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ANALYSIS OF HIGH-INTENSITY LARGE-SCALE MOVEMENTS IN TEAM HANDBALL

ANALIZA NAJINTENZIVNEJŠIH GIBANJ V ROKOMETU

Abstract

The intensity of large-scale movements in team handball can be classified in four categories of velocity. The primary aim of the article is to analyse the 4th velocity class (large-scale movements above 5.2 m/s) during a handball match, with a particular focus on the frequency and distances of such events. The sample group consisted of 36 male team handball players of different playing positions. The output data on large-scale movements obtained from the SAGIT programme were processed using selected descriptive statistical methods. The differences between the mean values of the results of the chosen loading variables were tested for the first and second halves of the match with the use of a t-test method for pairs. During the analysed matches, players from the chosen sample on average covered 620 m of movements with a velocity above 5.2 m/s. An analysis of the frequency of movements with the highest intensity showed that players from the sample averaged 80 events of the 4th VC per analysed match. The average distance of these movements (sprints) was 7.7 m. The results of the research show that players from the sample were unable to maintain the same level of loading throughout the entire match. Reasons for the smaller number of highest intensity cyclic movements in the second half can mostly be found in the level of physical preparation of the players included in the sample, as well as in the tactical plan of the teams trying to maintain the achieved result.

Key words: team handball, loading, velocity classes, match analysis, computer vision

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Izvleček

V rokometu lahko intenzivnost cikličnih gibanj opredelimo s štirimi hitrostnimi razredi. Hitrostni razred (HR) najvišje intenzivnosti je 4 HR, za katerega so značilna gibanja igralcev nad 5,2 m/s. Osnovni namen prispevka je bila podrobna analiza 4 HR med rokometno tekmo. Zanimala nas je pogostost pojavljanja ter dolžina tovrstnih gibanj, poleg tega pa smo želeli dobiti podatke tudi o količini najintenzivnejših gibanj v desetminutnih odsekih tekme. Vzorec merjencev je sestavljalo 36 rokometašev na različnih igralnih mestih. Podatke smo zbirali na šestih modelnih tekmah s pomočjo sistema SAGIT in jih kasneje obdelali s osnovno opisno statistiko. Razlike med aritmetičnimi sredinami rezultatov spremenljivk obremenitev v prvem in drugem polčasu tekem smo testirali z t-testom parov. Izbrani igralci so v povprečju opravili 620 m gibanj v 4 HR. Na analiziranih tekmah smo zabeležili v povprečju 80 gibanj nad 5.2 m/s, ki so bila v povprečju dolga 7.7 m. Rezultati analize so pokazali, da igralci niso bili sposobni ohranjati isto raven obremenitev skozi celotno tekmo. Razloge upada najintenzivnejših cikličnih gibanj v drugem polčasu smo iskali predvsem v ravni kondicijske priprave igralcev našega vzorca, kot tudi rezultatskemu taktiziranju ekip v drugem polčasu.

Ključne besede: rokomet, obremenitve, hitrostni razredi, analiza tekem, računalniški vid

INTRODUCTION

The study of the intensity and loading of handball players during matches and in training is currently very popular. Researches mainly examine the structure and dynamics of loading during matches. In general, researchers are interested in the types of loads which an athlete endures during the match, the frequency of their occurrence, as well as the relations between them (Al-Lail, 2000; Bon, 2001; Brandon, 1998; Pori, Kovačič, Bon, Dolenec, & Šibila, 2005; Šibila, Vuleta, & Pori, 2004). In handball, the intensity and volume of loads are very diverse. Alongside cyclical movements, which include different types of walking and running, acyclic activities also occur during a match, such as passes, shots and falls. During a handball game the loading occurs in intervals, which are a result of changes in the dynamics and types of loading. Cyclical movements are fundamental as they allow a player to move within the court in two dimensions (length and width). They include walking and running without a ball as well as dribbling the ball while walking or running.

The existing literature contains quite a lot of contributions concerning the volume of handball players' cyclical movements during matches. Authors who have used different methods of collecting, sorting and analysing the related data state that during a match handball players travel a distance of between 4,000 and 6,000 m (Cardinale, 2000; Kotzamanidis, Chatzikotoluas, & Giannakos, 1999; Martin, 1990). The variability in the volume of distances run or walked is caused by various factors such as the playing position (Cuesta, 1991), age category of the players (Pori et al., 2005), level or importance of the match (Cardinale, 2000) etc. It is difficult to deduce the dynamics of loads during matches merely from the data about the volume of cyclical movements. As velocity is one of the main indicators of load intensity, which during the handball game manifests itself in different forms, the research of Bon (2001) also evaluated the distances walked or run throughout a match according to the intensity of loading. The intensity of cyclical movements has been described as involving four velocity classes (VC's) (1^{st} VC –velocity of up to 1.4 m/s; 2^{nd} VC – velocity between 1.4 and 3.4 m/s; 3^{rd} VC – velocity between 3.4 and 5.2 m/s; 4^{th} – velocity above 5.2 m/s). Bon (2001) stated in the same research that players from the chosen sample spent on average at the analysed matches 7% of the playing time sprinting, 25% running fast, 31% running slowly and 37% of the playing time walking or standing still. Similar results were presented in the 2001 research by Pori on a sample of 84 handball players from youth, junior and senior categories. The weakness of these analyses, which were both carried out using the SAGIT system (Perš, Bon, Kovačič, Šibila, & Dežman, 2002), lies in the fact that all the intensities of cyclical movements could only be presented in percentage shares of the time the players spent in a specific velocity class. For the purposes of the research carried out by Pori in 2003, the module for showing the results in the SAGIT system was upgraded with a method that also allowed the presentation of data on the intensity of cyclical movements as the average volume of the distances which the players spent in a specific velocity class. Pori argued that the wing players from the chosen sample, whilst playing zone defence 6_0 in the position of the first defence player, executed on average 1620 m, SD = 100 m of movements in the 1^{st} VC, 1450 m, SD = 80 m in the 2^{nd} VC, 1170 m, SD = 80 m in the 3^{rd} VC and 645 m, SD = 50 m in the 4^{th} VC.

The present work aims to analyse in detail cyclical movements of the highest intensity in a game of handball. The category with the highest intensity is the 4^{th} velocity class (4VC), when

the players' movements exceed the velocity of 5.2 m/s (Bon, 2001). The primary aim of the article is to analyse the 4th VC during a handball match, with the frequency and distance of such events being of particular interest. In addition, data on the quantity of highest-intensity movements in 10-minute intervals of a match were studied.

METHOD

Participants

The sample group consisted of 36 male team handball players (average body height 189 cm, SD = 2.4 cm; average body mass 86.2 kg, SD = 4.4 kg; average age 21.8 years, SD = 3.1 years) of different playing positions. Specifically, 12 were wing players, 18 back players and 6 pivots, who at the time of the measurements were included in senior teams and had played in the first or second Slovenian national handball league. Data on the work rate of large-scale movements were collected from six model matches and one team was monitored at each of the matches. In all of the matches certain environmental conditions were standardised: i) the playing time for all games was two times 30 minutes; ii) all the teams played a 6_0 zone defence; iii) selected players had to play the entire game; and iv) and a one-minute team time-out was not allowed.

Instrument

The sample of variables included those related to large-scale cyclical movements by definition.

Movements in the 4th VC (velocity above 5.2 m/s) were presented as distances the players travelled during an entire match, in each half and in 10-minute intervals of the match. In addition, data on the frequency of occurrences and the length of movements in the 4th VC were obtained.

Data collection method

The collection of data on players' large-scale cyclical movements in handball matches was based on a computer-aided automatic tracking method using the SAGIT (Ljubljana, Slovenia) system (Perš, et al., 2002). In the field of biomechanical motion an analysis the accuracy of the motion acquisition system is one of the most important factors when such systems are compared, and the accuracy is measured in millimetres (Richards, 1999). The SAGIT system has some errors, which have been analysed in several stages (Perš, 2004).

Data analysis

The output data on large-scale cyclical movements obtained from the SAGIT programme were processed using selected methods of descriptive statistics. The differences between the arithmetical mean values of the results of the chosen loading variables were tested for the first and second halves of a match with the use of a t-test method for pairs. Statistically significant differences were accepted with a 5% statistical significance threshold (two-tailed testing).

RESULTS

Figure 1 shows the average volume of distances run within the fourth velocity class. Players from the sample executed on average during the analysed matches 620 m, SD = 70 m of movements with a velocity above 5.2 m/s (above 18.7 km/h). The average distances are greater in the first half of the matches. The average volume of movements during the first half was 350 m, SD = 58 m, compared to 265 m, SD = 41 m during the second half. The t-test results of pairs confirmed statistically significant differences ($p < 0.001$). The average decrease in the volume of movements in the 4th VC from the first to the second half was 85 m.

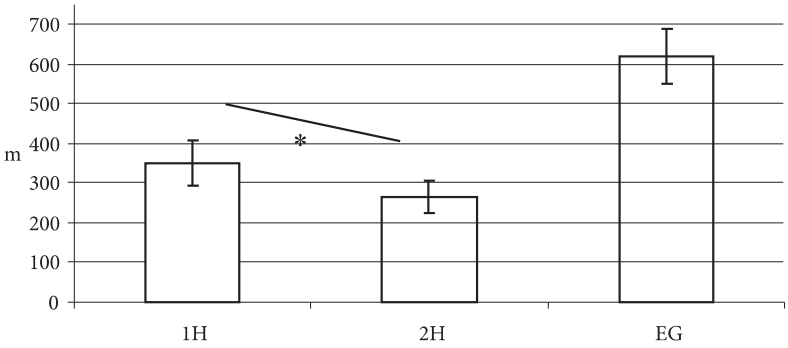

Figure 1: Average volume of large-scale movements in the 4th velocity class (VC)

Legend: 1H – 1st half; 2H - 2nd half; EG – entire game; m – metres; * - statistically significant difference

An analysis of the volume of movements in the 4th VC during 10-minute intervals revealed different average distances in particular periods of a match (see Figure 2). During the first ten minutes (145 m, SD = 35 m) and in the second ten minutes (119 m, SD = 23 m) of a match, the distances in the 4th VC were greater than during the last part of the match. In the last analysed interval of the match (from the 50th minute until the end of the match) the average volume of movements in the 4th VC (78 m, SD = 18 m) nearly halved relative to the first 10-minute interval of a match.

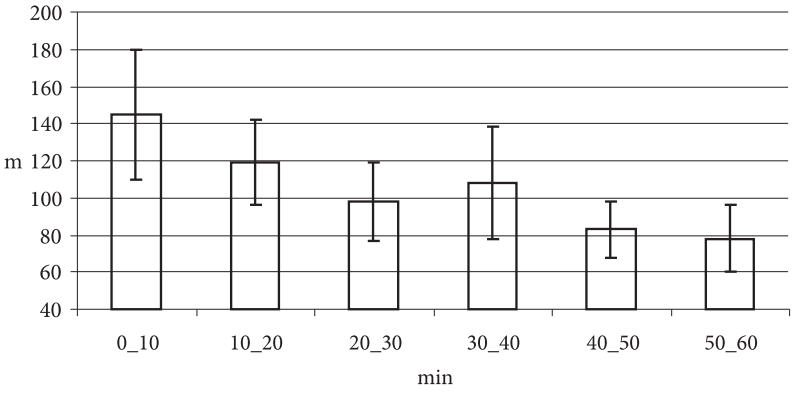

Figure 2: Average volume of large-scale movements in the 4th VC for 10-minute intervals of a match

Legend: min – minutes; m – metres; 0-10 - (interval from the start to the 10th minute of a match)…, 50-60 – (interval from the 50th to the 60th minute of a match)

Figure 3 shows the results of the frequency of movements with the highest intensity for players from the sample. In the analysed matches, on average 80, SD = 14 of such events were noted. Like before, the frequency of movements was higher during the first half of a match (42, SD = 8), compared to the second half (38, SD = 6). This difference was statistically significant ($p < 0.002$).

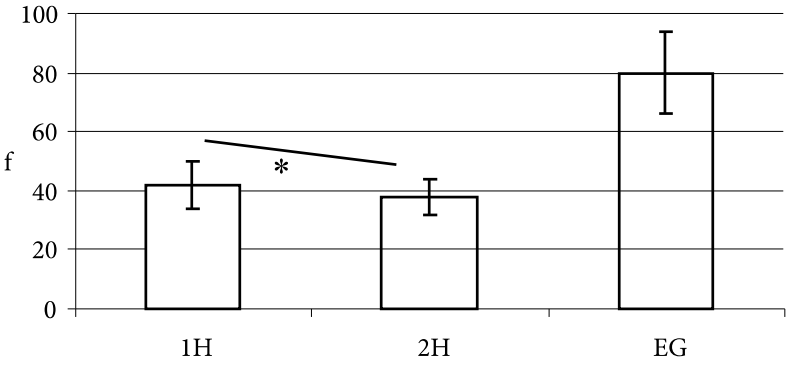

Figure 3: Average frequency of large-scale movements in the 4th VC

Legend: 1H – 1st half; 2H - 2nd half; EG – entire game; f – frequency of movements in the 4th VC; * -statistically significant difference

The average distance of movements (sprints) with a velocity above 5.2 m/s was 7.7 m, SD = 2.3 m (see Figure 4). During the first half of a match, the average distance of sprints by players from the sample was 8.1 m, SD = 2 m and was significantly higher ($p < 0.001$) than during the second half (6.9, SD = 2.4). The difference in the average distance of sprints from the first to second half was 1.2 m.

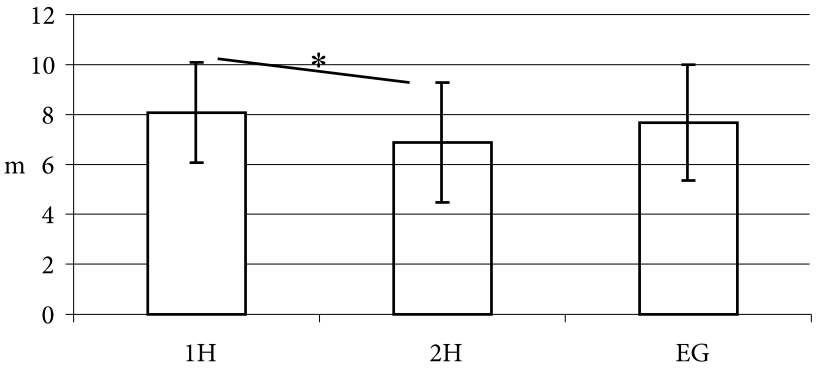

Figure 4: Average distance of large-scale movements in the 4th VC

Legend: 1H – 1st half; 2H - 2nd half; EG – entire game; m – metres; * - statistically significant difference

DISCUSSION

During a handball match players are exposed to cyclical loads of both high and low intensity. The share of phases with high and low intensity varies from one match to another (Šibila,Vuleta, & Pori, 2004). The present work analyses high-intensity cyclical movements in handball; they

are described by the movements of players with a velocity of above 5.2 m/s. These movements are placed in the fourth velocity class (VC) (Bon, 2001).

The players from the sample ran, during the analysed matches, in the 4th VC on average 620 ± 70 m. These results are on average slightly lower than those found by Pori in 2003. The wing players included in that research ran during a zone defence 6_0 on average 645 m, SD = 50 m, and 558 m, SD = 114 m during the 3_2_1 zone defence. However, the research from 2003 only included wing players in the sample of measured subjects, whereas the sample in the present research also includes outside players and pivots. Namely, studies show that the specific nature of the wing players' model of the game (i.e. starting playing position in attack) results in a larger total volume of movements during matches compared to other playing positions (Cuesta, 1991; Pori, 2001; Šibila, Vuleta, & Pori, 2004).

Also analysed was the average frequency of occurrences of movements with the highest intensity, as well as their average distance. The results show that players from the sample reached the 4th VC on average 80 times, SD = 14 times, with an average distance of sprints during the entire match at 7.7 m, SD = 2.3 m. Similar results can also be found in the study by Martin from 1990. Considering that a handball match lasts 60 minutes, this consequently means that the analysed players executed a movement of the highest intensity on average every 45 s, with the average distance of such movement being between 7 and 8 m.

High loadings during specific periods of a match also require large effort and result in a decrease of loading in the second half compared to the first half of a match (Cuotts, Reaburn, & Abt, 2003; Deutch, Maw, Jenkins, & Reaburn, 1998; Krunstrup, Mohr, & Bangsbo, 2002). The authors of several researches in the fields of rugby and football found that fatigue manifests itself in a decrease of both the volume and intensity of cyclical movements in the second half. Whilst studying the movements of side referees, Krustrup et al., (2002) found that movements of the highest intensity in second half decreased by 33% and the overall volume of movements by 30%. He also presumed that the decrease of intensity of a player's game on the field leads to a decrease in the abovementioned loading variables.

Similar to previous studies, the present research found a statistically significant decrease in loading in the second half of a match for all chosen variables of large-scale movements of the highest intensity. An analysis of 10-minute intervals of a match allowed a closer look at the dynamics of the loading intensity for specific periods of the match. The volume of large-scale movements in the 4th VC was decreasing from the beginning to the end of the match, with the exception of the first ten minutes of the second half. When comparing the first and last ten minutes of a match, it can be seen that movements of highest intensity fell by nearly a half, specifically by 67 m. As was previously estimated, the average distance of sprints was 8 m, meaning that players from the sample executed approximately 8 sprints less in the last ten minutes of a match than in the first ten minutes.

The results of the research show that players from the sample were unable to maintain the same level of loading throughout an entire match. The reasons for this can mainly be found in the level of physical preparation of the players from the chosen sample; in the opinion of the authors it was insufficient to allow for such a model of a game which required playing throughout the entire match at a higher level. However, it needs to be considered that the experiment did not allow any substitutions to be made during a match. It rarely happens in a modern game of handball that one player plays throughout the entire match. Five years ago

the European Handball Federation (EHF) decided to enlarge handball teams, which can now include seven players on the field and seven substitutions.

Clubs and coaches quickly adapted to the changed rules and now more often include in a team two players of high quality for each playing position. In addition to positive competitiveness among the players in a specific playing position, this change of rules (allowing more substitutions) also has a positive impact on maintaining the high competition pace in all playing positions and phases of the handball game.

Conclusion

The ongoing development of the game of handball, resulting from a modern game model, facilitates the need to improve and optimise training. The modern approach to handball training should be based on training procedures, methods and forms which closely imitate the loading and effort of players during a match. The results of the research show that players from the sample performed a movement of the highest intensity on average every 45 s, with the distance of such movement being between 7 and 8 m. These movements represented approximately 10% of the total distance covered during a match. The high loads seen in individual intervals of a match, which required great effort, also resulted in smaller loads in the second half. Reasons for the smaller number of highest intensity cyclical movements in the second half can mostly be found in the level of physical preparation of the players included in the sample, as well as in the tactical plan of the teams trying to maintain the achieved result.

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