This chapter aims to review the literature regarding performance analysis in handball. Different approaches to throwing analysis, goalkeeper assessment, characterization of physical activity profiles of players and time-motion analysis are presented and discussed.

The static and dynamical approaches in handball match analysis are compared. The static approach is structure-oriented and represented by descriptive and comparative studies based on the summarized game statistics data; the dynamical approach is oriented to the match process and uses play-by-play data, which are promising for addressing chronological changes of the performance and complex assessment of factors that influence a handball team’s efficiency. The chapter finishes with suggestions for further investigation in handball performance.

Brief description of the game and major issues of performance analysis in handball

Handball is a time-dependent invasion game, played by two teams of seven players each (six outfield players and a goalkeeper). Each team attempts to score by throwing the ball into the opposing team’s goal during a 60-minute match (two halves of 30 minutes each). The opposing teams alternate possession of the ball, so each team has about the same number of opportunities to score by the end of the match. The ball possession ends when a team attempts a field shot, when a seven-metre throw is not rebounded by the offence (possession continues after an offensive rebound) or in the case of a turnover. Handball is a high-scoring game, where the majority of ball possessions end with a shot. This very brief description of handball focuses on some important aspects of the game, which provides a rationale for some of the quantitative and qualitative performance analysis techniques applied to handball that are discussed in this chapter.

This is a review of studies selected from ISI Web Knowledge All Databases based on the criteria that the studies involved performance analysis in handball during the last two decades with a tendency to focus on the following issues:

1. Throwing performance analysis;
2. Goalkeeper performance assessment;
Handball

3. Physical activity profiles of players and time-motion analysis; and

Hierarchical structure of performance in handball can be represented by four groups of performance factors: 1) basic anthropological characteristics; 2) specific abilities and skills of handball players; 3) situation-related parameters of competition activities or playing efficiency; and 4) outcome of a match (Vuleta et al., 2003). The next three sections of this chapter are related to the first two groups of performance factors and the fourth section concerns the last two groups.

Throwing performance analysis

One of the key subjects in individual handball performance analysis is the study of the throwing patterns used by players. The throwing ability of players is a critical factor for success in handball, which is why there is a lot of interest in research on this issue. Maximal ball velocity and precision of throwing are considered primary characteristics that influence shot effectiveness (Fradet et al., 2004; Gorostiaga et al., 2005; Granados et al., 2007; van den Tillaar and Ettema, 2007).

Several studies have concluded that ball velocity depends on the type of throw technique, sequences and timing of body segment actions, such as trunk flexion and rotation, shoulder flexion, elbow extension and wrist deviation, as well as on muscle strength and power (Rivilla-García et al., 2011; Wagner and Muller, 2008).

The shot in handball has been analysed from a biomechanical perspective, by measuring 3D kinematic parameters (maximal joint velocity, angle range and maximal angular velocity) and quality of movement (throw accuracy), based on the following factors:

1. Type of throw – jump throw, standing throw, with and without run-up, and the pivot throw (Fradet et al., 2004; Gorostiaga et al., 2005; Granados et al., 2007; Ohnjec et al., 2010; Wagner et al., 2011);
2. Parameters of muscular force of throwers (Bayios et al., 2001; Gorostiaga et al., 2005; Granados et al., 2007; van den Tillaar and Ettema, 2004);
3. Target locations in the handball goal (Bourne et al., 2011; Schorer et al., 2007);
4. Level of players (Bourne et al., 2011; Schorer et al., 2007; Wagner et al., 2010); and
5. Influence of opposition – goalkeeper and defensive player (Gutiérrez et al., 2006; Párraga et al., 2002; Rivilla-García et al., 2011).

The above-mentioned studies confirmed significant differences in ball velocity between different throwing techniques. The highest ball velocity was achieved in the standing throw with a three-step run-up, followed by the standing throw without a run-up and then the jump throw (Gorostiaga et al., 2005; Granados et al., 2007; van den Tillaar and Ettema, 2003, 2004; Wagner et al., 2010, 2011).

In order to study the speed–accuracy trade-off in handball throwing, van den Tillaar and Ettema (2003) applied five types of instructions that emphasized velocity or accuracy, or both, of throwing. When the instruction prioritized accuracy, the ball velocity was changed. In general, instructions which focused on speed and/or accuracy of throw did not influence the throwing technique and relative timing of the different body segments involved in the throwing of experienced handball players.
With reference to parameters that influence throwing accuracy, the recent study of Bourne et al. (2011) did not find any significant differences in the dynamical structure of handball penalty shots directed at four separate targets located at each corner of the goal. Also, the study did not observe any differences in complete time-series data analysis or in the analysis of different phases of shots (the wrist and finger mechanics were not registered during the experiment). According to the authors, these findings could possibly denote the importance of the last phase of the shot for speed and accuracy, which had been suggested by previous studies (Wagner and Muller, 2008).

The study of throw-movement patterns according to players’ expertise has revealed a significant relationship with the skill level of players, both male and female. Schorer et al. (2007) reported a high correlation between a shooter’s expertise and throw-movement duration ($r=0.76$, $p<0.01$), as well as the ball-flight duration ($r=0.71$, $p<0.01$). In the same study, the authors also registered a high correlation between thrower’s expertise and accuracy of shots assessed by hit–miss ratio ($r=0.90$, $p<0.04$). According to Wagner et al. (2010), an increase in trunk flexion, trunk rotation, shoulder internal rotation and angular velocity during throw execution resulted in an increase in ball velocity. High-level handball players demonstrated better results for ball velocity than their less-experienced colleagues. The fact that elite players were taller and heavier was given as one of the reasons that influenced handball throwing performance. Similar results were described by Gorostiaga et al. (2005) and Granados et al. (2007), who found higher ball velocity in standing throws and three-step running throws of male and female elite players compared to amateurs. This result was associated with higher absolute maximal strength and muscle power of elite players.

The comparison of intra-individual movement patterns in penalty throws performed by novice, advanced and elite handball players indicates that novice motor performance is characterized by higher random variability. Advanced players demonstrated the most stable patterns of throwing, while elite players showed more variability in various aspects of movement patterns (Schorer et al., 2007). The authors differentiated between the active functional variability of experts’ throwing from the random variability of novices. According to Schorer et al. (2007), the variability in expert execution could be explained by players’ intention to reduce the visual information and deceive the opposition.

An analysis of segmental organization of the throwing arm, based on linear velocities of the joints, had revealed that the temporal sequence of the segments used in the handball throw was different from the usual sequencing pattern (from proximal to distal) of throwing activities, like baseball pitching and javelin throwing (Fradet et al., 2004; van den Tillaar and Ettema et al., 2009). This fact could also be related to the need to adapt throwing execution to the constraints imposed by the defenders and goalkeeper.

The ability to conceal the movement pattern is crucial for successful throwing performance in the goalkeeper-and-thrower duel. However, the literature review reveals the predominance of opposition-free conditions in studies of handball throwing. Only a few studies analysed the influence of opposition on ball velocity in handball throwing (Gutiérrez et al., 2006; Párraga et al., 2002; Rivilla-Garcia et al., 2011).

Párraga et al. (2002) demonstrated that ball velocity was influenced by the goalkeeper position. When the goalkeeper was diagonally opposite to the thrower’s attacking arm, the ball velocity was reduced.

Gutiérrez et al. (2006) observed no kinematic differences in the technical execution of handball throws with and without opposition, with the exception of time of run-up before throw, which was shorter when a defensive player was involved. A small sample (11 players) of sub-elite athletes and some measurement limitations could possibly explain this result.
Handball

The recent findings of Rivilla-Garcia et al. (2011) showed a negative effect of opposition on ball velocity in the jump throw of three groups of handball players (elite, amateur and adolescent). It has also been observed that the effect of opposition on throwing velocity does not vary according to the expertise level of players.

The majority of studies in handball throwing appear to focus on identifying the factors that influence ball velocity and shot accuracy in experimental protocols that exclude the goalkeeper and opposition, and subsequently do not consider the influence of misleading skills, perception and anticipation on handball shot effectiveness. Further research should try to analyse the handball throw in more representative designs that allow the players to explore the dynamic and time-constrained context of interaction between throwers and their opponents, as in real play.

Goalkeeper performance evaluation

The great influence of the goalkeeper’s effectiveness on the game outcome in handball has been highlighted in several studies (Fuertes et al., 2010; Pori et al., 2009; Volossovitch and Gonçalves, 2003). This fact explains the wide research interest in the goalkeeper’s performance, which has been analysed by using virtual reality technology (Bideau et al., 2003, 2004, 2010; Bolte et al., 2010; Vignais et al., 2009, 2010), eye-tracking systems (Schorer, 2005), 3D kinematic analysis (Gutiérrez-Davila et al., 2011; Rogulj and Papić, 2005), force platforms (Gutiérrez-Davila et al., 2011) and observational methodology followed by sequential data analysis (Prudente et al., 2010).

Comparing goalkeeper performance according to different levels of expertise in the penalty throws, Schorer (2005) revealed significant differences in reaction quality, movement time and number of goalkeepers’ gaze fixations. In successful trials, elite goalkeepers were faster and needed a lower number of gaze fixations than their less-experienced colleagues. The results of the study suggest that experienced goalkeepers delayed their movement to the ball, but moved significantly faster. This strategy, to start later, helped them to obtain more information about the ball trajectory without revealing their own intentions.

Rogulj and Papić (2005) analysed speed variation in a specific goalkeeper’s movement (low side-step) during the low shot from long distances. The authors also found that initial and medium phases of goalkeeper movement were slower, while there was a considerable acceleration in the final phase.

In several recent studies, the goalkeeper’s performance has been analysed in virtual environments from a perception–action coupling perspective (Bideau et al., 2004, 2010; Bolte et al., 2010; Vignais et al., 2009, 2010). It was shown that the handball goalkeeper’s behaviour was similar in real and virtual situations, making it possible to extrapolate results obtained in computer-generated situations to interception actions in the real game (Bideau et al., 2003, 2004). Focusing on the real-time interactions between goalkeeper and virtual thrower, virtual reality systems provide standardized experimental situations that allow reliable measurement of performance in reproducible throwing actions. Furthermore, virtual environments help to record the effect of small changes in the thrower’s movement and their influence on the goalkeeper’s behaviour.

Bideau et al. (2010) assessed goalkeepers’ anticipation skill in a virtual throw situation and registered a faster response time in successful actions. The computer-generated visual environment enabled systematic variations of throwing parameters, allowing the confirmation of how each particular factor influenced the goalkeeper’s behaviour. In order to determine which information was used by the goalkeeper to control his interception actions, the authors dissociated the visual information about the thrower’s behaviour from the ball trajectory. Results suggested that ball trajectory is more informative for the goalkeepers, contributing to a higher percentage of successful reactions.
The goalkeeper’s perception–action activity in coupled and uncoupled conditions has been analysed by Vignais et al. (2009), also using the virtual environment. As in previous research (Dicks et al., 2010; Farrow and Abernethy, 2003), it has been shown that the players’ performance was more precise in the motor-task conditions than in judgment reports.

Gutiérrez-Davila et al. (2011) investigated the effect of uncertainty on anticipatory goalkeeper strategies. The results suggested that, in greater uncertainty conditions, the goalkeepers started their lateral movement later and slower. Authors classify this goalkeeper behaviour as precautionary. The delay in the action allows the players to conceal their intentions and deceive the opponent, as well as gain time for modifying their movement, in order to adjust it better to the thrower’s behaviour. The data suggested that goalkeepers identified more precisely the clues related to the side of throw than the throw height.

Research on handball goalkeepers’ performance has shown that visual–motor activity during ball interception is based on the perception–action coupling between thrower and goalkeeper. It has also been demonstrated that the goalkeeper’s behaviour is influenced by the defenders’ actions (Prudente et al., 2010). Thus, further studies should continue to identify pertinent perceptual information that contributes to the precision of goalkeeper’s judgments about throwing actions and ball trajectories. In order to improve goalkeepers’ performance, it is also necessary to develop and test different training scenarios based on this relevant visual information.

Activity profiles of handball games

Handball is an intermittent, high-intensity contact sport game. Motor activity of players includes running, jumping, throwing, hitting and blocking, and requires high levels of agility, speed, strength, power and aerobic skills. Anthropometric and physical activity profiles of elite male and female handball players are well reported (Čavala et al., 2008; Čavala and Katić, 2010; Chaouachi et al., 2009; Chelly et al., 2011; Gorostiaga et al., 2006; Granados et al., 2007; Ziv and Lidor, 2009). A higher stature and greater lean body mass are generally considered as advantageous for effectiveness of offensive and defensive players’ actions (Milanese et al., 2011; Granados et al., 2007; Wagner et al., 2010).

Previous research has confirmed significant differences between elite and amateur handball players, both male and female, in absolute maximal strength and muscle power (Gorostiaga et al., 2005; Granados et al., 2007). Elite handball players have also demonstrated greater relative maximal power, when compared to untrained subjects or endurance trained athletes (Rannou et al., 2001). These findings suggest that strength and power are imperative attributes for the dynamic and contact competitive activity that distinguishes the handball game.

The physiological measures of players suggest that the anaerobic metabolism is the most relevant for the performance in handball (Delamarche et al., 1987; Granados et al., 2007). The aerobic mechanism is also important and, being requested during low-intensity periods of a match, it enables a faster recovery of players from high-intensity effort (Rannou et al., 2001). However, handball players do not show a high level of aerobic capacity or maximum oxygen consumption (Buchheit et al., 2009; Chaouachi et al., 2009; Gorostiaga et al., 2005; Ziv and Lidor, 2009) because, during the match, they perform many more short- and high-intensity actions which do not demand a high aerobic capacity. Rannou et al. (2001) reported that \( \text{VO}_{2\text{max}} \) of elite male handball players was similar to sprint-trained athletes, higher than the \( \text{VO}_{2\text{max}} \) of untrained subjects and lower than the \( \text{VO}_{2\text{max}} \) of endurance-trained athletes. Similar results have been reported by Granados et al. (2007) for female players, suggesting only some importance of aerobic capacity for handball performance. In the review of physiological attributes of
Handball players, Ziv and Lidor (2009) concluded that maximum oxygen consumption as well as endurance capacity per se do not differentiate players according to their competitive level.

Position-related differences in anthropometric and physical profiles of players have been reported in male and female handball. Wings were shorter and lighter than players from other positions, and goalkeepers had a greater percentage of body fat (Chaouachi et al., 2009; Luig et al., 2008; Milanese et al., 2011; Rogulj et al., 2005; Sibila and Pori, 2009).

Research has reported conflicting results related to differences among playing position in physical performance. While some studies have claimed significant differences between the physical profile of wings and other playing positions (Čavala and Katić, 2010), others have not (Chaouachi et al., 2009). These conflicting results may be due to some particularities of observed samples and differences between female and male handball and should be addressed in future studies.

The literature review has clearly revealed a lack of time-motion analysis data recorded in handball match-play. Delamarche et al. (1987) monitored seven under-18 handball players during the first half of a handball game in a study that also evaluated blood lactate concentration and heart rate of players. Data were recorded every five minutes, and after a ten-minute rest period, suggesting frequent changing of heart rate of players during the game and variation of blood lactate concentration from 4 to 9 mmol.L⁻¹.

Recently, the motion profile of elite players who participated in the 2007 Men’s World Championship has been provided by Luig et al. (2008). Results obtained from the computer-based match analysis system (SAGIT) suggest significant position-related differences in motion profiles. The greatest distance was covered by wing players (3710.6 ± 210.2 m), followed by backcourt players (2839.9 ± 150.6 m), pivot players (2786.6 ± 238.0 m) and goalkeepers (2058.1 ± 290.2 m). The analysis of motion intensity revealed that 34.3 ± 4.9 per cent of the total distance the players covered was by walking, 44.7 ± 5.1 per cent by slow running and 17.9 ± 3.5 per cent by fast running and 3.0 ± 2.2 per cent by sprinting. As expected, wing players covered significantly longer distances by fast running and sprinting.

Chelly et al. (2011) confirmed that elite adolescent players covered a smaller distance and performed fewer technical actions in the second half of a match. These authors reported quite different results than Luig et al. (2008) with respect to the total distance covered on average per handball match (1777 ± 264.0 m) and intensities of players’ displacement. The fact that the study focused on elite adolescent and not adult players could be one of the many reasons (such as influence of match equilibrium or teams’ strategy, for example) that justifies the differences between the results reported by Luig et al. (2008) and Chelly et al. (2011).

In addition to scarce data about the running profile of handball players, none of the available analysis has taken into account the context of competition, quality of opposition and match equilibrium, which influence players’ motion activity, as has been shown in soccer (Lago et al., 2010).

**Match analysis and modelling of team’s performance**

The need for objective, accurate and relevant feedback on the individual and team performance has led to the development of technologically advanced match analysis systems that enable the recording of large amounts of quantitative data in sports games in general and in handball in particular. However, it should be recognized that the quantity of statistical and scientific work in handball match analysis lags far behind that done for basketball, baseball, ice hockey and soccer.

The review of research problems, methodologies and main results allows classification of the approaches used in handball match analysis into two core groups:
1. Static approach (also named ‘structure-oriented’ by Pfeiffer and Perl, 2006); and 
2. Dynamical process-oriented approach.

Static, structure-oriented approach to handball match analysis

The static approach in handball match analysis is represented by descriptive and comparative studies that relate the teams' performance profiles to the game or completion outcome. This analysis makes it possible to ‘roughly’ detect the principal components of success in handball.

In static, structure-oriented analysis, the patterns of play are traditionally represented by frequencies of several performance variables registered during a game. These summarized data in most cases are evaluated without taking into account the context of the match. The research that has been carried out according to the static approach could be categorized as:

1. Descriptive analysis of the frequency of events that characterize the performance of elite handball teams (Czerwinski, 2000; Feldmann, 2001; Mocsai, 2002; Pollany, 2006; Rogulj et al., 2011; Taborsky, 2008); and 
2. Comparative analysis of match statistics and play patterns of winning and losing teams (Rogulj et al., 2004; Srhoj et al., 2001; Vuleta et al., 2003).

The majority of descriptive analyses of elite teams’ performances are based on primary descriptive statistics. The results of these analyses are available in European Handball Federation Web Periodicals. Although these publications do not properly represent scientific studies, their results could be useful for coaches, providing them with information from the observation of behaviours of national teams.

The comparative analysis typically uses discrete variables containing information about teams’ actions associated with their outcome. Using 12 indicators of scoring efficiency, Vuleta et al. (2003) determined that the winning teams of the 2000 Men’s European Handball Championship were significantly more efficient than losing teams in practically all types of shots: back-court shots, six-metre shots and seven-metre throws.

Rogulj et al. (2004) analysed differences between tactical offensive patterns of winners and losers in 90 games of the Croatian First League of Handball. Nineteen indicators that characterized duration, continuity, systems, structure and spatial direction of the attack have been used in the study. The results of multivariate analysis of variance (MANOVA) and canonical discriminant analysis have shown that winning offensive patterns of play was distinguished by more frequent use of fast break and fast position attack with up to 25 s duration. According to the authors, it was not possible to identify any type of offensive system, organization or spatial direction of the attack that could significantly differentiate winning from losing teams in positional attack due to a great variability of teams’ actions.

In order to identify the set of relevant game indicators that discriminate winning from losing teams in the 2003 Men’s World Handball Championship, Volossovitch and Gonçalves (2003) used binomial logistic regression. The final model included four variables that had a significant effect on the game output: goalkeeper efficiency ($p = 0.001$), field shot efficiency ($p = 0.024$), fast break efficiency ($p = 0.045$) and number of assists ($p = 0.073$).

The analysis of key indicators which distinguish winning from losing teams’ performance in handball has revealed that the majority of studies reported a quite evident importance of field shot and goalkeeper efficiency.

Although there is enough evidence that home advantage influences the team’s performance, there is a lack of studies that address this issue in handball. We could identify only one study...
Handball

that has evaluated and confirmed the home advantage in games of the Spanish Handball League from 2005–2006 to 2009–2010 seasons (Gómez et al., 2011).

Some problems related to the data of static approach studies should be acknowledged. One of these problems deals with the relevance of information gathered from the summarized data accumulated by the end of the match. The examples of balanced games show that, in some cases, it is not possible to establish a direct and linear relationship between the quantity of actions and the match outcome. The isolated registration of actions analysed out of the context of the competition does not provide valid information about the match process and frequently does not enable understanding of the reasons for the final result.

Dynamical, process-oriented approach to handball match analysis

Tactical process analysis

The dynamical, process-oriented approach is based on the recording of substantial tactical actions in a chronological, sequential order and provides a deeper insight into the tactical models used by a team during a match (Pfeiffer and Perl, 2006). The studies carried out according to this approach aim to estimate the probability of occurrence of determinate actions in order to identify the sequential behavioural patterns that lead to success (Pfeiffer and Perl, 2006; Prudente et al., 2008).

Pfeiffer and Perl (2006) used neural networks to analyse tactical organizations in youth female handball and have managed to reduce the huge volume of data related to complex tactical behaviour to a small number of processes with similar tactical structures. Each offensive attempt was represented as the sequence of stages based on handball-specific concepts; offensive formation followed by four tactical actions registered on their chronological order. The Dynamically Controlled Network, used in the study, enabled the identification of typical tactical processes of 12 teams which participated in 15 matches of the Women’s Junior World Championship (2001).

Prudente et al. (2008) verified the relationship between type, area of ball recovery and path of the first offensive action with the ball, using the sequential analysis technique. The probabilistic analysis of data from 25 games of the eight best-placed teams that participated in the final phases of the 2002 European Championship and the 2003 World Championship allowed the dependence between the area and type of ball recovery as well as the first action with the ball to be determined.

Probabilistic analysis of handball match result evolution

One of the aims of match analysis is to provide an opportunity to predict sport performance in order to be well prepared for the future competitive scenarios. Vuleta et al. (2005) analysed the score evolution in 60 matches from the 2003 Men’s World Handball Championships to evaluate the predictive value of the goals scored in the different time periods of a match for the final outcome. The results of regression analysis showed that goals scored in the second and the first 15 minutes of a match have the greatest impact on the final score. In this study, the match equilibrium and round of competition were not considered. In addition, it was assumed that all periods of 15 minutes were independent, and the possible influence between subsequent game episodes was not taken into account. In this sense, the study of Vuleta et al. (2005) can be classified as being on the static–dynamical approach boundary of match analysis.

The dynamical approach should take into account the time evolution of performance
during the match, which implies considering how prior events influence subsequent ones. Thus, in order to evaluate more precisely the probability of winning, first it is necessary to calculate the probability of scoring and verify whether it varies as the match unfolds. This step implies checking if the probability of scoring is constant during the game and understanding what factors influence, and how, the probability of scoring; in other words, it is necessary to verify the hypothesis of independence and identical distribution of goals scored during a match. For solving this problem, the model with time-varying parameters for the probability of scoring based on the past performance of the opposing team and the current match result has been estimated (Dumangane et al., 2009; Volossovitch et al., 2010). A total of 32,273 observations of ball possession from 224 matches from the 2001, 2003 and 2005 Men’s World Handball Championships were used for model estimation. The influence of the match equilibrium and the rhythm of alternating ball possession on the dynamic of parameters of the model was evaluated later (Volossovitch et al., 2010). The results of model estimation suggest that the probability of scoring does not depend on the past offensive performance of one’s own team, but on the past offensive performance of the opponent (the own-team defensive performance) and on the point difference. It has been noted that the effects of the recent past performance of the opponent and of the point difference on the probability of scoring in handball are time-varying during the game and influenced by the quality and by the pace of the match.

There is no doubt that the teams’ behaviour and consequently the score evolution are products of dynamical interactions between the players of both teams. Thus, for a more complete understanding of the factors that influence success in handball, it is necessary to use mathematical models that incorporate information about offensive and defensive actions and their evolution in time. Dynamic modelling has great potential for solving this problem.

**Future work**

Many pertinent issues in handball performance analysis require further investigation. In order to better understand the factors that influence throwing effectiveness and goalkeeper efficiency in a real-game situation, it is necessary to study the handball throw and goalkeeper activity in more representative designs and in-situ experimental tasks that reproduce the functional coupling thrower–defender and thrower–goalkeeper.

A more substantial research effort is needed for time-motion analysis of handball players in different game contexts. In match analysis, it is crucial to focus more on the defensive activity. The identification of critical game periods that have a significant influence on the final outcome is also a relevant issue for research in handball.

More studies assessing the influence of contextual variables (quality of opposition, home advantage and score-line) on the handball teams’ performance should be carried out. More data are required to characterize position-related playing performance profiles. A further challenge for future research is to create techniques for individual player evaluation and their contribution to the team’s success. As a general suggestion, future research should be more focused on the female game.

**Concluding remarks**

Research work in handball performance analysis has been reviewed in this chapter. Studies regarding throwing performance are focused on identifying the factors that influence ball velocity and shot accuracy. The research results suggested that, along with the throwing technique and players’ muscular force, external stimuli (such as opposition) have also influenced the throwing kinematics and thus should be included in future experimental designs.
Handball

The goalkeeper’s performance has been analysed by using virtual reality technology, eye-tracking systems, 3D kinematic analysis and force platforms. It has been shown that players perform better in motor-task conditions than in judgment reports, that the reaction quality, movement time and number of goalkeepers’ gaze fixations are related to the goalkeeper expertise and that virtual reality offers promising tools for studying goalkeeper’s activity.

Elite and amateur players showed different physical activity profiles, but their movement activity during competition should continue to be studied. Studies in handball match analysis have been carried out using static, structure-oriented and dynamical, process-oriented approaches. A criticism of the first group of studies is that they do not consider the interaction between different performance variables and the context of competition. On the other hand, the models are oriented to the match process and, based on the play-by-play data, are promising for addressing chronological changes of the performance and complex assessment of factors that influence a team’s efficiency.

References


Handball


A. Volossovitch


