Introduction

Combat sports, especially judo, are among acyclic sports which are characterised by changeable intensity of effort and frequent changes of fight conditions [1]. At the same time, movements of judo practitioners have to be very accurate and fast, otherwise, the techniques applied during the fight are ineffective. For these reasons, this sport is classified as being on the highest, i.e. the third level of coordinative complexity [2]. Nevertheless, researchers rarely tackle the issue of motor coordination and a speed effort in this sport.

Movement coordination depends on physical processes based primarily on the nervous system properties. In the accessible literature there are definitions of 5 [3] up to 11 [4] basic (elementary) coordinative skills. A high level of coordinative skills conditions the efficiency of learning new technical elements as well as the way of conducting sports competition, particularly in sports dominated by open motor structures [5, 6]. The richness of techniques in a given sport influences directly the importance of motor coordination in this sport. In the technically complex sports (such as jujutsu or wrestling) it is the most important component [3].

In scientific debate while comparing physique parameters with chosen motor skills in judo, researchers seek an optimal solution in response to the question of which features especially predispose players to achieve the highest possible results [7,8].

Game effort in handball is based on natural movements such as running, jumping or throwing. A large area of the game (40mx20m court), constant physical contact and the speed of actions necessitate perfect preparation of the players not only with regard to techniques and tactics, but also concerning their motor skills. Due to an unlimited number of changes, the
players have to play at a very fast rate and change on showing symptoms of fatigue in order to maintain the speed of their actions on an unchanged level. This shows that the speed of moving on the court is one the most significant coordinative skills that ought to characterize a modern handball player. Numerous researchers [9,10] claim that the speed of running over short distances is an important element of action in a team of handball players. Players have to cover distances of 10-20-30 metres with the maximum speed from the phase of attack to defense, after losing the ball or in order to prevent the game from fast stopping. As research shows, the players on a master level can run a distance of 30 meters within 3.8-4.4 seconds. In reality, handball players are capable of performing a great number of actions, i.e., jumps, running, changes of direction of running as well as specialist technical manipulative skills with the ball within short periods of time and in the order that depends on a current tactical situation [11]. Running with and without the ball in a straight line and in various directions, jumps, throws, passes and taking over the ball while it is in motion or during its flight add to perfect technical skills of a modern handball player [12]. In order to play on the highest possible level, it is necessary that the training process should be held in a way that most resembles conditions that exist during the real game on the court [13].

A detailed analysis of physical activity of handball players was carried out during a First League match in Slovenia [17]. The research results showed that all the players covered a distance of circa 4790 meters with 7% of the distance covered by sprint, 25% by a fast run, 31% by a slow run and 37% of the time the player did not move (he stood) or walked.

A number of points scored by teams and actions performed in the attack and defense has been growing with each passing year, which is connected with the increasing speed of the game and changes in rules that facilitate this acceleration (e.g., the so called fast center). Sybila [14] while analysing a number of actions in the attack in subsequent European Men’s Handball Championship confirmed these findings by indicating a constant growth in this regard, namely, in 2002 this number was 54, while in 2004, 2006 and 2008 it was 58. Other researchers focused on various ways in which players move on the court [15]. They proved that handball players during a match move by means of quick running on average 30 times and also 30 times by means of sprint and on average they move 73 times with high intensity (8.8% of all means of moving). This takes place in situations of danger from the opponent; therefore this run is performed with changes of speed and direction. Gruić (2006) [15] in his research proved that a number of actions in the attack and defense in the case of the best teams oscillates in the range of 60-70 actions.

**Goal of the study**

Taking into consideration the fact that speed is one of the most important motor abilities both in combat sports as well as in team sport games, an attempt was made at assessing this ability revealed in two sports characterized by various profiles of physical activity. The study was aimed at comparing the speed of movement of judo practitioners and handball players while running in a straight line and running in a broken line (with a change of direction).

**Research question**

- What are the differences in the speed of moving of judo practitioners and handball players while running in a straight line?
- What are the differences in the speed of moving of judo practitioners and handball players while running with a change of direction (running in a broken line)?

**Material and methods**

Our research material constituted 16 handball players of the First League club WKS Śląsk Wrocław and 14 judo practitioners of the Wrocław clubs KS AZS-AWF Wrocław and Gwardia Wrocław. Members of both groups were in their period of active sport competition. The mean age of handball players was 27, i.e. (from 22 to 40 years), while the mean age of judo practitioners was 24 (from 17 to 32 years). The length of training in the case of handball players was on average 12 (from 7 to 18 years), whereas judo practitioners were characterised by the length of 10 years of training on average (from 6 to 14 years). The observed players are characterised by a high sport level. The handball players are high in the rank of the First League while judo practitioners had at least First Sporting Class. Hence, it can be assumed that the subjects constituted a representative group at the stage of specialist training.

The average body height of handball players was 186.3 cm, while in the case of judo practitioners it was 180.2 cm; the average body mass of handball players was 91.3 kg and in judo practitioners it was 89.9 kg. Average body mass index BMI with judo practitioners was 27.1 while for handball players it was 26.2. We can thus assume that groups of handball players and judo practitioners were comparable taking into account their body height and mass as well as BMI and sport class.

For the purpose of examining the speed of running we employed SmartSpeed system. Fusion Sports SmartSpeed system enables a comprehensive speed analysis at given distances, the assessment of reactions to visual stimuli, spatial orientation and other motor abilities not mentioned before. The subjects performed a speed trial at a distance of 30 meters in a straight line and in a broken line at a total distance of 42 m (Fig. 1). Their task was to cover a distance of 30 and 42 meters as fast as possible running at their maximum speed. Each distance was covered twice with a 5-minute rest break. A subject started running at a visual signal, i.e. a photocell switched on. Measurement of time took place every five meters by means of photocells. Only the better times obtained during the particular trials were subjected to an analysis. Thirty minutes before the speed trial the subjects started a warm-up of an increasing intensity. The warm-up included general improvement exercises, dynamic-static and co-ordinated exercises, run at an increasing speed at a distance of 15-30 meters, exercises improving the stimulation of the Central
Nervous System (e.g. acceleration, starts, braking, deceleration, jumps). Before the first measurement each subject performed one test effort in order to get acquainted with the research protocol.

A statistical analysis of the data was carried out by means of statistical package StatSoft, Inc. (2009). STATISTICA (data analysis software system), version 9.0. We determined for the examined groups in the case of both trials (running in a straight line and running in a broken line) arithmetical means, minimum and maximum values as well as standard deviation. For determining coherence of the obtained results (homogeneity), we applied a coefficient of variation analysis. In order to define the statistical significance within one examined group in both trials, we used t-Student test for dependent groups, whereas to arrive at the statistical significance between the examined groups with regard to the same trial, we used t-Student test for independent groups.

Results

Comparison of speed of moving of judo practitioners and handball players in a straight line

Results obtained by judo practitioners in running in a straight line

Judo practitioners in running in a straight line at a distance of 30 meters on average reached 4.33 seconds. The best result was 4.03 seconds whereas the worst results was 4.75 s. The box graph below presents the distribution of times obtained by judo practitioners in particular sections (Fig. 2).

Results obtained by handball players in running in a straight line

Handball players in running in a straight line at a distance of 30 meters on average reached 4.36 seconds. The best
result obtained by handball players was 4.07 seconds whereas the worst one was 5.38 seconds. The box graph below presents the distribution of times obtained by handball players in particular sections (Fig. 3).

**Differences in the speed of moving in a straight line between judo practitioners and handball players**

Differences in the results of running in a straight line obtained by judo practitioners and handball players are not statistically significant (Tab. 1). The average result of handball players, i.e. 4.36 seconds and that of judo practitioners, i.e. 4.33 seconds does not differentiate in a statistically significant way neither of the two researched groups.

**Comparison of speed of moving of judo practitioners and handball players in a broken line**

Results obtained by judo practitioners in running in a broken line

Judo practitioners in running in a broken line on average reached 12.37 seconds. The best result obtained by subjects was 10.77 seconds whereas the worst result was 14.53 s. The box graph below presents the distribution of times obtained by handball players in particular sections (Fig. 4).

**Results obtained by handball players in running in a broken line**

Handball players in running in a broken line reached on average 11.31 seconds. The best result obtained by handball players was 10.67 seconds whereas the worst one was 12.13 seconds within the researched group. The box graph below presents the distribution of times obtained by handball players in particular sections (Fig. 5).

**Differences in the speed of moving in a broken line between judo practitioners and handball players**

An analysis of the results carried out by means of T-student test for independent groups showed that the time during which a particular section was covered differentiated statistically and significantly the researched groups (p<0.05). A difference between the mean total of the obtained results amounted to 1.07 seconds in favour of handball players. A statistically significant difference in running in a broken line was noticed at each analysed section of the run (p<0.05) (Tab. 2).
In the light of the conducted research it can be concluded that judo practitioners and handball players achieved a similar level of speed abilities. It was expected that handball players would represent a higher level of speed abilities while performing a trial of 30 m run in a straight line and a broken line test than judo practitioners. However, as it turned out, it was not the case. Hence, we can agree with opinions of numerous researchers that this results from exhibiting a similar level of the maximum power during the training process [18]. It was observed that judo practitioners in running in a straight line at a distance of 30 meters achieved less and less uniform results as they progressed in covering their distance, which may indicate significant discrepancies between the best and the worst result obtained in the examined group (Fig. 2). A big difference in the achieved results may evidence various levels of speed preparation of the subjects and releasing the maximum

<table>
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<tr>
<th>Variable</th>
<th>t (value of t-student test)</th>
<th>p (significance)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 m</td>
<td>1,48</td>
<td>0,150</td>
</tr>
<tr>
<td>10 m</td>
<td>0,69</td>
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<td>30 m</td>
<td>0,39</td>
<td>0,700</td>
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</tbody>
</table>

![Fig. 4. Graphic presentation of results obtained by judo practitioners in running in a broken line in particular sections](image1)

![Fig. 5. Graphic presentation of results obtained by handball players in running in a broken line in particular sections](image2)
power at different levels. On the one hand, it might be the effect of the represented speed potential and motor predispositions and on the other hand it could result from the quality of the actual training. Similar changes were observed in handball players where the greatest differences occurred between 25 meters and 30 meters (Fig. 3).

A very similar result of a trial of 30 m run in a straight line (difference at the level of 0.03 s) achieved by players who represented two sports differing as regards physical effort may demonstrate a similar level of their speed abilities. According to the observations carried out so far, achieving and maintaining the maximum speed parameters during sport competitions is one of the basic factors leading to sports mastery.

An analysis of the results obtained by judo practitioners in a trial of the run in a broken line indicates significant differentiation of athletes with regard to their speed abilities exhibited during the conducted trial. The difference between the best and the worst time was 3.76 seconds which exemplifies a very differentiated level of speed preparation and coordinative preparedness. It was noted that the biggest differences in the run in a broken line occur at circa 17 meters and they tend to increase along with the covered distance with the greatest diversity towards the end of the conducted trial (Fig. 4). An analysis of the results achieved by handball players showed only a slight difference of players as far as speed abilities were concerned. The difference between the best and the worst time was only 0.67 second which illustrates a very even level of speed preparation and coordinative preparedness of the examined players (Fig. 5).

A statistical analysis of the results obtained in the run in a broken line at a distance which was 30 meters in a straight line (with the entire covered distance totalling 42 meters) yielded statistically significant differences between the two researched groups (1.07 s). Handball players obtained much better times (the average time of covering a 42-metre distance in a broken line was 11.30 ± 0.42 s). Judo practitioners covered this distance within 12.37 ± 0.83 s on average. When milliseconds play a decisive role in scoring points or winning the game, it seems reasonable to pay more attention to this aspect of motor preparation in the training process [19]. A better result obtained by handball players in the run in a broken line can be interpreted as a consequence of the specific character of this sport. According to kinematic research, it can be inferred unambiguously that during the game effort handball players perform many movement activities when changing a direction of running, which actions cannot be observed during a judo fight. We must bear in mind that while training judo the dominant efforts are short-term ones of an explosive nature performed over few meters [20,21]. Therefore, better results were recorded for the broken line trial in handball players who cover longer distances by running with the maximum intensity. The presented research results do not have their references in the existing bibliography. It is thus not possible to carry out a comparative analysis in 30 meters run in a straight line in judo practitioners because there are no accessible research results on a speed ability in the case of this particular sport.

Conclusions

1. A similar level of speed abilities was observed in the conducted research although there are big differences in the specific character of game effort that is manifested by judo practitioners and handball players.
2. The fact that better results were recorded for the broken line trial in the case of handball players when compared with judo practitioners may result from the specific character of this sport and better preparation with regard to strength and speed.

References


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Received: 14.05.2013
Accepted: 18.08.2013