Introduction

Classification systems are used in various sports. They are particularly useful in sports for persons with various disabilities and impairments of physical function, who are classified according to their age, body weight and disability type [1]. Differences between sports results achieved by athletes within given classes are smaller than they would be between non-classified athletes, which greatly encourages the individuals with disability to participate in various sports [2]. Originally, sports for the individuals with disability were mainly propagated by physicians and physiotherapists, and the early classification systems were based on anatomic and medical criteria such as assessment of muscle strength, range of motion, length of limb stump, level of the spinal cord injury or spasticity [3].

In the 1970s wheelchair rugby was played only by tetraplegics, and the wheelchair rugby athlete classification was based on a system developed by the International Stoke Mandeville Games Federation (ISMGF) in which the classes were largely determined by the level of the athletes’ spinal cord injury [4]. Later on it was noted that the level of attained compensation in disabled
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N. Morgulec-Adamowicz et al., Game efficiency in wheelchair rugby

persons was better reflected by their functional abilities, which could affect their sports successes to a much greater extent than their anatomical and medical assessments. Gradually, functional classification systems specific to the unique functional demands of particular sports superseded medical classifications. Functional classification is based on the athlete’s functional abilities specific to the physical demands of each unique sport and it ensures that athletes with different kinds and levels of disabilities have an opportunity to compete in the same sport. One of the reasons for the changes in classification system in wheelchair rugby was the need to include athletes with disabilities other than spinal cord injuries with impairments similar to tetraplegia (e.g. muscular dystrophy, cerebral palsy, neuromuscular disorders). At present, wheelchair rugby athletes are individuals with neurological disorders (of the central or peripheral nervous systems) or non-neurological disabilities, with impaired or absent upper and lower limbs movement. The functional classification allows comparison of potential athletes’ functional abilities with the accepted classification criteria [8]. The current wheelchair rugby medical-functional classification system was developed in 1991. The classification process comprises three components: (1) physical assessment consisting of manual muscle tests [9] and trunk tests; (2) functional skills tests (wheelchair skills: pushing forward and backward, starting, stopping, turning, changing direction; ball handling skills: one-hand and two-hand passes, catching, retrieving the ball from the floor, dribbling; blocking and picking); and (3) observation assessment of athletes during warm-up, training, practice and competition (e.g. transfers to and from the wheelchair, putting on gloves, straps and binders) [8]. Following the assessments each athlete is allocated one of seven sports classes (numerical categories) ranging from 0.5 to 3.5 points. The 0.5 class includes athletes with the most disability, and the 3.5 class athletes with the least disability eligible for the sport of wheelchair rugby. In wheelchair rugby the total number of points of all four athletes in a team on court at any time cannot exceed 8.0 points. The introduction of the point limit is aimed to equalize the medical and functional potential of the competing teams.

The wheelchair rugby classification system has been constantly verified to improve game efficiency of individual athletes and teams [4, 6, 10, 11]. The growing significance of functional assessment in the classification process has made a number of researchers examine relationships between wheelchair rugby specific fitness tests and player classification. Morgulec and Lencse-Mucha [7] revealed statistically significant correlations between the classification of Polish National Team wheelchair rugby players and the results of Beck Battery tests carried out twice – in 2001 and 2003. Similar observations were made by Malone et al. [10], who found a significant correlation between player classification and five wheelchair rugby specific fitness tests (20 m sprint, endurance sprint, up and back, passing, and slalom). The correlations observed indicated a certain tendency, while analysis of statistically significant differences between particular classes of players may yield some more detailed data about the accuracy of a classification system [13]. Morgulec et al. [12] in their study with the use of the Beck Battery revealed no significant differences between players from most IWRF classes, but only between the 0.5 class players and the remaining classes.

Wheelchair rugby combines short intense bouts of full effort exercise, thus it requires anaerobic capacity. Morgulec et al. [14] used the Wingate test to examine differences between individual classes of wheelchair rugby athletes and only noted significant differences between the 0.5 and 2.0–2.5 and 3.0–3.5 class players.

In team games, apart from the players’ functional abilities necessary for development of skills and habits, also the praxeological assessment of individual players and the team as a whole are highly significant for attainment of good sports results. The praxeological evaluation is usually carried out using such criteria as rationality, efficiency, economy and profitability [15, 16]. The most basic and common praxeological criterion, measured with the level of conformity between the sport result and the goal is efficiency. An action is efficient if it achieves a specified goal, but also when it enables or enhances its achievement [15].

Very few studies concerning disability team sports, including relatively new wheelchair rugby, have been devoted to the assessment of game efficiency of players and teams. One of them is a study by Molik et al. [11] which used a modified game efficiency sheet from wheelchair basketball. The study was conducted on a sample of 105 wheelchair rugby players during the European Championships in 2005. Statistically significant differences in game efficiency were only noted between the 0.5–1.5 and 2.0–3.5 class players.

Vanlandewijck et al. [17] observed that differences between players at the national level can be determined
to a great extent by such extra factors as previous sport experience, training methods, creativity, talent as well as physical, psychological, technical and tactical potential. Thus the total of these factors and the player’s functional abilities may not reflect the classification points assigned to the player on the basis of his functional abilities only. However, at the international level (world championships, the Paralympics) the extra factors determining the players’ sports levels are comparable between individual players and therefore reflect better the assigned classification points alongside the assessment of functional abilities. This assumption may seem doubtful as the players’ various intellectual skills may also be decisive in achieving the ultimate sports successes. An analysis of game efficiency of players with different levels of functional abilities can greatly contribute to the improvement of accuracy of the classification system. The aim of the present study was to assess game efficiency of wheelchair rugby players representing different IWRF classes.

It was assumed that an analysis of wheelchair rugby players on the highest sports level (Paralympic games athletes) would permit an objective comparison of selected parameters of game efficiency between athletes with disability representing different classes. It was also assumed that the level of game efficiency would be dependent on player classification, i.e. high-point class players (with greater functional abilities) would represent a higher level of game efficiency.

The confirmation of this assumption may contribute to the improvement of player and team sports training, in particular, to the process of optimal selection of players with regard to their classification.

The main research question was whether game efficiency was a factor discriminating between top level wheelchair rugby players?

**Material and methods**

The study sample included wheelchair rugby players from the world top teams: Australia, China, Japan, Canada, Germany, New Zealand, the United States and Great Britain. Only players who spent at least one quarter of the game played time on the court (8 min) were taken into consideration. Out of 88 players who took part in the Beijing Paralympics (September 6–17, 2008) 77 qualified for the study. Each Paralympic team played five matches during the tournament. The players represented all seven IWRF classes: 0.5 points \( (n = 9) \), 1.0 point \( (n = 11) \), 1.5 points \( (n = 7) \), 2.0 points \( (n = 23) \), 2.5 points \( (n = 10) \), 3.0 \( (n = 13) \) and 3.5 points \( (n = 4) \). Their percentage distribution at the 2008 Paralympic wheelchair rugby tournament is shown in Figure 1.

![Figure 1. Percentage distribution of wheelchair rugby players from different IWRF classes at the Beijing 2008 Paralympics](image)

The subjects \( (n = 77) \) were divided into four groups (I–IV) encompassing the respective IWRF classes.

<table>
<thead>
<tr>
<th>Group</th>
<th>IWRF classes (pts)</th>
<th>( n )</th>
<th>Age (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>mean (SD)</td>
</tr>
<tr>
<td>I</td>
<td>0.5</td>
<td>9</td>
<td>33.9 (6.4)</td>
</tr>
<tr>
<td>II</td>
<td>1.0–1.5</td>
<td>18</td>
<td>31.2 (5.8)</td>
</tr>
<tr>
<td>III</td>
<td>2.0–2.5</td>
<td>33</td>
<td>31.8 (5.2)</td>
</tr>
<tr>
<td>IV</td>
<td>3.0–3.5</td>
<td>17</td>
<td>30.1 (6.6)</td>
</tr>
<tr>
<td>I–IV</td>
<td>0.5–3.5</td>
<td>77</td>
<td>31.8 (6.0)</td>
</tr>
</tbody>
</table>

On the basis of the tournament match statistics (20 matches) the following six game efficiency parameters were analyzed for each subject: played time (T), sum of all points scored (PT), assist passes (AS), assist blocks (AB), turnovers (TO) and steals (ST). An assist pass (AS) is the last pass to a player who scores a point (only one assist pass can be assigned to each scored point). An assist block (AB) is blocking of an opponent’s wheelchair by a player without possession of the ball resulting in the ball carrier’s crossing the opposing team’s goal line and scoring a point (only one assist block can be assigned to each scored point). A turnover (TO) is the loss of possession of the ball. A steal (ST) is an interception of the ball resulting from a defending player’s intended action [11]. Played time (T) was calculated as a player’s averaged time played in all matches of the competition (no shorter than 8 min) over 32 min (total match time). The other parameters (PT, AS, AB, TO, ST) were averaged out over played time (T).

The Statistica 5.1 software package (StatSoft, Poland) was used for statistical analysis. In order to determine the differences in particular game efficiency parameters...
between the four study groups of wheelchair rugby players the Kruskal-Wallis one-way analysis of variance was used ($p \leq 0.05$). When the Kruskal–Wallis test results were statistically significant, the Mann–Whitney test was used to determine differences between the individual study groups (I–IV). Because of multiple comparisons for paired tests between groups I–IV a correction was applied ($\alpha/[k(k–1/2)]$), thus the level of statistical significance for each Mann–Whitney test amounted to $p \leq 0.002$.

**Results**

No significant differences between the groups of players (I–IV) were found with respect to age. The means and standard deviations of wheelchair rugby game efficiency parameters (averaged out over played time) are shown in Table 2. The large SD values may indicate a dispersion of the data in particular groups. In terms of such game efficiency parameters as PT, AS, TO and ST a tendency to attain higher values by players with smaller disability can be observed. It is not the case, however, with T and AB.

Table 2. Means and standard deviations (SD) of game efficiency parameters in four study groups (I–IV)

<table>
<thead>
<tr>
<th>Group</th>
<th>T</th>
<th>PT</th>
<th>AS</th>
<th>AB</th>
<th>TO</th>
<th>ST</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>2.30</td>
<td>0.07</td>
<td>0.28</td>
<td>1.69</td>
<td>0.38</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>(1.08)</td>
<td>(0.20)</td>
<td>(0.36)</td>
<td>(1.17)</td>
<td>(0.41)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>II</td>
<td>1.34</td>
<td>3.20</td>
<td>0.77</td>
<td>3.30</td>
<td>1.28</td>
<td>0.61</td>
</tr>
<tr>
<td></td>
<td>(1.09)</td>
<td>(3.17)</td>
<td>(0.83)</td>
<td>(2.35)</td>
<td>(3.38)</td>
<td>(1.00)</td>
</tr>
<tr>
<td>III</td>
<td>2.41</td>
<td>10.95</td>
<td>4.94</td>
<td>2.66</td>
<td>2.35</td>
<td>0.76</td>
</tr>
<tr>
<td></td>
<td>(1.13)</td>
<td>(3.69)</td>
<td>(2.85)</td>
<td>(1.83)</td>
<td>(1.89)</td>
<td>(0.74)</td>
</tr>
<tr>
<td>IV</td>
<td>1.99</td>
<td>18.85</td>
<td>6.67</td>
<td>1.29</td>
<td>2.84</td>
<td>1.18</td>
</tr>
<tr>
<td></td>
<td>(1.30)</td>
<td>(6.06)</td>
<td>(2.01)</td>
<td>(1.56)</td>
<td>(2.40)</td>
<td>(1.13)</td>
</tr>
</tbody>
</table>

T – played time, PT – sum of all points scored, AS – assist passes, AB – assist blocks, TO – turnovers, ST – steals

The non-parametric Kruskal–Wallis test revealed statistically significant differences between the groups under study in all parameters (Tab. 3). The level of statistical significance was $p \leq 0.001$ for the sum of all scored points (PT), assist passes (AS) and turnovers (TO); $p \leq 0.01$ for assist blocks (AB) and steals (ST); and $p \leq 0.05$ for played time (T).

Table 3. Statistical significance of differences between the groups studied in particular game efficiency parameters (Kruskal–Wallis test)

<table>
<thead>
<tr>
<th></th>
<th>T</th>
<th>PT</th>
<th>AS</th>
<th>AB</th>
<th>TO</th>
<th>ST</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\chi^2$</td>
<td>9.66</td>
<td>55.84</td>
<td>52.40</td>
<td>14.14</td>
<td>27.01</td>
<td>18.88</td>
</tr>
<tr>
<td>$p$</td>
<td>0.022</td>
<td>0.000</td>
<td>0.000</td>
<td>0.003</td>
<td>0.000</td>
<td>0.001</td>
</tr>
</tbody>
</table>

$df = 3$, T – played time, PT – sum of all points scored, AS – assist passes, AB – assist blocks, TO – turnovers, ST – steals

Table 4. Statistically significant differences between the groups (I–IV) for particular wheelchair rugby game efficiency parameters (Mann–Whitney post hoc analysis)

<table>
<thead>
<tr>
<th>Groups</th>
<th>T</th>
<th>PT</th>
<th>AS</th>
<th>AB</th>
<th>TO</th>
<th>ST</th>
</tr>
</thead>
<tbody>
<tr>
<td>I vs. II</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>I vs. III</td>
<td>n.s.</td>
<td>**</td>
<td>**</td>
<td>n.s.</td>
<td>**</td>
<td>*</td>
</tr>
<tr>
<td>I vs. IV</td>
<td>n.s.</td>
<td>**</td>
<td>**</td>
<td>n.s.</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>II vs. III</td>
<td>n.s.</td>
<td>**</td>
<td>**</td>
<td>n.s.</td>
<td>**</td>
<td>n.s.</td>
</tr>
<tr>
<td>II vs. IV</td>
<td>n.s.</td>
<td>**</td>
<td>**</td>
<td>n.s.</td>
<td>*</td>
<td>n.s.</td>
</tr>
<tr>
<td>III vs. IV</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

*p $\leq$ 0.002, ** $p \leq$ 0.001, n.s. – non significant, T – played time, PT – sum of all points scored, AS – assist passes, AB – assist blocks, TO – turnovers, ST – steals

The Mann–Whitney test revealed significant differences at $p \leq 0.001$ in sum of all points scored (PT), apart from those between groups I and II) and assist passes (AS; apart from those between groups I and II, and III and IV). Significant differences at $p \leq 0.002$ were noted for steals (ST) between groups I and III and between I and IV. For turnovers (TO) statistically significant differences at $p \leq 0.002$ were noted between all the groups studied, apart from those between groups I and II, and III and IV. No significant differences were found between all the groups studied at the corrected level of $p \leq 0.002$ (for repeated measures), for played time and assist blocks (with the exception of a significant difference between groups III and IV at $p \leq 0.001$).

Figure 2. Percentage of total played time of each wheelchair rugby national team at the 2008 Paralympics for players representing different IWRF classes
Figure 2 shows the percentage distribution of total played time (5 matches, 160 min) of each wheelchair rugby national team at the 2008 Paralympics for players representing different IWRF classes (0.5–3.5).

Discussion

Classification is an additional factor that affects player efficiency in team games for individuals with disability. It can also make the assessment of game efficiency more difficult and complicated. Wheelchair rugby as a relatively young game without any equivalent among team games for the able-bodied, has limited possibilities of reliance on any commonly applied game efficiency assessment tools. So far the only attempt at evaluation of wheelchair rugby game efficiency has been a study by Molik et al. [11]. The present research confirms the problem of appropriate choice of assessment tools in sports for individuals with disability, which has been earlier discussed in the cases of some more developed team games for individuals with disability [17–24]. Objective methods of assessment of player and team behavior during the game are still being sought in wheelchair basketball [17–20], standing volleyball [21] and sitting volleyball [22–24]. They are to determine the level of game efficiency in relation to players’ functional levels, which in consequence should contribute to the improvement of sport proficiency of these Paralympic sport events.

In the present study the assessment of game efficiency in wheelchair rugby focused on an analysis of six parameters (played time, sum of all points scored, assist passes, assist blocks, turnovers and steals). Played time (T) was not a statistically significant parameter discriminating between players from the groups studied (Tab. 2). The longest time on the court was spent by 2.5 and 2.0 class players, followed by 0.5, 1.0 and 1.5 class players and 2.0, 2.5, and 3.0 and 3.5 class players. Perhaps, the selection of world top players rather than European elite players only can serve as an explanation. One should not exclude either the impact of the dynamic development of wheelchair rugby over the last three years resulting in certain specializations of athletes. Also the expanded range of disability types of top players. Perhaps two separate study groups might have confirmed certain similarities in game efficiency between the 1.5 class players and 2.0, 2.5 and 3.5 class players as well as between 2.0 and 2.5 class players and 3.0 and 3.5 class players.

In terms of sum of all points scored (PT) all the study groups differed significantly, apart from differences between groups I and II. It comes as no surprise since 0.5, 1.0 and 1.5 class athletes usually fulfill the role of blockers during offensive parts of the game. Due to their considerable limitation of hand function the low-pointers (0.5–1.5 points) are not major ball handlers and rather assist their high-point class teammates (2–3.5 points). Thus the statistically significant differences between 0.5, 1.0 and 1.5 class players and 2.0, 2.5, and 3.0 and 3.5 class players seem to be justified. The noted significant difference between players from group III (2.0 and 2.5 points) and IV (3.0 and 3.5 points) may derive from the coaches’ tactical suppositions that the players from classes 3.0 and 3.5 are more likely to score points than their teammates from classes 2.0 and 2.5. On the other hand, the difference in the sum of scored points seems to confirm that functional differences between the IWRF point classes are reflected in game efficiency. The present research findings do not support the study results of Molik et al. [11], who failed to show statistically significant differences in the sum of scored points between 1.5 class players and 2.0, 2.5, 3.0 and 3.5 class players as well as between 2.0 and 2.5 class players and 3.0 and 3.5 class players. Perhaps two separate study groups might have confirmed certain similarities in game efficiency between the 1.5 class players and higher class athletes. The observed discrepancies between our results and those of Molik et al. [11] are hard to explain. Perhaps, the selection of world top players rather than European elite players only can serve as an explanation. One should not exclude either the impact of the dynamic development of wheelchair rugby over the last three years resulting in certain specializations of athletes. Also the expanded range of disability types of top world wheelchair rugby players might have affected the research results. There has been an observable increase in the number of wheelchair rugby athletes with tetra-equivalent function (e.g. four limbs amputations, cerebral palsy) usually assigned high-point classes. For instance, each athlete with tetraplegia experiences problems with trunk stability while sitting, which is not usually the case with amputees or athletes with cerebral palsy.
The analysis of assist passes (AS) revealed statistically significant differences between all the study groups, apart from those between groups I and II, and III and IV. Like in the sum of scored points, the lack of differences between players fulfilling the roles of blockers (0.5, 1.0 and 1.5 points) seems justified. The lack of statistically significant differences between groups III and IV can be explained by the limitations related to the applied statistical methods requiring correction of the level of statistical significance. Although the difference in assist passes between groups III and IV was not significant at $p \leq 0.002$, it amounted to $p = 0.009$. On the other hand, the lack of differences between high-pointers was confirmed in Molik et al. [11]. Moreover, both studies also revealed significant differences in the number of assist passes between players from classes 0.5 and 2.0; 2.5, 0.5 and 3.0 and 3.5; 1.0, 1.5 and 2.0, 2.5; and between 1.0, 1.5 and 3.0, 3.5. An analysis of the number of assist passes from the 2005 European Championships revealed a significant difference between the 0.5 and 1.0 class players.

It is a curious observation taking into account the functional ability and the predominantly defensive role of these class players on the court. The noted difference could have resulted from the large differentiation of results in 0.5 and 1.0 players studied by Molik et al. [11] as confirmed by the means and standard deviation values obtained ($\bar{x} = 0.06$, $SD = 0.13$ and $\bar{x} = 1.11$, $SD = 1.02$, respectively). The lack of significant differences in the number of assist passes between groups III and IV is most certainly due to the specific nature of wheelchair rugby. The players from these two groups usually serve as ball handlers on the court, as opposed to their teammates whose functional limitations may involve a serious risk of losing the ball. It should be noted that in combination with the sum of scored points the athletes from classes 2.0–2.5 concentrate on handling the ball, by – for instance – making the final pass before scoring a goal. The functional limitations on the other hand (e.g., slower wheelchair pushing) affect negatively the sum of scored points. The 3.0–3.5 class rugby players with much stronger upper body muscles are usually much faster ball handlers and playmakers.

Assist block (AB) is a parameter determining the efficiency of offensive play without the ball. An assist block is attributed to a player who blocks an opponent with his wheelchair, in a way that leads to scoring a goal by his teammate (for a goal to count, two wheels of the player’s wheelchair must cross the line while the player has possession of the ball). The statistically significant differences in the number of assist blocks were only found between players from groups III and IV. The analysis of mean values revealed a large, but non-significant difference between the results from groups II and IV ($p = 0.003$). The lowest results attained by the most functionally able athletes confirm that their role in offensive play is ball handling allowing crossing the opposing team’s goal line and scoring a point. On the other hand the low-pointers, due to their functional limitations, are almost as active as high-point counterparts (2.0–2.5 points) playing without the ball. Assist block seems to be an important parameter, which can contribute to further defining of parameters determining game efficiency of 0.5–1.5 class players. Molik et al. [11] did not analyze the number of assist blocks as they were not considered to be a reliable parameter.

In terms of the number of turnovers (TO) significant differences were found between all the study groups apart from those between I and II, and III and IV. The obtained results are confirmed by earlier studies showing that the 0.5, 1.0 and 1.5 class wheelchair rugby players are usually blockers on the court, whereas players representing classes 2.0, 2.5 and 3.0 and 3.5 are mostly ball handlers and equally risk loss of ball possession. Molik et al. [11] did not find any statistically significant differences between the 1.5 (constituting a single group of subjects with 1.0 players in the present study) and 2.0–2.5 class players.

The numbers of steals (ST), i.e. ball interceptions, differed significantly only between players from group I and players from groups III and IV. The high-pointers are generally more predisposed to perform successful steals on the court owing to their better functional grip and trunk control. The surprising lack of differences between the players from group II and players from groups III and IV can be due to large differences in results in group II ($\bar{x} = 0.61$, $SD = 1.00$). However, steals tend to be more successful if performed by high-point class wheelchair rugby players. Similar results were reported by Molik et al. [11] in their analysis of steals.

It was also assumed that the level of game efficiency would be determinate by player classification, i.e. high-pointers (with greater functional abilities) would represent a higher level of game efficiency. The total analysis of six parameters of game efficiency revealed a significant impact of functional abilities on the efficiency of players of all classes (with the exception of classes 0.5–1.5). A similar game efficiency level between the low-point class players was not, however, significantly
correlated with their functional abilities. On the other hand, the research results obtained should constitute an important guideline to team coaches, who should use similar training loads and tasks with the wheelchair rugby players of classes 0.5–1.5. The study results reveal a significant impact of functional abilities on game efficiency of players of the other IWRF classes. The diverse levels of game efficiency should be an indication to wheelchair rugby coaches to continue further specialization of their players. It can be observed that three game efficiency parameters (AS, PT, ST) show that high-pointers tend to achieve a higher level of game efficiency; however, some of the noted differences were not confirmed statistically. The higher number of turnovers (TO) points leads up rather to a higher activity level of high-pointers as ball handlers than to a lower level of game efficiency. The number of assist blocks (AB) seems, in turn, to confirm a certain specialization of low-point class players as blockers. The above analysis of game efficiency parameters shows a similar number of scored points and assist passes among the participants in the European Championships and Paralympic Games. The results in particular groups (based on players’ functional abilities) were also similar. On the other hand, high-point class wheelchair rugby athletes taking part in the European Championships achieved more turnovers and steals per game (1.75–2.94 and 3.05–5.01, respectively) than the participants of the Paralympic wheelchair rugby competition (0.76–1.18 and 2.35–2.84, respectively). An unambiguous interpretation of these results is rather difficult. The higher numbers of steals and turnovers at the European Championships can result from offensive players’ own mistakes (e.g. wheelchair and ball mishandling), which can be confirmed by the lower level of training of European rugby wheelchair players. But it can also be indicative of effective defense play of European athletes, whose active and creative play as well as anticipatory skills make their opponents lose ball possession more often on the court. This way it could also be a confirmation of a higher level of game efficiency of European wheelchair rugby players. In other words, a clear and objective assessment of differences in game efficiency, using the existing methods is not possible.

It should be kept in mind that following the statistical requirements for paired tests between groups I–IV in post hoc analysis the level of statistical significance for each Mann–Whitney test was set at \( p \leq 0.002 \). It then decreased the number of statistically significant differences between the studied groups. At the same time large standard deviations were noted for many parameters, which was indicative of a large differentiation between results in particular groups (I–IV).

**Conclusions**

The above analysis of game efficiency of wheelchair rugby players from different IWRF classes seems particularly important with regard to changes in the wheelchair rugby rules introduced after the Beijing 2008 Paralympics [25]. According to the new regulations, a team has 12 seconds to advance the ball from their back court into the front court (15 seconds according to the old rules). Also a team in possession of the ball has a total of 40 seconds to score a point or concede possession (there are no such stipulations in the old regulations). The new changes are controversial since there is a certain risk that low-point class players (0.5 and 1.0 points) might not be able to take active part in offensive play within the designated limit of 40 seconds and to maintain the dynamic pace of the game. It may – in a sense – lead to some coaches’ “discrimination” against the low-pointer, for whom a more optimal team on the court will comprise players from classes 1.5–3.5. The new regulations can most likely contribute to an increase in popularity of wheelchair rugby low-point tournaments (classes 0.5–1.5), in which the total classification value of all players on the court for a team at one time cannot exceed three and half points. In the long term it can lead to a split in the sport of wheelchair rugby. The new rules are also highly controversial from the standpoint of the main principle of sports for individuals with disability which should guarantee a chance to participate in sports for athletes with different types and severity of disability on equal terms. It should also be remembered that wheelchair rugby was developed by athletes with cervical spinal cord injuries for whom the pace of wheelchair basketball was too fast. The increase in the attractiveness and dynamics of wheelchair rugby resulting from the new rules could be made at the expense of those for whom the game was originally developed. The game efficiency analysis of wheelchair rugby athletes playing according to the new rules should an implication to undertake further research. Future studies into game efficiency of athletes taking part in the World Championships in Vancouver in 2010 and Paralympics in London in 2012 according to the new rules may bring some interesting results.

Another area of studies is assessment of team game efficiency and determination of the most decisive pa-
rameters of sport success in present-day wheelchair rugby at different competition levels. Differentiation of certain technical and tactical actions seems necessary as well. For example, a loss of ball possession can be a result of a player’s error or the opponent’s effective defensive play. The solution to these problems, however, requires further research allowing designing objective game parameters involving praxeological criteria (efficiency, reliability or economy) and expert opinions.

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References


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