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**Original Article**

# Intensity of training load in various forms of small-sided games in soccer

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**Abstract**
The aim of this study was to point out to the difference between the internal load of soccer players in individual variations of small sided games with various ratio of load interval and rest load. We assumed that the ratio of load interval and rest interval are significantly affecting the internal response of players´ organism in small-sided games. The research group consists of 8 players (n = 8) from the DAC 1904 Dunajská Streda U15 category. We can state on the basis of ascertained data that with lowering of the rest interval length had the average values of HR in the SSG increased. The highest achieved average value of heart rate of the observed players was recorded in SSG3. It was 177.6 ±9.9 beats.min$^{-1}$. The significant differences of heart rate was ascertained between SSG1 and SSG2, SSG1 and SSG3, SSG2 and SSG3 ($p < 0.01$).
**Key Words***:* soccer, training load, heart rate, small-sided games

**Introduction**

The overall development of contemporary soccer influences the quality of the systematic training process level. Increasing the level of training process brings with it significant questions, such as optimization and intensification of the soccer players´ training load.

In premeditated training process of soccer players have a dominant position the small-sided games with different modifications. By means of the small-sided games it is possible to increase the level of skill potential and fitness capacity of players. During small-sided games have to players deal with various complex game situations under time-space deficit and under constant pressure of the opponent. The conditions in the small-sided games are becoming very identical with the soccer match conditions.

Through a systematic training process can be the adaptive capabilities of player´s organism to the load increased. The players will have to deal with them in the game itself or rather in a competitive match (Holienka 2004). Training process is focused on the creation of specific player´s adaptations caused by repeated stimuli of adaptation (Holienka 2012).

If the training stimuli are apportioned deliberately and purposefully then they are contributory to the development, increase, stabilization and maintenance of the training experience condition of a player. In this case we speak about the training load (Kačáni 2005).

Holienka (2012) claims that the indicators of internal load, heart rate included, enable to determine an efficient measure of training load intensity. Heart rate measuring devices can record HR values precisely and reliably. They provide accurate information on the current response of player´s organism to the training load (Babic et al. 2018).

Holienka (1998) claims that the current required principle in soccer training process – all with a ball – fulfils the game training. The dominant position in it have the small-sided games, which contain a wide range of such game situation that are similar to the real game situations during a match. Ideally, the training process has to contain such small-sided games, where the physiological curve moves at the level of the anaerobic threshold.
The small-sided games are widely used in soccer practice (Clemente et al. 2012). SSGs allows the players to gain experience, because they have to deal with the game situations, which occur during matches.
When solving the various complex game situations during trainings, players are able to improve their technical, tactical und fitness aspect of their game preparedness and their mental resistance as well.
Kačáni (2015) divides the small-sided games according to the number of players into 3 groups:

1. group = SSSG – small (1-on-3 players)

In small forms of SSG (1-on-1 to 3-on-3) is the training load often higher than the competitive soccer match load.

2. group = MSSG – medium (4-on-6 players)

In medium forms of SSG (4-on-4 to 6-on-6) is the training load at the same level of intensive load as during the soccer matches.

3. group = LSSG – large (7-on-9 players)


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In large forms of SSG (7-on-7 to 9-on-9) is the load in training process at the level of the real load during a soccer match. Soccer coaches can influence the intensity of training load in small-sided games in case that they act adequately with the variables, which are affecting the intensity of small-sided games. The variables include: size of the soccer field, number of players, encouraging by coach, presence of goalkeepers, game rules, size of the goal, number of goals, load interval and rest interval (Owen et al. 2004; Rampinini et al. 2007; Hill-Haas et al. 2011; Evangelos et al. 2012; Köklü et al. 2013).

**Material & methods**

In our research we focused on assessing the possible changes in heart rate. The research group consisted of soccer players (n = 8) from FC DAC 1904 Dunajská Streda U15. The average age of observed players was 14.5 ±0.53, with the average maximum heart rate ($HR_{max}$) 202.0 ±6.6 beats per minute. The $HR_{max}$ was calculated using field test by Hipp (2007). During testing have to the tested sportsmen run 50 metres in a defined area, which they will be overcoming with various intensity. The test includes 6 repetitions in every single set of run. Players went through 4 sets and in each one of them was the intensity gradually increased to the maximal subjective intensity.

The test included:

Field width run (50 m)

- low-intensity run (warm-up) – 120-130 BPM – 6 times,
- medium intensity run – 130-150 BPM – 6 times,
- submaximal intensity run – 150-170 BPM – 6 times,
- maximal (subjective) intensity run – once.

There was a 30 seconds rest interval between the repetitions and 60 seconds between the sets. According to the maximal heart rate ($HR_{max}$) we determined 5 load zones. These zones were determined on the basis of level of difficulty, which were defined by percentages of the $HR_{max}$ values.

**Table 1** Intensity zones of load according to the heart rate (Moravec et al. 2007)

| **ZONE** | **% from $HR_{max}$** | **Character** |
|---|---|---|
| Zone 1 | 50 – 59 % | very low intensity |
| Zone 2 | 60 – 69 % | low intensity |
| Zone 3 | 70 – 79 % | medium intensity |
| Zone 4 | 80 – 89 % | submaximal intensity |
| Zone 5 | 90 – 100 % | maximal intensity |

The research situation represented an examination of individual selected physiological and functional load indicators. In this case, it concerned the heart rate of soccer players by various parameters of small-sided game. A dependent variable is the internal load of player´s organism, expressed by the heart rate level and independent variable was the ratio of load interval to the rest interval.

The research group consisted of 8 players (n = 8) from FC DAC 1904 Dunajská Streda. These players are playing the First League of U15, the highest competition of this age group in Slovakia.

The main method to acquire the data used during this research was heart rate (HR) measurement. First of all, we ascertain the values of maximal heart rate ($HR_{max}$) using the field test of Hipp (2007). After measuring the $HR_{max}$, we created 5 load zones according to the difficulty, which we defined by percentages of $HR_{max}$. To measure the heart rate was used the set of sports testers POLAR TEAM 2 PRO. The calculation of the percentage and time representation of HR values was done by using a special program and software.

The head coach divided the players into two teams (4:4) according to the player's performance-related level. The players remained in the selected team during all three variants of the small-sided game. Goalkeepers did not have the sports tester on them, since we did not monitor the level of their heart rates.

The playing field had the size of 20 x 30 meters, 600 $m^2$ and was marked out with cones. The portable goal had standard size, the height of 2.44 meters and width of 7.32 meters.

The small-sided games were prepared 9 balls, 6 of them spread around the field, 2 of them were in goals and with one of them played the players soccer. The spare balls were also there in case that the ball would leave the playing field, so the game could continue with another one. In this way, we tried to ensure the continuity of the game and to maintain the load intensity of players. There was a minimum of coaches´ interference in game with verbal instructions, but players could verbally encourage with the aim to maintain the intensity of small-sided game.

The heart rate in small-sided games was measured with various parameters. We chose 3 variants of the small-sided game, which differ from themselves in the ratio of load interval to rest interval, with stable number of players (4:4 with 2 goalkeepers) and with fixed rules.

The size of the playing field was 20 x 30 meters. During the small-sided games took the players 4 repetitions of the load interval (LI), which lasted 2 minutes. The rest interval (RI) had in each variant a different lengths with an active character. In SSG1 was the ration of LI to RI 1:2. In SSG2 was the ratio 1:1 and in SSG3 was the ratio 1:0.5.

The one-way ANOVA and Bonferroni post hoc test were used to determine the statistical significance of HR. The level of statistical significance was set at 5 % level. The results were interpreted, compared and we also found the connections between them. On the basis of these data, we formulated conclusions and recommendations for the training practice.

**Results**

In this study was monitored the internal response of soccer players´ organism, which was expressed by the level of heart rate. We have detected the minimal, average, maximal values of heart rate and time spent by the players in each load zone.

**Table 2** Variants of small-sided games

| SSG | Player | GK | Field dimensions | | Field area | Area/ player | Batch load | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | (n = 8) | (n = 2) | Width [m] | Lenght [m] | [$m^2$] | [$m^2$] | LI [min.] | RI [min.] | NR | NS | L [min.] |
| SSG1 | 4/4 | 1/1 | 20 | 30 | 600 | 75 | 2 | 4 | 4 | 1 | 8 |
| SSG2 | 4/4 | 1/1 | 20 | 30 | 600 | 75 | 2 | 2 | 4 | 1 | 8 |
| SSG3 | 4/4 | 1/1 | 20 | 30 | 600 | 75 | 2 | 1 | 4 | 1 | 8 |

The teams played in a defined area (20 x 30 m) with unrestricted number of ball contacts. The playing field was divided into 2 halves. The goal was valid only when the players made between themselves at least 3 passes and 3 players of the attacking team had to be on the opponent´s half of the field. If the ball crossed the playing field over the side line, then the team play the ball with foot from the place, where the ball has left the field. If the ball has got outside the playing field over the goal line, then the ball had a goalkeeper and could start a new attacking (offensive) game or the opponent had the advantage of a corner kick. After a goal was scored, the game started with the goalkeeper of a team that did not score the goal. This team remained after the goal in the attacking phase of game. The "offside rule" did not apply for the opponent.

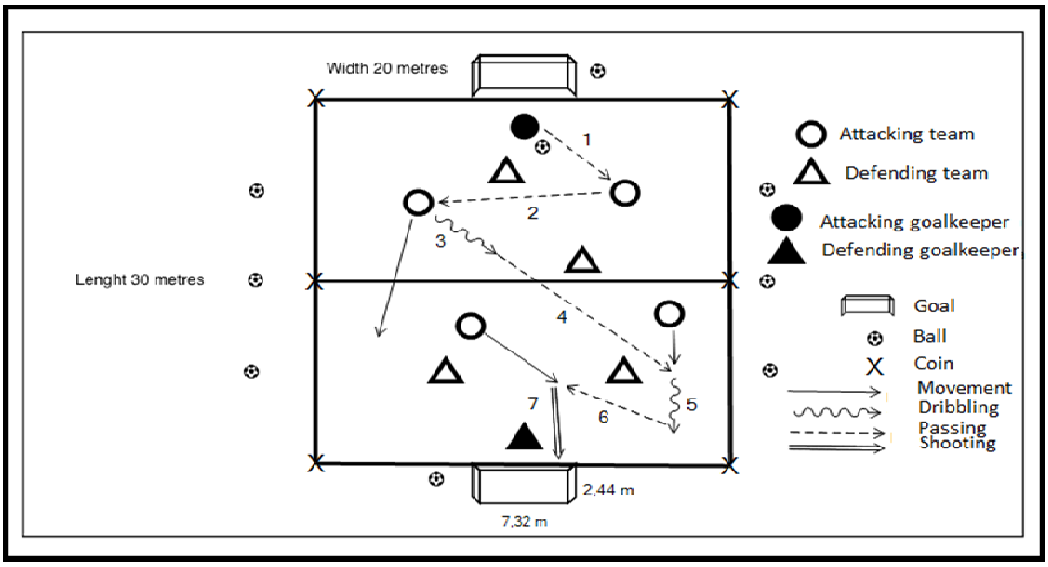


**Fig. 1** An example of a possible way how to score a goal in the small-sided game

**The internal response of players´ organism to load in SSG1**

The small-sided game (SSG) took 24 minutes in total and the net load time was 8 minutes. The load interval (LI) took 2 minutes and the rest interval (RI) was 4 minutes. The ratio of batching between LI and RI was 1:2. The internal response of players´ organism to load in SSG is stated by the values of heart rate (HR).

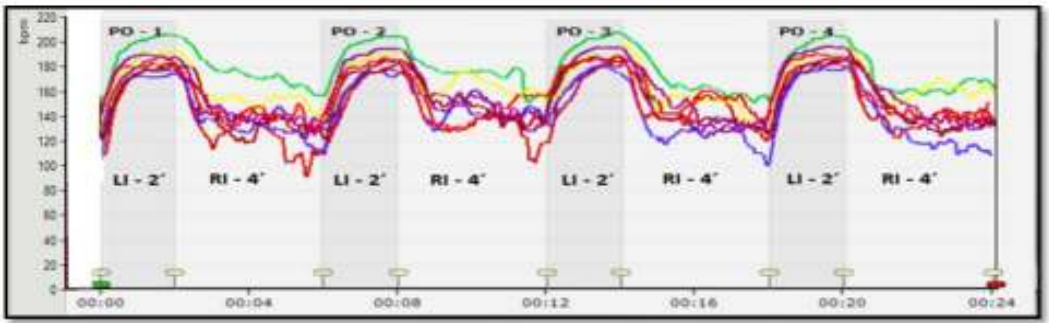


**Fig. 2 Physiological curve of the monitored players in SSG1**

In above stated Fig. 2 is a physiological curve of the monitored soccer players during the SSG1 to be seen. On this physiological curve are 4 repetitions of LI and RI. Physiological curve is representing the internal response of players´ organism to the load in SSG1.

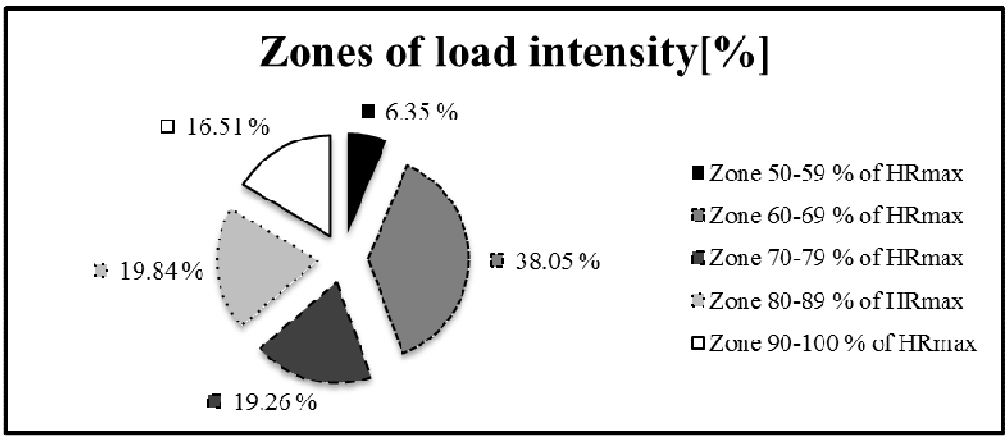


**Fig. 3** Abidance of players in each zone of load intensity in SSG1

In terms of dwell time in the individual zones of load intensity during SSG1 remained the players the longest time in the low intensity load zone (zone 60-69 % of $HR_{max}$). The average time was 0:09:11 ±0:01:09 minutes (38.05 % of SSG1 duration). The shortest time spent players in the zone of very low load intensity – this zone is sufficient to accelerate the regeneration (zone 50-59 % of $HR_{max}$), average 0:01:31 ±0:01:05 minutes (6.35 % of SSG1 time). The zone of maximal load intensity covered the players on average in 0:03:59 ±0:02:41 minutes (16.51 % during SSG1). On average spent players above ANP 0:04:55 ±0:02:35 minutes (32.58 % during SSG1). In rest intervals was used the active rest during which the players juggled with balls. The player´s organism was able to regenerate sufficiently during the rest interval, which lasted 4 minutes. The values of HR were before beginning of the LI below the level of 120 beats.min$^{-1}$.

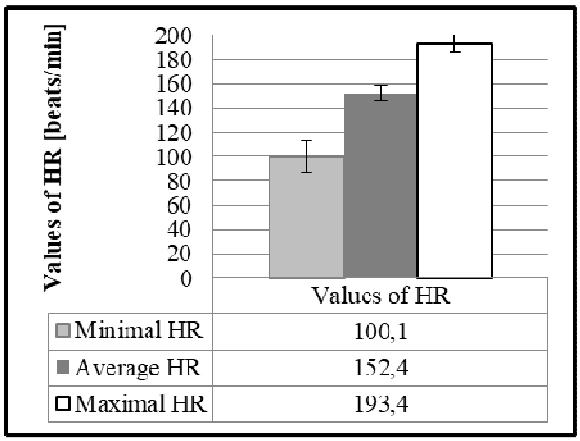


**Fig. 4** Average values of players´ HR in SSG1

The measured value of $HR_{min}$ achieved by players in SSG1 was 100.1 ±13.01 beats.min$^{-1}$. The average HR value of monitored players was during the entire SSG 152.4 ±6.5 beats.min$^{-1}$. The average value of $HR_{max}$ was 193.4 ±7.3 beats.min$^{-1}$.

**The internal response of players´ organism to load in SSG2**

The small-sided game took 16 minutes of which the net load time was 8 minutes. The load interval lasted 2 minutes, the rest interval also 2 minutes. The ratio of batching LI:RI was 1:1.

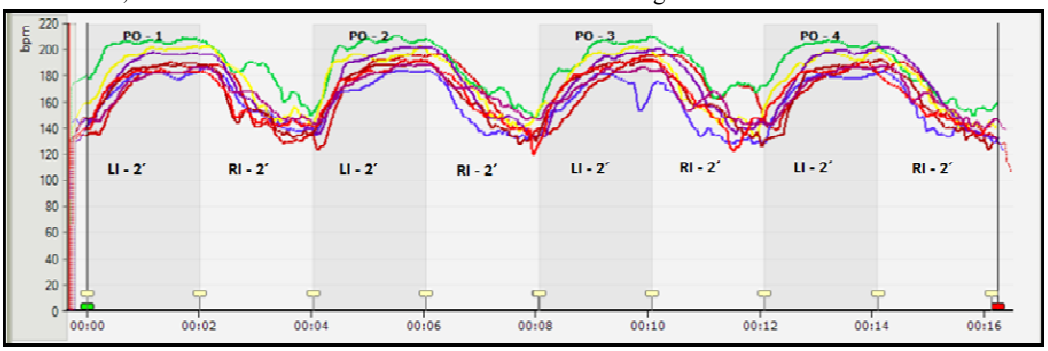


**Fig. 5 Physiological curve of the monitored players in SSG2**

In above stated Fig. 5 are physiological curves of monitored soccer players during SSG2 to be seen. On this physiological curve is a graphic illustration of soccer players´ load during SSG2 with four different vertices, which represent 4 repetitions with the ratio of LI to RI at the same level.

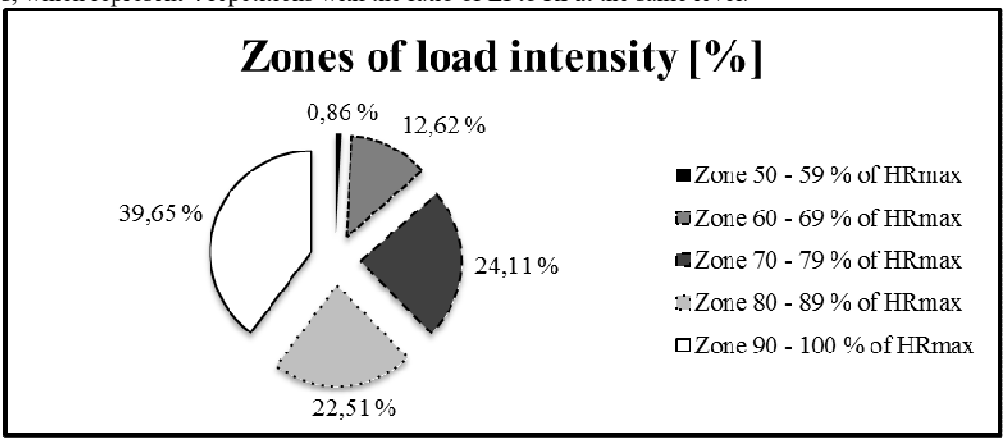


**Fig. 6** Abidance of players in individual zones of load intensity in SSG2

In terms of dwell time in individual zones of load intensity during SSG2 remained the players the longest time in the maximal intensity load zone (zone 90-100 % of $HR_{max}$). The average time was 0:06:24 ±0:01:52 minutes (39.65 % of SSG2 duration). The shortest time spent players in the zone of very low load intensity (zone 50-59 % of $HR_{max}$), average 0:00:09 ±0:00:01 seconds (0.86 % of SSG2 time). The shorter rest interval did not enable the players to spent more time in zone that would be sufficient in order to speed up the regeneration/rebuild. On average spent the players above ANP 0:05:14 ±0:02:35 minutes (32.59 % during SSG2).

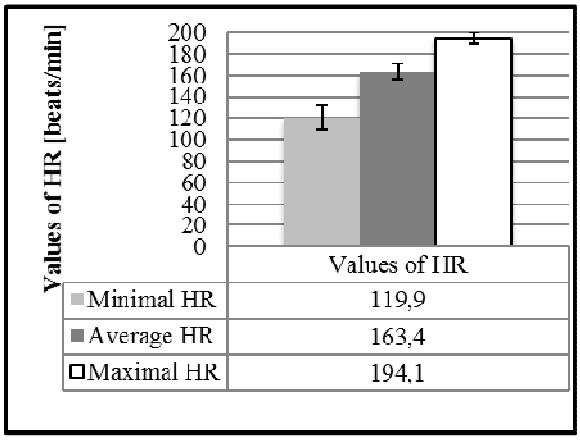


**Fig. 7** Average values of players´ HR in SSG2

The measured value of $HR_{min}$ achieved by players in SSG2 was 119.9 ±11.3 beats.min$^{-1}$. The average HR value of monitored players was during the entire SSG2 163.4 ±7.4 beats.min$^{-1}$. The average value of $HR_{max}$ was 194.1 ±5.5 beats.min$^{-1}$.

**The internal response of players´ organism to load in SSG3**

The small-sided game took 12 minutes and the net load time of it was 8 minutes. The load interval lasted 2 minutes, the rest interval 1 minute. The ratio of batching LI:RI was 1:0.5.

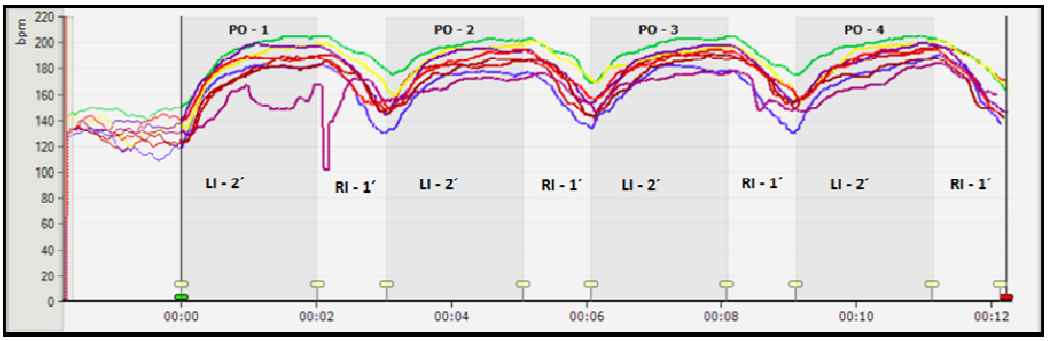


**Fig. 8** Physiological curve of monitored players in SSG3

In above stated Fig. 8 is a physiological curve of monitored soccer players during SSG3, which refers to the regularity of load in four repetitions during entire SSG3.

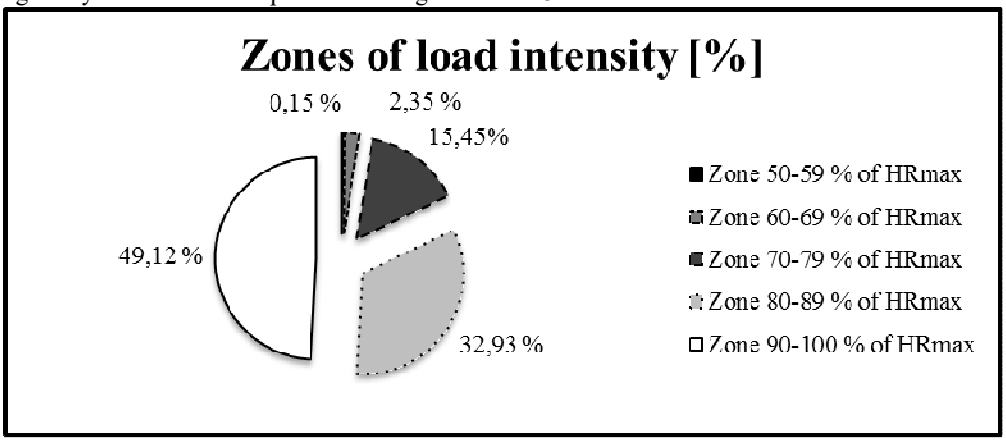


**Fig. 9** Abidance of players in individual zones of load intensity in SSG3

In terms of dwell time in individual zones of load intensity during SSG3 remained the players the longest time in the maximal intensity load zone (zone 90-100 % of $HR_{max}$). The average time was 0:05:58 ±0:02:41 minutes (49.12 % of SSG3 duration). The shortest time spent players in the zone of very low load intensity (zone 50-59 % of $HR_{max}$), average 0:00:01 seconds (0.15 % of SSG3 time). On average spent the players above ANP 0:06:51 ±0:02:46 minutes (56.38 % during SSG3).

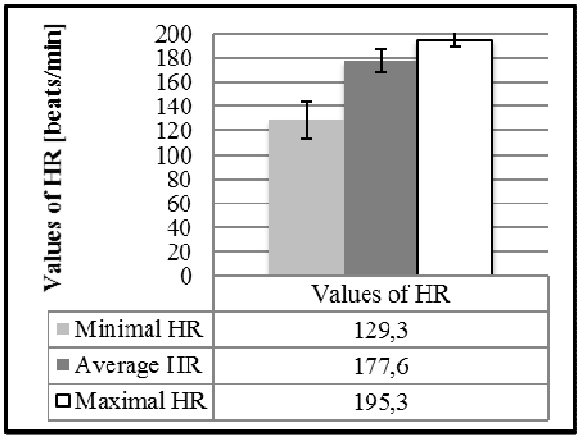


**Fig. 10** Average values of players´ HR in SSG3

The measured value of $HR_{min}$ achieved by players in SSG3 was 129.3 ±15.4 beats.min$^{-1}$. The average HR value of monitored players was during the entire SSG3 177.6 ±9.9 beats.min$^{-1}$. The average value of $HR_{max}$ was 195.3 ±6.8 beats.min$^{-1}$.


**Fig. 11** Values of HR achieved in different forms of SSG

From Fig. 11 is obvious that with the decreasing rest interval the average values of HR increased. In SSG1, when the ratio of LI to RI was 1:2, the average values of HR were the lowest. The duration of RI was 4 minutes and LI lasted only 2 minutes, which means that the player´s organism had enough time to recover. The highest intensity was ascertained in SSG3, when after the 2 minute LI followed only 1 minute RI. This variation of ratio of LI to RI was more difficult for the players´ cardiovascular system.

**Table 3** Average values of HR

| | **test** | **SSG1 W:R - 1:2** | **SSG2 W:R - 1:1** | **SSG3 W:R - 1:0,5** |
|---|---|---|---|---|
| **Player** | **$HR_{max}$** | **$HR_{avg}$** | **$HR_{avg}$** | **$HR_{avg}$** |
| Player 1 | 194 | 177 | 160 | 148 |
| Player 2 | 198 | 167 | 157 | 143 |
| Player 3 | 209 | 193 | 161 | 152 |
| Player 4 | 210 | 186 | 171 | 159 |
| Player 5 | 207 | 183 | 171 | 162 |
| Player 6 | 193 | 173 | 165 | 151 |
| Player 7 | 201 | 179 | 161 | 157 |
| Player 8 | 204 | 163 | 155 | 147 |
| ***Me*** | 202.5 | 178 | 161 | 151.5 |
| ***M*** | 202 | 177.6 | 163.4 | 152.4 |
| ***SD*** | 6.59 | 9.89 | 7.37 | 6.50 |
| ***min*** | 193 | 163 | 155 | 143 |
| ***max*** | 210 | 193 | 177 | 162 |
| ***Vr*** | 17 | 30 | 22 | 19 |

On the basis of one way ANOVA results, there was a statistically significant difference in heart rate after participating in small-sided games with various ratio of load interval and rest interval ($F$ = 53.608; $p$ < 0.01). Concerning the differences in heart rate between individual small-sided games, the statistical significance was between the SSG1 and SSG2 ($T$ = 6.3499; $p$ < 0.01). It was probably caused by the fact that the ratio of LI to RI did not significantly influence the average HR values.

In SSG1 we found out a statistically significant lower values of average HR than in SSG3 ($T$ = 10,2576; $p$ < 0.01). This significant difference can be explained as follows: in SSG3 with the batching ratio of LI and RI 1:0.5 was only 1 minute break and the value of HR did not decrease to low values.

We found out a statistically significant differences in HR average values between SSG2 and SSG3 ($T$ = 3.9076; $p$ < 0.01). The difference between the values of average HR was 14.2 beats.min$^{-1}$.

In these variations of SSG had the rest interval a shorter duration and the values of HR did not decrease to low values.

**Dicussion**

Heart rate is a generally accepted and often used physiological indicator of the players´ physical activity in the training process (Holienka 2016; Holienka & Cihová 2016). When speaking about the results obtained from sports testers, one has to respect the fact that the HR values showing the training load intensity of soccer players´ organism in different forms of small-sided games are only indirect indicators.

The duration of the time that players spent in the zone of maximum intensity was the most intense in SSG3, the most time moved the players in this zone (49.12 %). The longest time in the zone of submaximal load intensity was recorded in SSG3 as well (32.93 % of the total load time). In SSG1 spent players the shortest time in the maximum intensity zone, it was only 16.51 %. In this variant had the players a rest interval of 4 minutes, therefore they spent the longest time in a low load zone (zone 60-69 % of $HR_{max}$) - 38.05 % of SSG1 duration.
On the basis of the obtained and evaluated data, we can assert that the small-sided game with the batching ratio of LI 1 to RI 0.5 was, in terms of the achieved HR values and also in terms of time spent in individual load zones of $HR_{max}$, the most intense. Players have spent in this small-sided game variation the most time in the submaximal and maximum intensity zone, which are for the soccer match and a systematic training process, in terms of load intensification, restrictive. From the physiological point of view of the player's load was this variation the one closest to the competitive match conditions.

| AUTHOR (YEAR) | AVERAGE HR [beats/min] | TYPE OF MATCH |
|---|---|---|
| Bangsbo et al. (1991) | 164 | competitive |
| Florida-James & Reilly (1995) | 165 | competitive |
| Thatcher & Batterham (2004) | 166 | competitive |
| Helgerud (2001) | 171 | competitive |
| Capranica (2001) | 180 | competitive |
| Krustrup (2006) | 156 | pre-season |
| Reilly (1996) | 157 | pre-season |
| Frýbort et al. (2011) | 158 | pre-season |
| Seliger (1968) | 165 | pre-season |
| Van Gool et al. (1988) | 166 | pre-season |

The average HR values obtained in individual forms of SSG are at the same level as those found in matches of different types. The achieved HR values in SSG1 are identical to the mean HR values measured during pre-season matches (Reilly 1996; Krustrup 2006; Frybort et al. 2011). The average values of HR in SSG2 with the same batching ratio of load intervals and resting intervals are identical to the average values found during both pre-season and competitive matches (Seliger 1968; Van Gool et al. 1988; Bangsbo et al. 1991; Florida-James & Reilly 1995; Thatcher & Batterham 2004). The average values of HR in SSG3 with the batching ratio of LI and RI 1:05 are the same as the HR values measured in the competitive matches (Bangsbo et al. 1991; Florida-James & Reilly 1995; Thatcher & Batterham 2004). These average values of HR in SSG3 are close to the HR values measured in the competitive matches of junior age categories (Capranica 2001; Helgerud 2001). Peráček (2014) mentioned, that the training process must stimulate the energy systems, which prevail in matches. In practice is this criterion replaced by the cognition and adequate batching of length and ratio of load interval and rest interval too. As the results showed, the above mentioned criterion with the batching ratio of LI and RI 1:1 and 1:0.5 can fulfil this criterion. That type of condition we found in the SSG2 and SSG3.
Aktas et al. (2014) found that if the rest interval is shorter, then the intensity of the SSG load is much higher than in case, when the soccer player has more time to recover. In terms of load intensity are the most ideal variants of the SSG the ones with short load interval and also short rest interval (Owen 2016).

In SSG can all age categories develop special endurance and players are in a constant contact with the ball. The soccer players are improving their technical side of the individual game activities, they are participating in the course of the game action, try to predict the actions of the opponent and they react operatively, thus

improving their tactical skills as well. The well-designed small-sided games make it possible for us to direct the soccer players to the goal that we want them to score during the training. However, we should not forget about the proper and optimal batching of loads.

Christopher et al. (2016) claim that the training of soccer players should take into account also the specific technical, tactical and physiological requirements of the individual game performance. As a result, the SSG has become a favourite way in order to increase the level of fitness that imitates the conditions that a player may encounter during the match.

When considering the individual disposition of players, it is very important to adhere to the principle of adequacy when batching the load and rest interval. Holienka (1998) states that inevitable is an adequate application of training load and resting time. In any case, the coach should not be influenced in the training process by the statement "He is young – he can endure it". It is the insensitivity and the inexperience during load batching that have already prematurely ended the sporting activity of many excellent young soccer players.

**Conclusions**

Soccer is developing and advancing unusually fast. It puts higher demands on the coach himself and the entire training process. Purposeful planning, appropriate management and innovative approaches in everyday training activity are the things that lead every coach to the right path to success. The use of modern technologies in trainings, for example sport testers allow the coach to identify the internal response of players organism and receive objective feedback on the adequacy of the training load. Unfortunately, only a few soccer clubs have the option of using such devices that would serve as an aid for improvement of the players' performance level. In our study we tried to expand our knowledge of this not much examined topic. Another aim was to point out to the ideal ratio of load intervals to rest intervals in small-sided games, which reach the intensity of the soccer match load itself.

From obtained data it is possible to state that with the variation of batching ratio of load interval and rest interval were the HR values in individual SSGs different. The most intense it was in SSG3 with ratio LI:RI 1:0.5 where the LI was 2 minutes and RI only 1 minute. During SSG3 achieved the players the highest HR average values. The average values of HR were in SSG2 at a lower level. The lowest HR values were measured in SSG1 – RI between individual repetitions was too long what caused that the average values of HR gradually declined. The theoretical activity of a soccer coach is based on the fact that, according to the physiological laws, he premeditate and prepare the training process in advance. During training have to be observed the rules of the adaptive changes of the soccer players to the training stimuli. In small-sided games is also very important, besides the load interval, the length of the rest interval between repetitions and sets. It is possible to evoke the required functional changes in players´ organism and to prepare the soccer players to handle the load, which prevails in the match. We can achieve it by optimizing the batching ratio of load and rest intervals.

**Recommendations for the didactic theory and training practice**

The monitoring of HR values and the time spent in each zone of load intensity using sport testers provides feedback about the intensity of the training load in the various SSG forms both to the coach and the player. It should be used in the training process on a regular basis, because of the adequacy of the training load.
Our recommendation is to integrate into the systematic training process the small-sided games with the longer load intervals and with shorter rest intervals. The reason is that these place demands on the cardiovascular system of the players and they are similar to the competitive match conditions.

Optimization and intensification of the training load can be adjusted also by load intervals and rest intervals. We recommend to select SSG in a ratio of 1:1 and 1: 0.5 (LI:RI). It will help the players to increase the level of their skills by specific means.

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