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Review article

Individual and Team Performance in Team-Handball: A Review

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Abstract
Team handball is a complex sport game that is determined by the individual performance of each player as well as tactical components and interaction of the team. The aim of this review was to specify the elements of team-handball performance based on scientific studies and practical experience, and to convey perspectives for practical implication. Scientific studies were identified via data bases of PubMed, Web of Knowledge, SPORT Discus, Google Scholar, and Hercules. A total of 56 articles met the inclusion criteria. In addition, we supplemented the review with 13 additional articles, proceedings and book sections. It was found that the specific characteristics of team-handball with frequent intensity changes, team-handball techniques, hard body confrontations, mental skills and social factors specify the determinants of coordination, endurance, strength and cognition. Although we found comprehensive studies examining individual performance in team-handball players of different experience level, sex or age, there is a lack of studies, particularly for team-handball specific training, as well as cognition and social factors.

Key words: Coordination, agility, strength and power, endurance, constitution, social factors, cognition

Introduction

Team-handball is an Olympic sport ball game that is characterized by fast pace defensive and offensive action during the game with the objective of the game to score goals. To score goals, the offensive players (6 players and one goalie) attempt to establish an optimal position for the throwing player by fast movements over short distances performing powerful changes in direction (with and without the ball), one-on-one action against defensive players and passing the ball using different offensive tactics.

To describe team-handball play, especially to determine factors that influence performance is difficult because team-handball play is complex and multifactorial. Team-handball players have to coordinate their movements well for running, jumping, pushing, change of direction and team-handball specific movements of passing, catching, throwing, checking and blocking. Intensities during the game always change between standing and walking, jogging and moderate running, sprinting and fast forward, sideward, and backward movements (Michalsik et al., 2012; Povoas et al., 2012), therefore, a specific high level of endurance is important to keep up a high level of play during the entire game (2×30min). However, team-handball is strongly influenced by the tactical concepts, social factors as well as cognitive aspects. Finally, as in other team sports nutrition, illness and injuries as well as external influences of materials and environmental conditions could influence the performance in team-handball (Figure 1).

Determining the factors that influence performance in team-handball based on scientific studies should contribute to the increase in quality of training for coaches and practitioners as well as to develop specific measuring methods and tests from scientific studies. Different tactical components in team-handball offense and defense are well described in team-handball specific journals and well documented by the European (EHF) and International Handball Federation (IHF). The homepages of the EHF and IHF have published detailed statistics for every final round for the last 10-15 years of World, Olympic and European Championships as well as the EHF Champions League. In this context it have to be known that the game analyses of the IHF and EHF is not peer-reviewed and therefore these data should not be used for scientific studies. Since nutrition for team-handball is very similar to other team sports and injuries in team-handball are well documented, we limited this review to the influence of coordination, strength, endurance, constitution, social factors and cognition to the performance in team-handball.

The aim of this review was threefold: (1) summarize the most important findings of different scientific studies, (2) define the determinants of team-handball performance based on these studies, and (3) provide perspectives for practical implication.

Literature search methodology

We searched the following computer databases: PubMed, Web of Knowledge, SPORT Discus, Google Scholar, and Hercules. The search terms used to identify the studies were handball (some studies used handball instead of team-handball) in combination with test, training, throw and/or shot, jump, sprint, coordination, agility, strength, power, endurance, change of direction, shuttle run, cognition, mental skills, personality, social factors and/or group coherence. The word searches were specifically adjusted to each database for free text words and categorized free terms. In the first step, language was limited to English. At the beginning of the season 2001/2002, a change in the rules (fast throw on) in team-handball altered the characteristics and fundamentally changed the game. Therefore, this search was limited to January 2002 through December 2013. Additionally, we manually searched the references of published studies.

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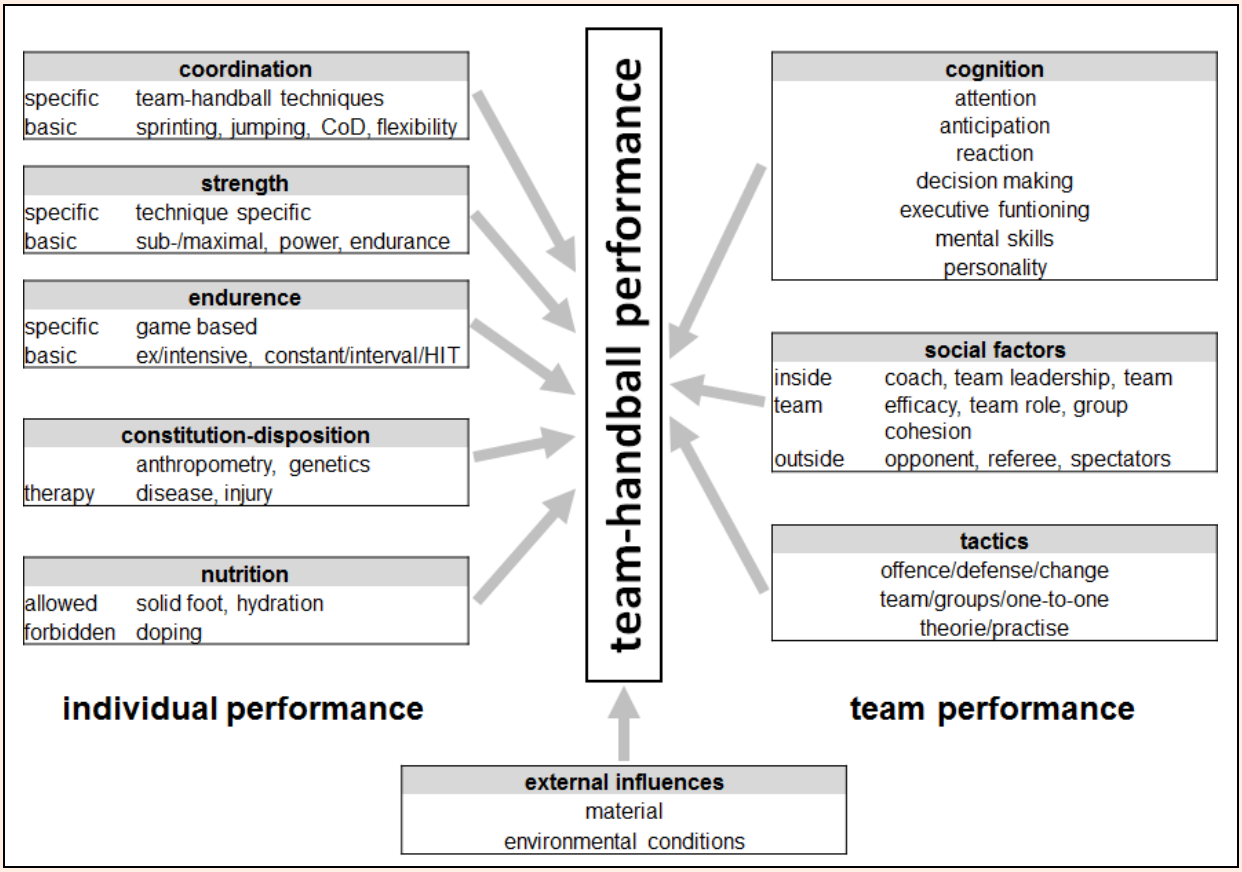

Figure 1. Determinants of team-handball performance.

If we were not able to find a minimum of five studies in each category, we extended the search to older investigations (prior to 2002), studies in other team sport games or studies published in the German language. This was especially true for cognition and social factors. In this context, we used specific electronic databases of the institute of sport science i.e. BISp, SPOLIT and SPONET.

Inclusion criteria

Studies detected in initial searches were screened using the following inclusion criteria: (1) using elite or experienced team-handball players as subjects, (2) analyzing performance that were similar to competition, (3) full length texts had to be available, (4) if similar tests or analyses were used in several studies we used only those studies that were close to the first two inclusion criteria, and (5) total numbers of studies per sub-category were limited to seven studies.

Coordination and agility

Van den Tillaar and Ettema (2003; 2006) analyzed the velocity-accuracy trade off in team-handball throwing and found that training experience was not related to the velocity-accuracy trade off. However, experienced team-handball players are trained to throw very accurately at a relatively high ball velocity (85% of the maximal ball velocity) and ball velocity is reduced when throwing with the opposition of a goalkeeper and/or defensive player (Gutierrez Davila et al., 2006; Rivilla-Garcia et al., 2011). It has been shown that in different team-handball throwing techniques, ball velocity is strongly influenced by maximal pelvis, trunk and shoulder internal rotation angular velocity (Van den Tillaar and Ettema, 2004a; 2007; 2009; Wagner et al., 2010a; 2010b; 2011; Wagner and Müller, 2008). Measuring the proximal-to-distal sequencing in team-handball throwing, it was found that the maximal joint angular velocities occurred in a specific order (Figure 2A) starting with pelvis rotation, followed by trunk rotation, trunk flexion, elbow extension, shoulder internal rotation, forearm pronation and shoulder flexion (Van den Tillaar and Ettema, 2004a; 2009; Wagner et al., 2010a; 2012). In less experienced players, trunk rotation and flexion occurred earlier compared to elite players resulting in a decrease in ball velocity (Wagner et al., 2012). Comparing different throwing techniques it was found that the highest ball velocity (Figure 2D) was attained in the standing throw with run-up due to a better acceleration of the pelvis and trunk over the on the floor braced leg (Wagner et al., 2011). We concluded that throwing performance is determined by a high ball velocity that is influenced by upper body strength and power as well as an optimal movement coordination that is determined by a handball specific proximal-to-distal sequencing and an increase in maximal upper body rotation angular velocities.

Throwing in team-handball has to be always considered under tactical considerations. Although, the

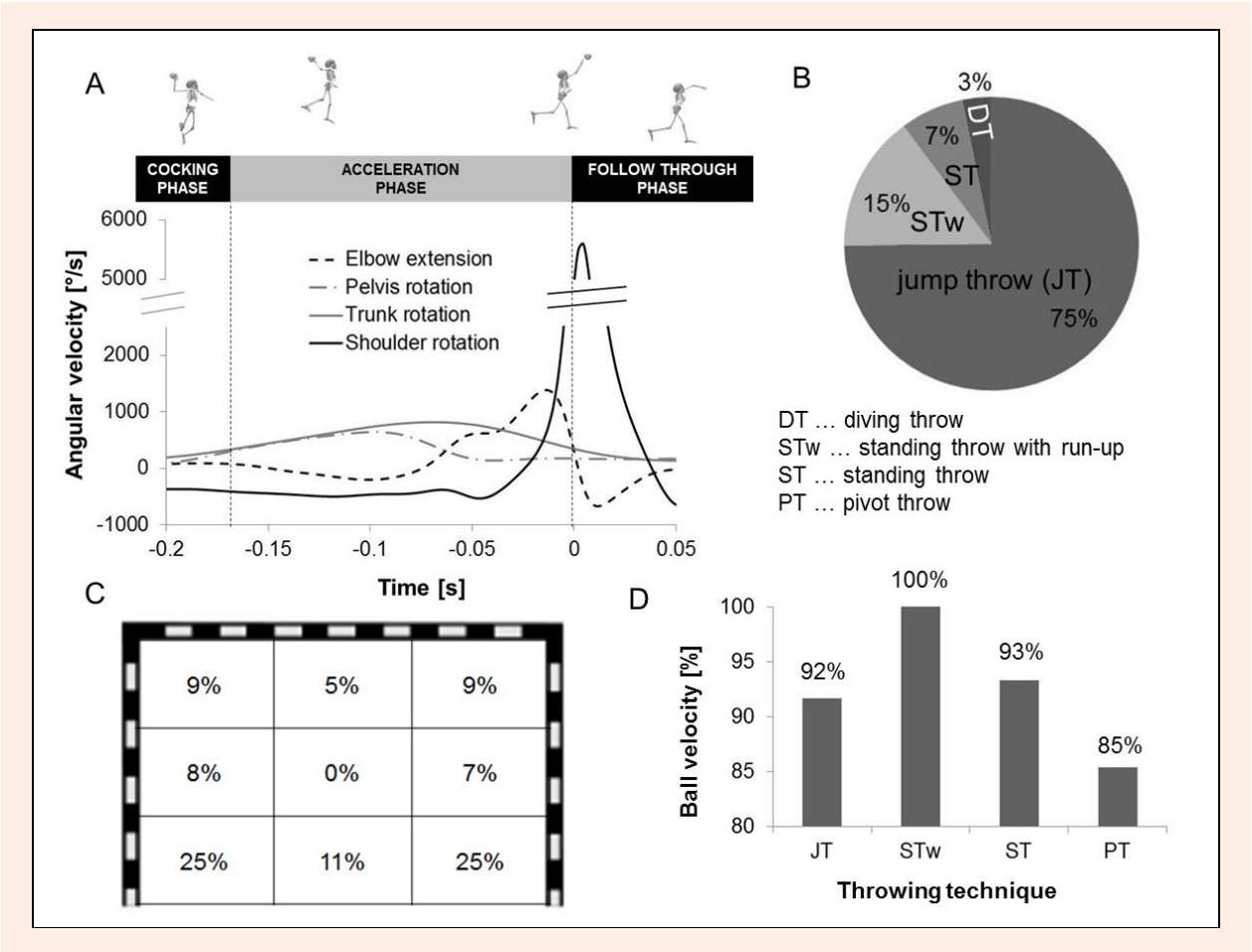

Figure 2. Pelvis and trunk rotation, shoulder internal rotation and elbow extension angular velocity during jump throw (A), percentage of throwing types (B) and shot distribution (C) during competition, and percentage of ball velocity in different throwing techniques (D).

standing throw with run-up is the throwing technique with the highest ball velocity (ball velocity is the main performance variable in team-handball) the jump throw is the most often applied throwing technique (>75%, Figure 2B) in team-handball (Wagner et al., 2008). The advantage of this throwing technique is that it enables a better throwing position (wing players and pivots, fast break, brake through), throwing over the rival block (backcourt players) and more time for decision making (throwing or passing, throwing direction, watching the goalkeeper). Another tactical consideration in team-handball throwing is that most throws (50% in the Olympic team-handball tournament in Bejing 2012) were placed in the lower corners of the goal (Figure 2C). Throwing to the lower corners of the goal enables a higher ball velocity and accuracy (longer arm acceleration and ball control) and a higher success rate. For the goalkeeper, it is more difficult to make saves with the legs compared to throwing to the upper corners of the goal.

Jump height is important for the jump throw in team-handball to reach a high vertical position to throw over the block of the rival defensive players when throwing from backcourt position or to have more time for throwing (an increase in flight time) to mimic or to react to the movements of the goalkeeper. On defense, jump height is important to block the rival offensive player when throwing. Jump heights in team-handball were often measured during a counter movement jump; however, no significant differences were found between elite and amateur male (Gorostiaga et al., 2005) and female (Granados et al., 2007) players. Michalsik et al. (2011b) measured the jump height during a counter movement jump (43.9 ± 6.0 cm) and a jump and reach test including a run-up (71.4 ± 7.8 cm) in Danish elite team-handball players and found to be significantly increased in the jump with run-up. That the type of jump could influence throwing performance was shown by Pori et al. (2005). Upper body kinematics and ball velocity in the jump throw were different when throwing with take-off from one (leg from or opposite from the throwing arm) or two legs, while throwing with take-off from one leg opposite to the throwing arm enables the highest ball velocity (Wagner et al., 2011).

It is well known from practice and training that sprints are often used to increase performance in team ball sport games. Sprinting performance is easily measurable by different sprint tests utilizing standard time measuring equipment. Young et al. (2001) analyzed the specificity of sprint and agility training methods and found a significant increase in performance after a six week training session in experienced team sport athletes. The more interesting finding of this study was that the sprint training group

(20-40 m sprints) increased their performance in the straight sprinting test (30 m) but less in the agility tests (direction changes) and vice versa. Young et al. (2001) suggested that straight sprint and agility training methods are specific and produce only limited transfer from one to the other. Testing straight sprinting performance in team-handball Gorostiaga et al. (2005) found no significant differences in the running time for 5 and 15 m between elite and amateur players. However, when including change in direction in a sprinting test (2×12.5 m shuttle sprints) Buchheit et al. (2011) found that the sprinting time was influenced by age, sex and skill level in team-handball players. Movements in team-handball are characterized mostly by short accelerations (0-3 m) with stops (30-40 per game) and changes in direction (30-40 per game) and less by sprints (10-30 m) over the entire game field (Michalsik et al., 2011a; 2011b; Povoas et al., 2012), constituting only 1-3% of the total playing time per match were attributed to sprints or fast running. Tests including changes in direction might be more suitable to measure team-handball performance, although learning effects could influence the results (especially in training studies) and these tests could not resemble the real demands in team-handball competition. Straight sprinting is not often used in team-handball competition but could also strongly influence the result of the game because it is important in the fast break. Therefore, Wagner et al. (2014) developed and validated a game based performance test that is suitable to measure team-handball specific agility (typical movements in offence and defense) and sprinting performance (fast break and running back). It was shown that the test is valid and reliable but results about differences in sex, age and experience level are lacking. We conclude that coordination is a main determinant in team-handball to optimize throwing performance (proximal-to-distal sequencing, upper body rotation, adaptations to different situations), jumping performance (block, jump throw, with one or two legs, with or without run-up) and specific agility (in offence and defense, short accelerations, changes in direction).

Strength and power

Gorostiaga et al. (2005) investigated power and strength of Spanish elite and amateur team-handball players and found that the elite players have a higher one-repetition maximum ($1RM_{BP}$) in the bench-press (+22%), a higher average power output of the upper extremities (+20%) and a higher average power output in half-squat (+16%) compared to amateur players. A positive correlation was found between ball velocity in the 3-step running throw and concentric velocity production at a load of 30% of $1RM_{BP}$ ($r = 0.72$) as well as concentric power production during half-squat action ($r = 0.62$). A positive influence of strength and power on ball velocity in the team-handball throw was also found in several studies (Chelly et al., 2010; Debanne and Laffaye, 2011; Granados et al., 2007; Marques et al., 2007). Gorostiaga et al. (2005) suggested that higher values of maximal strength and muscle power would give a clear advantage to sustain the forceful muscle contractions during team-handball specific movements. Strength and power training is therefore important to improve performance in team-handball. To increase strength and power, different dynamic strength and power exercise over training periods between 6 and 12 weeks were employed in several training studies (Gorostiaga et al., 2006; Hermassi et al., 2011; Marques and Gonzalez-Badillo, 2006; Marques et al., 2007). Thorlund et al. (2008) examined acute fatigue-induced changes in muscle mechanical properties and neuromuscular activity in elite team-handball players following a simulated team-handball game and found a significant decrease in single-joint isometric muscle strength and power from pre to post test. Michalsik and Aagaard (2014) analyzed the physical demands in elite male and female and Michalsik et al. (2014b) the technical match characteristics in elite male team-handball players. They found sex and position specific differences in performing fast breaks (more sprints for wing players), physical confrontations (more for backcourt players and pivots), strength related actions and high intensity running (more for male players) as well as relative work load in competition (more for female players). We therefore recommend that upper and lower limb strength and power are important to increase performance in the team-handball specific movements as well as to prevent a decrease in performance in the later stages during a team-handball game. To optimize team-handball specific strength and power training different demands in sex and playing position have to be considered (Michalsik and Aagaard, 2014; Michalsik et al., 2014b).

Endurance

Endurance of team-handball players was determined by measuring blood lactate concentration (BLC) during endurance running (Gorostiaga et al., 2005; 2006; Ramadan et al., 1999), maximal oxygen consumption (VO_2max) during an incremental treadmill running test (Buchheit et al., 2009b; Buchheit et al., 2009a; Michalsik et al., 2011a; 2011b; Wagner et al., 2014) or VO_2max, BLC, heart rate (HR) and other variables during specific shuttle runs or sprint tests (Buchheit, 2008; Buchheit et al., 2009a; 2009b; 2009c; 2010a; 2010b; 2012; Wagner et al., 2014). Gorostiaga et al. (2005) measured BLC of Spanish elite and amateur male team-handball players immediately after a four-stage (10, 12, 14, 16 $km.h^{-1}$) submaximal discontinuous progressive test on the team-handball court and found no significant difference in the mean BLC between the two groups. Gorostiaga et al. (2005) suggested that endurance capacity does not represent a limitation for performance in team-handball. Comparing different studies that measured VO_2max during an incremental treadmill running test (Buchheit et al., 2009a; 2009b; Michalsik et al., 2011b; Rannou et al., 2001) it was found that the VO_2max ranged between 55 and 60 $ml \cdot kg^{-1} \cdot min^{-1}$ for elite and experienced team-handball players. Because of the relatively constant value of the VO_2max in elite and experienced team-handball players, we assert that the VO_2max during an incremental treadmill-running test should be higher than 55 $ml \cdot kg^{-1} \cdot min^{-1}$.

Buchheit et al. (2009a) measured BLC and VO_2max during an incremental treadmill running test, a

Table 1. Basic and team-handball specific endurance tests (*n.r.* no results for this variable in the present study).

Test	Reference	Results: HRpeak (beat·min^{-1}) BLCpeak (mmol·l^{-1}) VO_2max (mmol·l^{-1}·kg^{-1})
Repeated sprints with directional changes	Buchheit et al. (2012)	0°: 184±7, 10.1±2.2, *n.r.* 45°: 181±8, 8.0±2.3, *n.r.* 90°: 178±9, 6.1±2.5, *n.r.* 135°: 180±8, 7.4±2.3, *n.r.*
30-15 intermittent fitness test (IFT), repeated sprints with (RSS) or without (RS) shuttle runs	Buchheit et al. (2010)	IFT: 184±9, - , 50.2±7.4 RSS: ~174, 9.3±2.4, 38.9±3.8 RS: ~174, 10.0±1.7, 40.4±4.2
30-15 intermittent fitness test (IFT) and continuous graded test (CT)	Buchheit et al. (2009c)	IFT: 195±8, 11.8±2.3, 54.5±6.6 CT: 193±10, 8.9±2.1, 53.3±7.3
Small size game (HB), high intensity intermittent run (IE) and incremental treadmill running test (IR)	Buchheit et al. (2009a)	HB: 187±7, 8.9±2.3, 60.2±2.6 IE: 189±5, 11.6±1.4, 56.4±5.2 IR: 190±8, 9.3±1.3, 57.3±4.7
Endurance running with constant running speed	Gorostiaga et al. (2005)	10km/h: 140±8, 1.8±0.5, *n.r.* 12km/h: 158±7, 3.2±1.1, *n.r.* 14km/h: 172±6, 7.2±2.0, *n.r.*
Team-handball game performance (HB) and incremental treadmill running test (IR)	Michalsik et al. (2014)	HB:163±8, 2.8-10.8, 71±6%$_{VO2max}$ IR: *n.r.*, 10.5±2.9, 57.0±4.1
Team-handball game performance (HB) and incremental treadmill running test (IR)	Povoas et al. (2012)	HB: 157±18, n.r., 82±9%$_{VO2max}$ IR: 191±8, 55.3±4.6, *n.r.*
Team-handball game (HB), game based test (GBT) and incremental treadmill running test (IR)	Wagner et al. (2014)	HB: 182±7, 5.8±2.2, *n.r.* GBT: 184±11, 11.6±3.0, 54.8±5.6 IR: 190±8, *n.r.*, 54.5±5.3

shuttle run (15s exercise – 15s passive recovery) and a team-handball small size game. It was reported (Table 1) that the VO_2max was highest in the small size game (60.2 ± 2.6 ml·kg^{-1}·min^{-1}) compared to the shuttle run (56.4 ± 5.2 ml·kg^{-1}·min^{-1}) and incremental treadmill-running test (57.3 ± 4.7 ml·kg^{-1}·min^{-1}). BLCpeak was highest in the shuttle run (11.6 ± 1.4 mmol·l^{-1}) compared to the small size game (8.9 ± 2.3 mmol·l^{-1}) and incremental treadmill-running test (9.3 ± 1.3 mmol·l^{-1}). Buchheit et al. (2009a) found that running tests are not relevant for an accurate estimate of maximal cardiorespiratory fitness in team-handball players because the specific movements in team-handball are widely different from running. A limitation of these studies was that these variables were measured under standardized conditions that do not or only minimal reflect the demands in a real team-handball game. Consequently several studies (Michalsik and Aagaard, 2014; Michalsik et al., 2011a; 2011b; 2012; 2014a; Povoas et al., 2012) evaluated the physiological capacity and physical demands during match-play using heart-rate (HR) monitors and computerized locomotive and technical match analysis. There was found a relative workload of 65-80% of VO_2max, a total distance per match of 3900-4700m, a mean HR of 160-170 beats·min^{-1}, a high number of activity changes (600-1500 per match) and a post-match BLC of 3-11 mmol·l^{-1}. However, these physiological parameters differ significantly between male and female players as well as between wing players, backcourt players and pivots. A limitation of these studies was that aerobic capacity was evaluated only indirect by calculating the relative workload (percentage of VO_2max HR). To our best knowledge only Wagner et al. (2014) analyzed VO_2, BLC and HR under conditions similar to competition. In their valid and reliable game based performance test they found a VO_2peak of 54.4 ± 6.2 ml·kg^{-1}·min^{-1} and a BLCpeak of 10.9 ± 3.0 mmol·l^{-1} in experienced male team-handball players. Consequently we conclude that during competition team-handball players need a high aerobic capacity to regenerate during the low intensity phases to ensure playing on a high level in the high intensity phases (VO_2max of 55-60 ml·kg^{-1}·min^{-1}; BLCpeak 8-12 mmol·l^{-1}) during the entire game (2 × 30 min).

Constitution

Comparing elite and less experienced team-handball players, it was reported that elite players were taller and heavier compared to less experienced players (Bayios et al., 2001; Gorostiaga et al., 2005; Wagner et al., 2010a). Measuring the fat-free mass, Gorostiaga et al. (2005) found that Spanish elite players have a higher (81.7 ± 9.0 kg) fat-free mass compared to amateur players (72.4 ± 7.0 kg). In the team-handball game, body height is important for throwing in offense or blocking in defense and high body mass was important during one-on-one actions. Wagner et al. (2010a) demonstrated that taller team-handball players with a greater body mass have the ability to achieve a higher ball velocity in the jump throw. Van den Tillaar and Ettema (2004b) suggested that body size have a strong positive effect on the throwing performance and isometric strength. However, Michalsik et al. (2011a) found that the physical characteristics depend also on the playing position. Wing players are smaller and weight less (184.9 ± 5.7 cm; 84.5 ± 5.8 kg) compared to pivot players (194.8 ± 3.6 cm; 99.4 ± 6.2 kg) and/or backcourt players (191.9 ± 5.4 cm; 94.7 ± 7.1 kg). Similar results were also found by Sporis et al. (2010) in elite Croatian team-handball players.

Social factors

In team-handball members of the team communicate and interact during practice and competition. Coaches give

advice, instructions and feedback, opponents can be present and at times in very direct contact situations, referees interpret and enforce rules of the game in a way that one may not like, while spectators are yelling, cheering or booing.

In terms of team performance and team success, the importance of several group constructs were recently pointed out by Kleinert et al. (2012), e.g. team leadership, team efficacy, team roles, and group cohesion. The authors propose that group cohesion can be portrayed in two different perspectives. Social cohesion is reflected in the motivation of group members to establish social relationships (i.e. good friends), whereas task cohesion turns the focus on reaching group goals (e.g. winning the championship). Additionally, each person presumably has two different perceptions of the group. How attractive is it to be a member of the group (group attractiveness), and how the group is perceived as an integrated and coherent in its collective (group integration). A meta-analytic review revealed a positive relationship between group cohesion and team success, where the type of cohesiveness (task or social) is irrelevant. Team success leads to a higher sense of cohesion, and in turn, a strong feeling of togetherness may enhance the chance to be successful. As to sex differences, it has been shown that cohesion is stronger related to team success in female athletes than in male (Carron et al., 2002; Carron and Eys, 2012).

However, as team size increases and exceeds the number of six members, cohesion decreases substantially (Carron and Eys, 2012; Martin et al., 2013). A positive sense of sticking together may be a substantial psychosocial occurrence that contributes to team success. Analyzing the psychological characteristics of young team-handball players (Gonzales and Coronado, 2011a; 2011b) it was found that group cohesion has the highest level in male and female under 16 and 14 year old players and that social affiliation is the highest motivation for these players to play team-handball. In addition, recent research has shown that creating a task-oriented motivational climate can help to enhance cohesiveness and contribute to a better performance of teams (Heuzé et al., 2006; 2007). Task-orientation implies leadership behavior of coaches in terms of focusing on the individual as well as team development in a democratic way, looking out for each group member, emphasizing the importance of each person in the team and reducing rivalry.

Cognition

Cognitive aspects such as attention, anticipation, decision making and executive functioning have to be considered as important psychological determinants of team-handball performance. Revealing insights exist in decision making (Johnson and Raab, 2003; Raab and Johnson, 2007; Raab and Laborde, 2011) and attention processes (Memmert et al., 2009) in team-handball. However, we decided to focus in this review on mental skills and personality of team-handball players.

Mental skills such as concentration, anxiety management, self-confidence, mental preparation, motivation, etc., are well accepted and used to develop (Mahoney et al., 1987; Thomas et al., 1999) and utilize questionnaires in different sports. Gonzales et al. (2013) examined the assessment of psychological skills in young elite female team-handball players and found a significant difference in mental skills depending on the experience (years of competition). However, there were two approaches pursued to identify relevant psychological state and trait variables related to high team-handball performance. One approach was to analyze the sport-specific challenges a team-handball player has to cope with in practice and during competition. Silva (2006) and Wegner and Dawo (2012) formulated team-handball specific mental skills that are related to elite performance:

- High capability to cope with performance and mental loading pressure. The high pressure arises from the fact that a team-handball game is very often decided just in the last seconds of the match (Wegner and Dawo, 2012).
- High emotional stability in critical situations (Wegner and Dawo, 2012). Some decisions taken by the referee can be seen as critical. In such situations the player has to stay focused and not thinking about the decision. Other situations where a player has to be emotionally stable are constant provocations by the opponents.
- High pain tolerance. Team-handball players are constantly confronted with pain very often resulting in minor or major injuries. According to Silva (2006), a team-handball player must be able to train and play with a low to moderate level of pain.
- High discipline and patience. A team-handball player has to play an offensive action for so long until it is fully developed. The chance for scoring a goal should increase by generating a majority (e.g. 3 against 2) situation (Silva, 2006).
- Perfect switching between selfishness and unselfishness. A team-handball player must be able to make selfish on-court decision that will help the team. On the other hand a team-handball player must put himself in the service of the team performing in defense and offence (Silva, 2006).
- High amount of court sense. During competition a team-handball player has to know who is where-doing what (Silva, 2006). Game intelligence expresses a big part the factor of court sense. But it includes also aspects of working memory, anticipation, decision making, etc.

The second approach is to find out important psychological variables by the determination of differences of experts and near-experts. Christoforidis et al. (2010) investigated anger and aggressiveness of male and female team-handball players with different game expertise. Male players exhibit their aggressiveness during a handball game significantly more often compared to female players. Analysis of game experience level revealed the most experienced players acquired significantly higher aggressiveness scores followed by intermediate and inexperienced players. The concept of self-efficacy in team-handball was addressed by Wilhelm et al. (2013). They

developed a team-handball specific self-efficacy inventory (HASI) that assesses the perceived efficacy in individual-tactical and team-tactical performance. By using the HASI, they demonstrated that elite athletes achieve a higher perceived individual sport-game specific self-efficacy than other athletes.

Rogulj et al. (2006) investigated differences in personality between team-handball players of differing expertise. Using the Eysenck Personality Questionnaire (EPQ), they have demonstrated that efficient compared to less efficient team-handball players have attained lower values in dissimulation (EPQ-L-scale). Differences between successful and less successful handball goalkeepers were analyzed by Kajtna et al. (2012). Fluid intelligence, trait anxiety, trait aggression as well as simple reaction time were not related to high performance in team-handball goalkeepers. Geukes et al. (2012) have shown that team-handball players of high narcissistic values performed better in team-handball aiming task under pressure compared to players with lower values induced by the audience between 1500 and 2000 spectators. In a low pressure condition (no audience), the trait of narcissism had no impact on performance.

Practical implications

To increase individual performance in team-handball, we suggest basic strength and power training (bench press, squats and trunk rotation) (Marques, 2010), specific power training with heavier and lighter balls (van den Tillaar and Marques, 2013) as well as with a pulley system (Ettema et al., 2008), jumps in different directions with change in direction (also with additional weights) (Marques et al., 2013), fast accelerations with stops, short sprints with change in direction (Buchheit, 2012) and specific exercises for trunk stabilization. To improve general or specific coordination in team-handball, we recommend coordination training with variable exercises (Wagner and Müller, 2008) and to increase specific endurance in team-handball, a game based training including specific movements (Buchheit et al., 2009b) should be preferred instead of shuttle runs, high intensity running training or repeated sprint training. To improve mental skills and personality, team-handball players should be faced with mental pressure (Wegner and Dawo, 2012) and physical demands (Silva, 2006), should be expected to play aggressively (Wilhelm et al., 2013), to increase their self-efficacy and to play selfish if they have the opportunity to score a goal but with a high level of tactical discipline. To improve team performance, the coaches and the team should democratically define specific goals and group norms, develop strategies of in-group behavior or features that will make them distinct from other teams and they should have a clear idea of his/her role in the team as well as the roles of teammates (Kleinert et al., 2012; Martin et al., 2013). Role-playing games can help to understand each other's positions and perspective. Finally, cohesion depends on how members are able to express their feelings and thoughts, and communicate with each other in an effective and fitting way. Several techniques are described by Sullivan (1993), e.g. on learning, listening to each other, provide feedback, express their fears and hopes.

Conclusion

In the present review, we found comprehensive studies investigating individual performance of team-handball players of different experience level, sex or age, whereby more studies were found for male vs. female team-handball players. However, there is a lack of training studies, especially in team-handball specific training as well as cognition and social factors.

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Key points

- The specific characteristics of team-handball with frequent intensity changes, specific skills, hard body confrontations, mental skills and social factors define the determinants of coordination, endurance, strength and cognition.
- To increase individual and team performance in team-handball specific training based on these determinants have been suggested.
- Although there are comprehensive studies examining individual performance in team-handball players of different experience level, sex, or age are published, there is a lack of training studies, particularly for team-handball specific techniques and endurance, as well as cognition and social factors.

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