs</td>
<td>Somatotypes—endomorphic: 4.6 ± 1.1; mesomorphic: 5.1 ± 1.4; ectomorphic: 2.7 ± 1.1</td>
</tr>
<tr>
<td>Kondrič et al., 2012</td>
<td>n = 110; 17–18 years; high level European male players</td>
<td>Ht: 186.9 cm; BM: 84.31 kg. Center players heavier than field players excluding points</td>
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Note. Ht = height. BM = body mass. BMD = bone mineral density. DXA = dual-energy X-ray absorptiometry.
et al., 2009b). Perimeter players, in contrast, are smaller and leaner, which are desirable features given that speed and agility are more important in these positions. Finally, female Australian National squad players scored higher in various physical assessment tasks and were taller and heavier than National League players (Tan et al., 2009b). Position-specific physical attribute requirements for elite water polo players are useful for athlete profiling and decision making regarding suitable dietary interventions for developing athletes and elite athletes alike (Holway & Spriet, 2011).

Unlike male water polo players, it is difficult for female players to maintain and or achieve a high body mass without increasing body fat levels. In our experience, it is common for water polo coaching staff to direct female players to increase absolute strength and body mass, particularly if playing center positions. This is a challenging issue to manage given societal pressures for women to achieve a light and lean physique. The issue requires a delicate approach involving coaching staff, strength and conditioning, and sports psychology input, along with appropriate nutrition counseling to ensure the players realize the performance-related outcomes of the intervention and have the necessary dietary understanding to implement the suggested changes.

Important Nutrition-Related Factors for Water Polo Players

The various dietary interventions likely to improve water polo performance by either improving the response to daily training or match-day performance are discussed in the following sections. Although direct evidence for many of these strategies is lacking in applied research models that have replicated the demands of water polo match play, support exists in other team sports involving intermittent high intensity efforts.

Nutritional Strategies to Promote Muscle Mass

Because high body mass appears to offer a physical advantage in water polo, it is important to consider strategies that promote lean muscle accretion. This is particularly relevant to younger players aiming to transition into elite level competition. Strength and conditioning workouts form a routine part of weekly training and in some instances will be included throughout the annual training and competition calendar. Recent research has focused on feeding strategies that enhance protein synthesis after a bout of resistance exercise (Burke et al., 2014). Although some water polo players may believe that high protein intake is needed, current evidence indicates that 20–30 g of protein consumed immediately after a workout optimizes muscle protein synthesis (Moore et al., 2009). Furthermore, a fast acting protein such as whey seems to offer an advantage over other proteins, at least in the postworkout period (Tang et al., 2009). In a study investigating the efficacy of β-hydroxy-β-methylbutyrate (HMB) supplementation in male water polo players, all athletes underwent initial dietary counseling that included advice from a qualified sports dietitian regarding the most appropriate nutritional interventions to promote muscle hypertrophy (Slater et al., 2001). Although the training and dietary intervention implemented by the investigators resulted in significant strength gains and an increase in lean muscle mass, HMB supplementation had no influence on these variables. The findings of this study highlight the benefit of appropriate dietary counseling within a team sport environment where optimization of muscle mass is a priority. The reader is referred to Burke et al. (2014) for a list of suitable protein-containing recovery foods suitable for poststrength training snacks.

Fuel to Support Training, Recovery, and Competition

Recently formulated carbohydrate intake guidelines (Burke et al., 2011) should be carefully interpreted when applied to water polo athletes. Given that daily carbohydrate intake guidelines are expressed in grams per kilogram of body mass, an adjustment should be made to accommodate varying levels of adiposity observed amongst water polo players. The extent to which current recommendations are modified should reflect the individual morphological characteristics of the player, daily training commitments and work-related activity. It should be duly noted that daily carbohydrate needs are not static, but reflect daily, weekly, or seasonal changes in exercise within a periodized training program (Holway & Spriet, 2011).

Training routines during the preseason and precompetition phases, when twice-daily or three-a-day training sessions are commonplace, will require more aggressive daily fueling strategies. In fact, swimmers consuming a lower carbohydrate diet fail to maintain high quality workouts during intensified swimming blocks (Costill et al., 1988). Furthermore, during strenuous exercise (cross-country skiing) that involves upper and lower body muscle groups, muscle glycogen stores are depleted in the arms to a greater extent than in the legs (Nielsen et al., 2011). Thus, a water polo player’s daily carbohydrate intake should be modified throughout the training year and strategically coordinated with daily training sessions to support training performance.

Although we have no definitive assessment of carbohydrate usage during water polo training and competition, it is likely that daily requirements are within 4–8 g · kg body mass−1 · d−1. Higher intake may be required in younger players to accommodate growth and development, leaner athletes with high daily energy requirements, or athletes striving to gain lean muscle mass to maintain a positive energy balance. The lower range recommendations for carbohydrate intake are probably suitable for athletes with high body fat levels (given that recommendations are expressed relative to body mass), athletes returning from injury or on a break...
where training loads are reduced, or female water polo players striving to reduce body fat levels. It is of utmost importance for sports nutrition professionals to have an intrinsic knowledge of the daily training and competition demands as well as the body physique goals of the athlete to interpret the guidelines appropriately.

Adolescent athletes making the transition into elite level training and competition often require additional support in the way of formal nutrition education sessions and practical nutrition workshops to ensure they clearly understand the added fuel demands of rigorous daily workouts. Essential lifestyle nutrition skills such as shopping, preparing meals and snacks, and reading nutrition labels provide the foundation by which athletes can support the fueling demands of heavy daily training.

Elevating muscle glycogen stores by consuming a high carbohydrate diet for 24 hr has been shown to increase muscle glycogen content by 38% and to improve high-intensity work during a four-players-per-side indoor soccer match lasting 90 min (Balsom et al., 1999). It is difficult to extrapolate these findings directly to water polo given the difference in work-to-rest patterns, the nature of the game (running vs. swimming), and the duration of the game, but it does suggest that water polo players would be well served to commence match day with normalized or elevated muscle glycogen stores. Obviously, in tournament settings in which athletes are required to play several games over a weekend, elevating muscle glycogen stores is probably beneficial. Note that additional training should be incorporated on match day for bench players and reserve goal keepers who have little game time. Dietary habits of these players are likely to mirror those of starting players, resulting in an energy surplus and leading to unwanted weight gain or undesirable change in body composition over an intensified competition period.

Pregame meals are highly individual and will be heavily influenced by the scheduled game time. In general, familiar, easily consumed carbohydrate foods and fluids should be included in the pregame meal with a liquid meal supplement providing a suitable alternative for nervous athletes with a reduced appetite. For afternoon or early evening games, athletes should be reminded to maintain their typical daytime meal pattern throughout the day, rather than sleep in and miss meals.

Ample time is available during the scheduled breaks and substitutions for fluid and carbohydrate intake during the game. Although strategies that promote high carbohydrate availability (i.e., carbohydrate mouth rinse and ingestion of small amounts of carbohydrate) improve sustained running and cycling performance in protocols of approximately 45–75 min (Cermak and van Loon, 2013), results from studies adopting an intermittent test protocol with a duration similar to that of a water polo game are equivocal (Phillips et al., 2012; Dorling & Earnest, 2013). However, consuming carbohydrate during a game to fuel the brain for attention and decision making is as important in team sports as maintaining or enhancing physical performance (Winnick et al., 2005). Therefore, it would seem prudent to recommend that players consume carbohydrates in the form of sports drinks or carbohydrate gels throughout match play, intensified team training sets, or extended conditioning swimming sets to promote high carbohydrate availability. Only small amounts of carbohydrate are likely to be beneficial, because typical workloads undertaken throughout match play are unlikely to stress muscle glycogen stores. Some consideration should be made regarding this advice for adolescent athletes given concerns about erosion of tooth enamel (Phillips et al., 2011).

Rapid refueling after the completion of a game or training session is important when there is a short interval between matches or when the player is required to undertake further training in close proximity. Although games at major international competitions are typically scheduled 48 hr apart, younger players may be involved in round-robin tournaments in which they are expected to play several games over a weekend. Furthermore, senior players engaged in weekend fixtures are typically required to undertake training within 24 hr of scheduled matches, further highlighting the importance of a planned approach to nutritional recovery. Contact injuries and excessive postgame alcohol intake will probably delay muscle glycogen restoration (Mujika and Burke, 2010). Team sport athletes distracted by postgame celebrations further hamper recovery because sleep and rest are typically compromised by a big night out. Perhaps a more significant issue relates to player safety and misconduct when team athletes engage in excessive postgame celebrations.

Immediately after matches, nutritional recovery strategies can be encouraged with a well-organized, portable team recovery station, which may include sports drinks, liquid meal supplements (i.e., milk or soy-derived supplements), cereal bars, fruit, dried fruit and nut mixes, sports bars, and flavored milks. Easy postgame access to foods and fluids providing carbohydrates and protein will initiate refueling of muscle glycogen stores and simultaneously enhance protein synthesis (Breen et al., 2011; Howarth et al., 2010). The recovery process will be further enhanced by a nutritious meal scheduled 2–3 hr after the game, also allowing for social interaction among players and staff.

Hydration Considerations for Water Polo

Dehydration and heat stress are seldom considered a problem in aquatic sports such as swimming and water polo, although training and competition often involves prolonged high-intensity exercise. Although major water polo competitions are conducted in pools in which FINA mandates a small range in water temperature (25–28 °C), this may not be regulated during training and minor competitions. Cool water provides greater conductive and convective heat losses and reduces sweat losses compared with land-based activities (Cox et al., 2002). However, sweat losses are increased in warmer water, humid indoor settings, or hot weather for outside pools.
be influenced by a pack mentality that may not align with athletes. It is not unusual for athletes’ dietary intake to watchful eye of coaches and support staff in unfamiliar professional. Eating among other athletes and under the athletes, the coaching staff, and the sports nutrition eating with a team may present numerous challenges for restrictions apply and the sports nutrition professional would arrange catering needs directly liaising with the coaching staff and support staff in the form of physiologists, dietitians, and medical practitioners, less than half the athletes reported such providers as influential figures in their nutritional supplementation usage (Dascombe et al., 2010). In our experience, male water polo players and their coaches appear more interested in nutritional ergogenic aids that promote performance; female players are typically interested in supplements to support health and well-being.

**Nutritional Supplements and Sports Foods**

Like most team sport athletes, water polo players are interested in the potential performance benefit offered by nutritional supplements (Mujika and Burke, 2010). In a study of Australian state-based sports institute athletes, 89% and 86% of male and female athletes reported the use of nutritional supplements (Dascombe et al., 2010). Water polo players reported using approximately half as many nutritional supplements as swimmers in this study. Interestingly, despite the athletes having access to scientific support staff in the form of physiologists, dietitians, and medical practitioners, less than half the athletes reported such providers as influential figures in their nutritional supplementation usage (Dascombe et al., 2010). In our experience, male water polo players and their coaches appear more interested in nutritional ergogenic aids that promote performance; female players are typically interested in supplements to support health and well-being.

Nutritional ergogenic aids are likely to offer a performance advantage to water polo players given the activity patterns observed in match play include acute sodium bicarbonate loading, caffeine supplementation, and acute creatine monohydrate supplementation. We identified two studies that have directly assessed the efficacy of these nutritional ergogenic aids in water polo players.

Tan et al. (2010) failed to observe a performance benefit of acute bicarbonate supplementation in elite female water polo athletes using a simulated game, despite enhancing extracellular pH and bicarbonate levels. The authors concluded that the demands of female water polo match play may not be of sufficient overall intensity to elicit a performance enhancement from induced alkalosis. Using a simulated match protocol, Cort et al. (2005) failed to demonstrate a clear benefit of acute creatine monohydrate supplementation in a group of elite adolescent male water polo players. Players supplemented
with creatine monohydrate had increased body mass after supplementation, and their performance in a variety of sport-specific measures tended to decrease. Because water polo is unique with regard to the physical demands on match day and is one of the few aquatic team sports, further research is required into the efficacy of nutritional ergogenic aids for daily training and competition.

Conclusions

• Although research undertaken on land-based athletes using intermittent intensity protocols can be translated, careful consideration is required given the unique nature of water polo match play.

• Future research needs to investigate the dietary intake of water polo athletes. Furthermore, specific dietary interventions, including supplementation with nutritional ergogenic aids, should be investigated using protocols that simulate water polo match play.

• Unique physical characteristics for various playing positions have been identified, which provides valuable information to sports nutrition professionals and coaching staff.

• Nutrition strategies can enhance the response to daily training, recovery, and game-day performances in water polo athletes.

• Postgame celebrations should be managed with a multidisciplinary approach involving the senior athlete leadership group.

• Suitable planning and education should be undertaken in preparation for overseas travel to ensure that daily training and competition nutrition requirements are met.

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References


