

BEACH HANDBALL

PREPARING ATHLETES FOR COMPETITIONS

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INTRODUCTION

Beach handball (BH) is a sport which was developed in the 90's in Italy with the first demonstration game played in Misano Adriatico. The first set of rules was developed with the view of creating a beach version which could attract handball players and could provide an alternative competitive and training solution for the summer months when the indoor season was not active. The first tournament was played in 1992 and the International Handball Federation recognized the sport in 1994. The first world championships were played in 2004 in Hurgada in Egypt and since then, the sport has developed national and international competitions, culminating in the inclusion in the youth Olympics in 2018 and a demonstration tournament in Paris 2024 Olympics.

BH is played on a sand court of rectangular shape 27 meters long and 12 meters wide, consisting of a playing area and two goal areas. Dimensions of the court are measured from the outer edge of the boundary lines. The playing surface must be composed of levelled sand, as flat and uniform as possible, free of rocks, shells, and anything else which can be detrimental to the players. The sand must be at least 40 centimeters deep and composed of fine loosely compacted grains. There are 4 players on court per team at

any given time (1 Goalkeeper and 3 field players) with 1 goalkeeper substitute and 3 more field players substitutes. Field players can substitute in any part of the changing line assigned to the team; goalkeepers can only substitute in the goalkeeper entry zone assigned to the team on the same side of the team's substitution zone (see Figure 1).

Most elite teams tend to play with an attacking goalkeeper (i.e., specialist) which changes every time the team has ball possession to maximise the chances of scoring two points (goalkeepers' and specialists' goals are assigned two points). The game consists of two periods, which

are scored separately. Each period lasts ten minutes. The intermission lasts five minutes. Each period must end with a team winning, therefore if the score is even at the end of a period, the "Golden Goal" is used. The winner of each period is awarded one point. If each team wins a period, the result is a tie and to establish a winner a series of five shoot-outs is used.

Creative or spectacular goals, as well as goals scored from penalties, and goalkeeper goals are awarded two points each. All other goals are assigned one point (see details below). The game's rules facilitate spectacular actions and encourage the

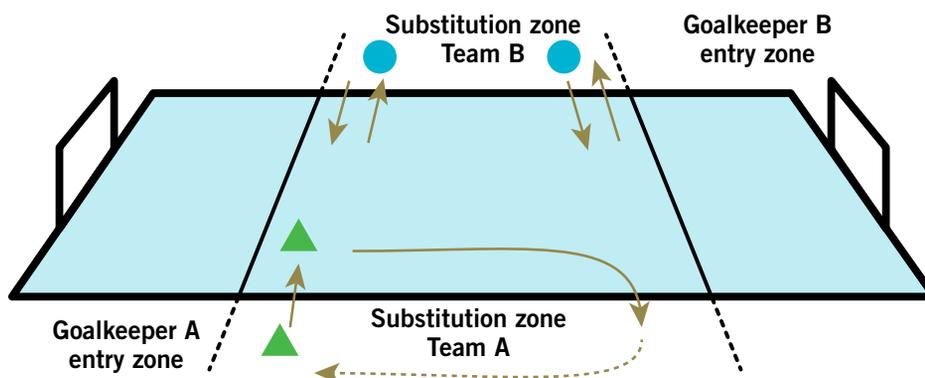


Figure 1: Playing court, substitution lines and zones.



Illustration

use of goalkeepers, in-flight shots, shots involving jumping with 360 degrees turns and rapid substitutions utilizing the whole length of the substitution line.

Performance Demands

Research into the performance profiles of BH players is expanding, similar to trends observed in indoor handball. This growing body of literature seeks to understand the specific physical, tactical and performance demands unique to BH. Previous research studies have analyzed individual and team performance profiles, establishing BH as a high-intensity mixed-metabolism sport¹⁻³. Characterized by a combination of high-intensity physical patterns, it requires movements involving speed and power, as well as quick accelerations, decelerations, and changes of direction⁴. The external and internal loads of BH players have been analyzed using GPS technology, and their physiological responses have been assessed through heart rate (HR) monitoring¹⁻⁵.

Time-motion analysis showed that matches were played on average by male players for 17.7 minutes, while female players played for approximately 18.7 minutes. During the matches, male players can cover an average distance of 1234.7 ±

192.0 meters, while female players cover 1118.2 ± 221.8 meters. Interestingly, both male and female players in BH exhibit relative distances similar to those observed in team handball, with men covering approximately 69.7 meters per minute (m/min) and women covering 59.8 m/min. A deeper analysis shows that male players cover the most distance while jogging, with an average of 432.7 ± 103.3 meters, followed by partial cruising at 356.0 ± 100.8 meters (zones 4.1–13 km/h) during a match. Female players, instead, exhibit lower speed zones during maximal displacement, with walking covering an average of 407.3 ± 64.3 meters and partially jogging at 370.6 ± 94.1 meters (zones 0.5–7 km/h) during a match⁴. Furthermore, during the segments of a game where the BH players were winning, men covered an additional average distance of 12 m/min compared to when they were losing. Similarly, women increased their average distance by 6 m/min during winning segments of the game².

In terms of average speed, previous research has shown that male players can maintain a pace of 4.2 ± 0.6 km/h, while female players averaged 3.9 ± 0.8 km/h⁴, and that the most extensive distances covered in a match typically range from

4 to 13 km/h for both genders^{2,4}. However, players spend only 56.8% of the match performing actions at speeds below 6 km/h⁶. The maximum speeds reached during matches can typically vary from 17 to 20.5 km/h in male games and 14 to 18.5 km/h in female games^{2,5}. Interestingly, for both men and women, the distance covered between speeds of 6 and 9 km/h doubles during winning game segments. Specifically, top male players typically excel when moving at speeds between 6 and 12 km/h, while for women, the ideal range is between 6 and 9 km/h, along with maintaining higher overall velocities. Thus, the capability to sustain longer distances at these speeds may be a key determinant of performance in BH.

The frequent changes between moderate-to-high intensity activities, including extended periods of low-intensity activity interspersed by brief bursts of high intensity characterize the demanding nature of BH. Both male and female players executed a similar number of accelerations ranging from 1 to 2 m/s², approximately 40 times throughout the entire match. This equates to approximately one body acceleration every 23 seconds for male players and every 27 seconds for female players⁴. Interestingly,

players execute 25% more accelerations per minute during winning segments. This could indicate that winning players are essentially quicker, or that winning teams engage in more plays that require sudden increases in speed².

Studies have shown that male and female BH players exhibit physical characteristics similar to the wing players of traditional handball, who are renowned for their agility, jumping ability, and skilled movements essential for their roles. Interestingly, BH players tend to be taller on average yet maintain comparable body weights to indoor handball wing players, enabling them to preserve mobility while benefiting from an extended reach, which provides a tactical advantage in the game^{2,4,7}.

Regarding the impacts during the game, male players experience an average of 3.9 impacts per minute, while female players have 4.7 impacts per minute⁴. These findings suggest that the intensity of impacts in BH is lower compared to other team sports. For example, team handball players experience approximately 13.6 impacts per minute⁸, while basketball players have around 8.2 impacts per minute⁹, and rugby players sustain about 21 impacts per minute¹⁰.

As for jumps, men jump more in winning segments, whereas women jump less. In women's matches, the role of the specialist player, who may not jump as frequently during standing and penetration shots, appears to be crucial in the offensive strategy and is more pronounced than in men's matches¹¹⁻¹³. This difference could explain why fewer jumps are associated with winning segments for women, suggesting a strategic divergence in how men and women's teams achieve success².

Male and female players achieve maximum/mean heart rates of $173 \pm 13 / 137 \pm 12$ beats per minute (bpm) and $177 \pm 13 / 138 \pm 18$ bpm, respectively. Additionally, 20.3% and 29.2% of the total match time for male and female players, respectively, is spent in the anaerobic zone (81–90% of maximum heart rate). Previous analysis of heart rate zones revealed that male players spend most of their time in zones 2 (61–70% of maximum heart rate) and 3 (71–80% of maximum heart rate), which together account for more than half of their total playing time. In contrast, female players spend the most time in zone 4 (81–90% of maximum heart rate), with nearly one-third of their total time in this higher intensity zone. Players perform a variety of actions during BH matches. Since the rules and the surface limit the

ability to dribble, players perform many movements with and without the ball and try to score more points performing spin shots. Spin shots are performed by jumping and rotating while in the air for 360 degrees and shooting before landing, resulting in spectacular moves. Due to the higher score allocated to spin shots (two points instead of the one assigned for regular goals), these are now the most common strategy used to score goals at the elite level^{11,14}.

According to the rules of the International Handball Federation, there are 6 types of shots that can be performed during a game:

- Inflight: Performed while flying through the air (two points);
- Spin shot: Taken with full turn of the body in the air (two points);
- Specialist: Performed by the specialist

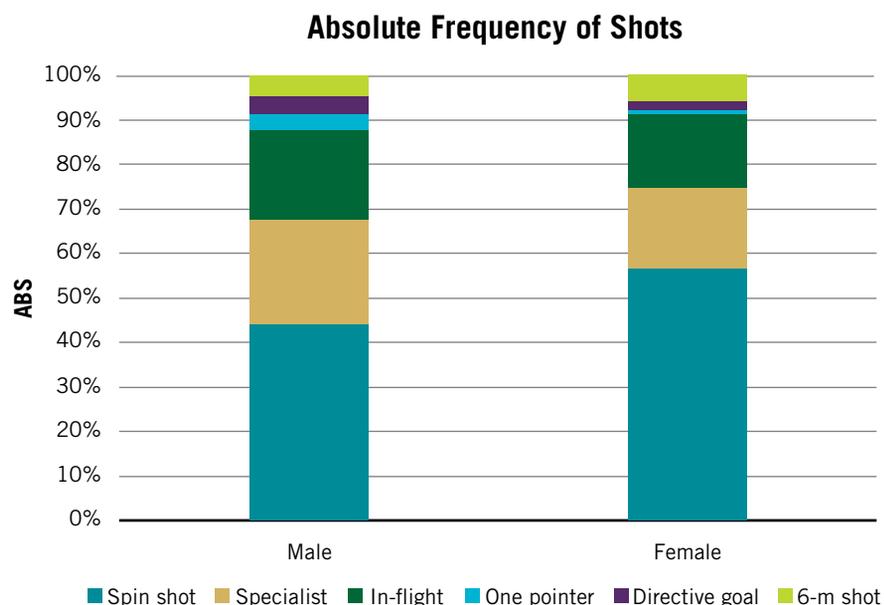


Figure 2: Frequency of shots measured during youth and seniors club tournaments. Data from (1).

Converted shots differences between winners and losers Kazan 2018

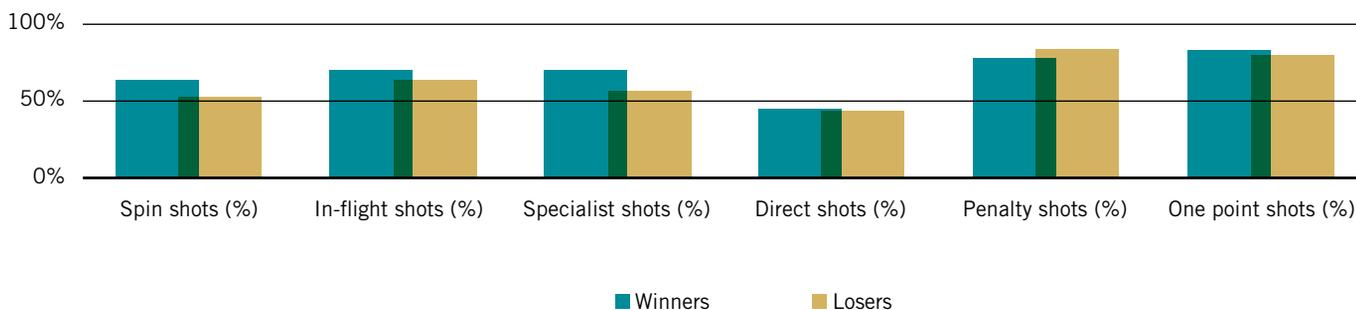


Figure 3: Converted shots differences between winners and losers during the Kazan 2018 Women's Beach handball World Championships. Data from (14)

- player [goalkeeper] (two points);
- Directive goal: Performed by the goalkeeper from the goal area (two points);
- 6-m shot: Penalty throw performed from the 6-m line (two points);
- One pointer: Non-attractive/ standard shot (one point)

Due to the way the game is played, spin shots tend to be performed mostly by players playing on the edges of the court (wing players).

Time-motion studies conducted in various BH tournaments with players of different levels report a total distance covered of less than 1500m in the whole match^{2,4,5}. This is a considerable difference compared to studies conducted in Indoor Handball where total distance covered is more than double and the game duration is also considerably longer. Therefore, while most of the technical requirements are similar to the indoor version of Handball (passing, jump shots, standing shots, defensive stance, ability to create space, goalkeeping), the overall demands of the game are completely different and for this reason players preparation should take a different approach.

The total distance covered is an overall indicator of the physical demands of the game. However, details of how movements are performed are paramount to properly identify the physical requirements. Currently, only a few papers have been published analyzing time-motion characteristics of BH games in tournament scenarios. However, they already provide a good insight into the details of the performance demands.

In particular, a study from Pueo et al⁴, was conducted on 12 players of the Spanish men's and women's national teams (respectively 5th ranked and world champions in the 2016 World Championships held in Budapest). The running profile collected during the matches was evaluated according to their frequency and duration using the distance attained in six speed zones: zone 1: standing (0–0.4 km/h), zone 2: walking (0.5–4 km/h), zone 3: jogging (4.1–7 km/h), zone 4: cruising (7.1–13 km/h), zone 5: high-intensity running (13.1–18 km/h) and zone 6: sprinting (>18 km/h). Impacts measured with accelerometry were also counted. The results indicated that the intensity zones where male and female players moved the most were walking (0.5–4 km/h) and jogging (4.1–7 km/h). The following variables showed significant differences between halves: total distance, average speed, distances covered in the standing and walking speed categories and average time spent in sprint. Female players covered 21.7% more distance in the first half than in the second half but with lower average speed. The average speed of locomotion during the match was 4.2 km/h in male and 3.9 km/h in female players, indicating that due to the playing surface and the size of the court, running speed requirements are relatively low. It is also important to note that the relative distance covered (m/min) in this study was similar to what has been reported previously in indoor handball. However, playing surface and environmental demands should be considered when evaluating these results. This is reinforced by the reported acceleration data showing relatively fewer accelerations and lower

intensity of accelerations when compared to indoor handball.

The game patterns were confirmed in another study on elite female players of the Spanish national team (albeit with different locomotion categories definitions¹⁶). The intermittent patterns of the game are characterized by many low intensity activities alternating with higher intensity ones (albeit overall of a lower intensity than the indoor efforts in terms of movement speed). This was also confirmed in a larger study on male players, as well as youth and adult female players in the German championships⁵. The typical maximum velocity reached can be closer to 15-16 km/h, but it is a rare occurrence in BH matches. Players' preparation therefore should be focused on preparing players to sustain rapid movements on sand which are key for creating attacking and defending opportunities as well as the need for using the rapid substitution rule (many high intensity runs in fact occur when players are rapidly exiting the court). Drills and training activities can be dedicated to increase the ability of players to sustain repeated high intensity movements on the sand in key moments of the game. Due to the specificity of moving barefoot on sand, as well as the physiological demands of training and competing mostly in the heat, it is important to emphasize training efforts on similar surfaces. Additionally, strength training should focus on getting players' lower limbs stronger due to the need to push against a moving/soft surface with longer muscle contraction times. What practitioners should also consider is that there is a large variability in demands according to the

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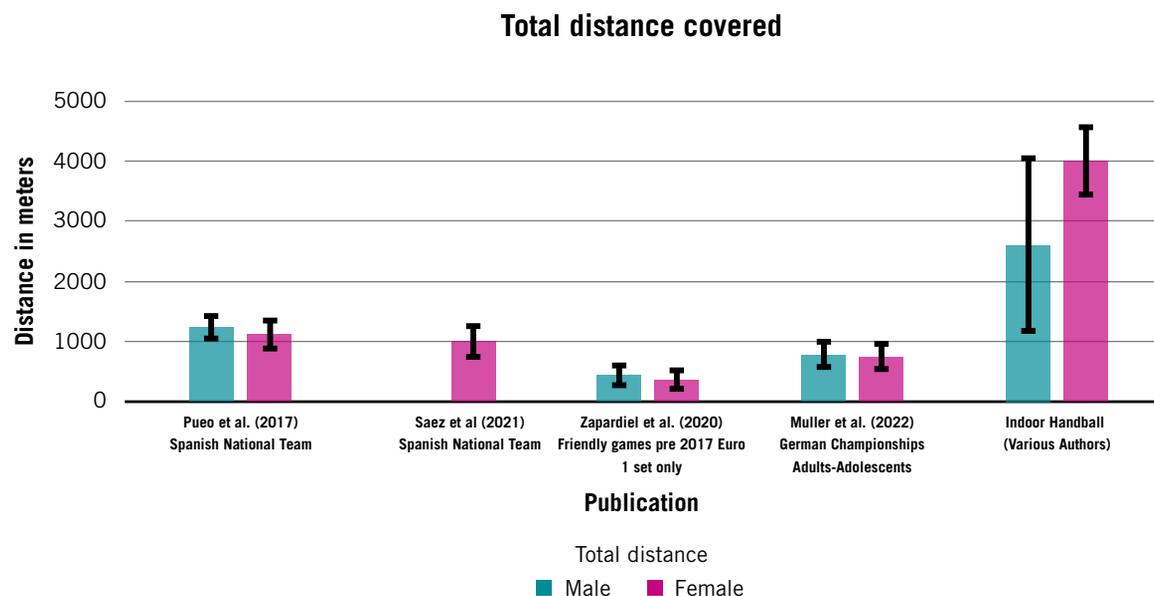


Figure 4: Total distance covered by players measured in various studies.

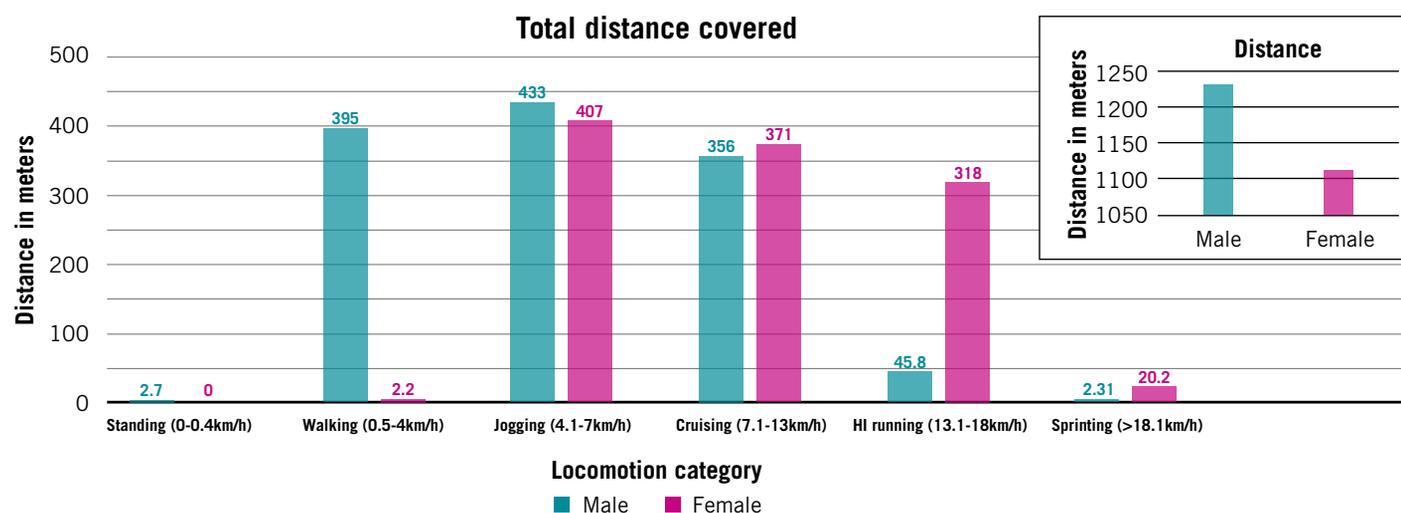


Figure 5: Distance Covered in different locomotion categories. Data From (4).

level of players and that often players must compete in several matches in the same day and therefore physical preparation should be focused on making sure players can sustain 4-5 matches in a day.

Metabolic Demands of Playing Beach Handball

As discussed in the previous paragraph, time-motion characteristics of BH players are the result of the game dynamics, the rules and the playing surface. Moving on sand requires 1.6–2.5 times more mechanical work than walking on a firm surface at the same speed. Walking on sand requires 2.1–2.7 times more energy expenditure than walking on a firm surface at the same speed, while running on sand requires 1.6 times more energy expenditure than running on

a firm surface. The increase in energy cost is primarily due to two effects: the mechanical work done on the sand, and a decrease in the efficiency of positive work done by the muscles and tendons^{17,18}. This is evidenced by an increase in oxygen uptake and heart rate a given speed. Therefore, while the motion outputs might suggest a lower metabolic demand, the fact that movements must be performed on sand and most times in hot and humid conditions suggests an increased metabolic load. Few studies have been conducted to determine metabolic demands of playing BH. Silva et al¹⁹ measured blood lactate concentration in six Brazilian female players. During the match, the lactate concentrations were 13.8 mM and 14.1 mM in the middle and at the end of the first set, respectively, and 11.7 mM and

12.0 mM in the middle and end of the second set. Lower values [~5mM] were reported in female Polish players²⁰ (See Figure 6).

Injury Prevention

BH has evolved into an increasingly dynamic sport, placing high demands on elite athletes, thus elevating the risk of potential injuries. A distinguishing feature of BH is the playing environment: sand, high temperatures, and the necessity to engage in several games within a single day. While studies are somewhat limited in this sport, some recent reports highlighted the high occurrence of injuries occurring during the second half of the game, immediately following the five-minute break. In particular, Holdauchs²¹ reported that 66% of all the injuries during the Women's Euro

2010 Championships occurred during the second half of competition, which could be attributed to a combination of fatigue, poor BH skills, heat stress and dehydration.

During the 2017 European Beach Handball Championships tournament, 87 injuries were recorded, yielding an overall injury incidence of 286.1 per 1000 match hours²². Time-loss due to injury was 49.3 per 1000 match hours. Senior players had a higher overall injury incidence with 395.3

injuries than U-17 players with 205.7 injuries per 1000 h match hours. Comparison of the injury incidence between the two sexes revealed 330.23 injuries per 1000 h BH exposure for male players and 234.9 injuries for female players. The most frequent injury type was sprains (21 injuries, 24.1%) followed by contusions (19 injuries, 21.8%) and skin abrasions (15 injuries, 17.2%). Central defenders and specialists had the highest injury incidence. Thighs, ankles, as

well as feet and toes (altogether 12 injuries, all 13.8%) were the three most frequently injured anatomic sites.

During the finals of the 2014 European Beach Tour (EBT), 122 BH players (72 female and 50 male) completed a self-reported anonymous questionnaire²³. During the previous 24 months, 34 of the 50 male athletes reported a total of 52 injuries while 45 of the 72 of female athletes reported a total of 50 injuries. The injury incidence rate for male BH athletes was 12 / 1000 hours during games, and 1.8/ 1000 hours of training. The injury rate for female athletes was 11.36/ 1000 hours during games, and 4 / 1000 hours of training. Injuries occurred more frequently during games both for male (77.3% of injuries) and female athletes (59.5% of injuries). The most common type of injury for both male and female players was muscle strains (male: 22.7%; female: 29.7%), although high percentages were also reported for muscle contusions (male: 13.6%; female: 10.8%), fracture (male: 9.1%; female: 18.9%) and ACL injury (male: 12.7%; female: 15%).

Investigating the injuries in 96 BH players of the men's national teams that participated in the 2007 European Beach Handball Championships, Manavis and colleagues²⁴ reported that 15.5% of the players suffered a serious injury, with goalkeepers and backcourt players representing the most injuries (71%). Most injuries were closed (85.7%), mainly affecting ligaments (57%), and involving the lower limbs, and the torso (42.8%). The main reported cause

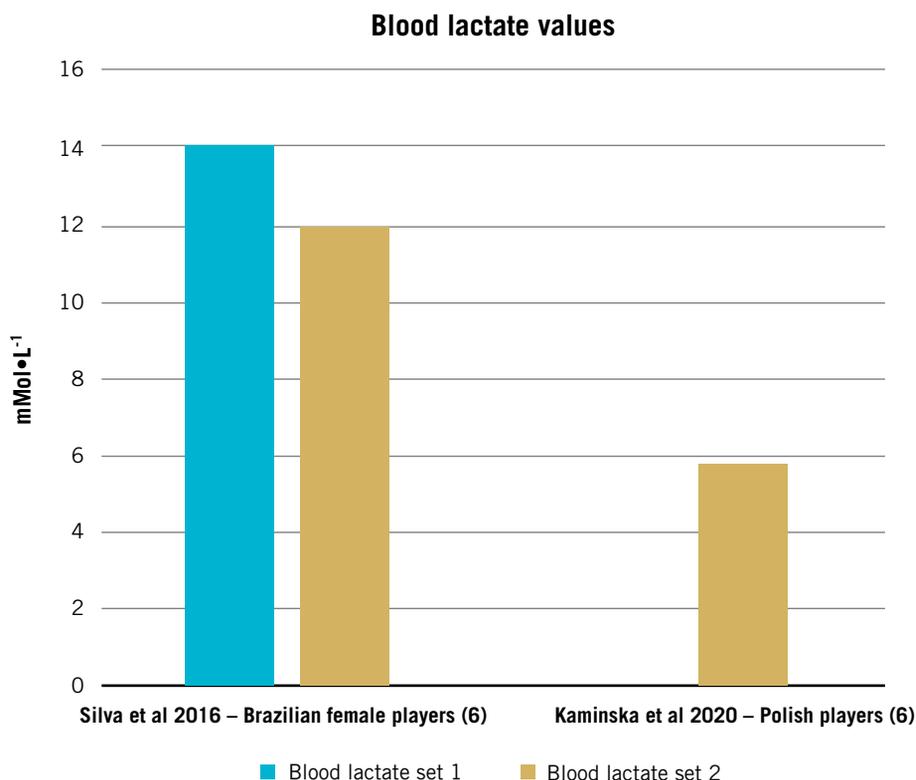


Figure 6: Blood Lactate values measured in different studies during beach handball matches.

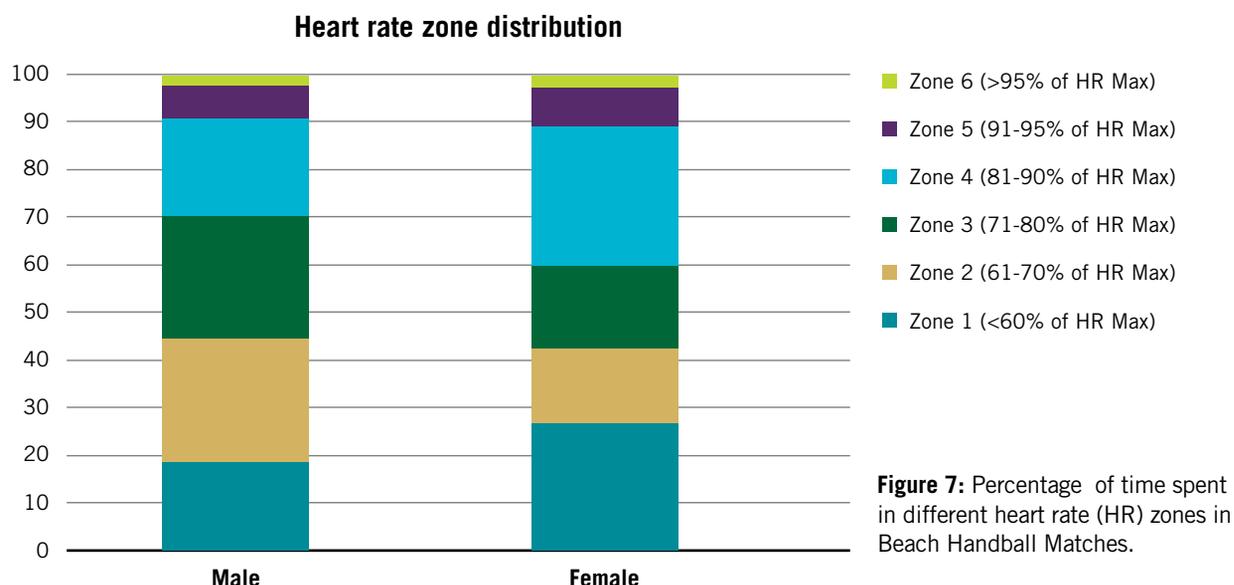


Figure 7: Percentage of time spent in different heart rate (HR) zones in Beach Handball Matches.



Illustration

was contact with the opponent (71.4%), mainly while attacking (71.4%). Regarding the severity of the injuries, 71.4% of cases resulted in a two-to-four-week absence, while 14.2% of cases lead to an absence of more than four weeks. Overall, injury frequency was low, but severity was high, due to the environment (sand, high temperatures, at least two games per day). Strength and conditioning programs for BH players should therefore focus on improving strength and power of the lower limbs, trunk strength and strength and power of the upper body to allow players not only to perform their technical skills efficiently, but also to reduce the risk of injuries. Guaranteeing a good range of motion of the ankle and shoulder joints is also paramount to be able to safely move on sand as well as perform shots/blocking in extreme ranges during attacking and defensive actions. Finally, due to the demands of changing direction on sand, particular attention should be placed on groin strength. Exercise progressions and exercise prescription for injury prevention and treatment for these joints are available to download here <https://www.aspetar.com/en/professionals/>

aspetar-clinical-guidelines/acute-adductor-injuries-treatment-protocol.

The training load should be changed to include tapering and breaks for sufficient recovery, optimizing hydration, resetting athletic performance goals, and nutritional strategies.

CONCLUSION

BH is an exciting sport progressing quickly towards professionalization. The inclusion in the youth Olympic program as well as the demo activities during Paris 2024 indicate that the sport has the potential one day to be in the Olympic program - following an evolutionary pattern similar to Beach Volleyball. Whilst research in this sport is in its infancy, the quality of players is increasing. It is therefore important to continue research efforts to identify the best ways to improve the performance of BH players as well as safeguarding their health during training and competitions.

References

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