Heart Rate Analysis of Semi-elite Female Basketball Players during Competitive Games

Analýza srdeční frekvence basketbalistek během soutěžních zápasů

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Abstract
Knowledge of the intensity of load in basketball appears to be an essential factor in composing an effective training process. The aim of this work is to ascertain whether there are any significant differences in load intensity between player positions and between 1st and 2nd half of the game in female basketball. 10 semi-elite female basketball players were included in this research. Total time of each player, in 3 intensity of load zones, was determined based on their HR_{max}. Differences between the individual player positions or in % of HR_{max} (guards vs. forwards vs. centers; 88.2 ± 3.5 vs. 87.8 ± 3.1 vs. 88.9 ± 3.4) were neither statistically nor practically significant. Moreover, the differences between the 1st and 2nd half in the zones and % of HR_{max} (88.6 ± 3.4 vs. 88.3 ± 3.3) were not statistically significant and the practical significance had small effect. These results can create a solid base for conditioning and also game-based training programs.

Key words
basketball, player positions, intensity of load, total time

Abstrakt
Poznanie intenzity herného zaťaženia sa javí ako nevyhnutný faktor pre zefektívnenie tréningového procesu. Cieľom práce je zistiť, či existujú významné rozdiely v intenzite zaťaženia medzi hráčskymi pozíciami a medzi polčasmi v ženskom basketbale. 10 výkonnostných basketbalistiek bolo zahrnutých do výskumu. Na základe SF_{max} bol každej hráčke určený celkový hrací čas, ktorý odohrali v 3 intenzitných pásmach. Medzi hráčskymi pozíciami nebol zaznamenaný štatistický ani vecne významný rozdiel v žiadnom pásme, ako ani v priemernom % z SF_{max} (88.2 ± 3.5 vs. 87.8 ± 3.1 vs. 88.9 ± 3.4; rozohrávačky vs. krídla vs. pivotky). Medzi polčasmi nebol v pásmach ani v priemernom % z SF_{max} (88.6 ± 3.4 vs. 88.3 ± 3.3; 1. polčas vs. 2. polčas) taktiež zaznamenaný štatisticky významný rozdiel a vecná významnosť poukazuje na malý efekt. Na základe uvedených výsledkov môžu byť koncipované herné a kondičné tréningové programy.

Key words
basketbal, hráčske pozície, intenzita zaťaženia, celkový hrací čas

INTRODUCTION

The concept of sports training in basketball should be based on real game conditions in order to increase athletic performance. According to Drust, Reilly, & Cable (2000), Hoffman (2003), Spencer, Bishop, Dawson, & Goodman (2005) for the training process, and thus the improvement of basketball performance, it is necessary to have knowledge of the physical and physiological demands experienced by the players during competitive matches. Basketball is characterized by its dynamic nature (frequent changes between the offensive and defensive phases of the game), therefore a continuous physical load does not occur. According to numerous authors (Ben Abdelkrim, El Fazaa, El Ati, & Tabka, 2007; Bishop & Wright, 2006; Conte et al., 2015; McInnes, Carlson, Jones, & McKenna, 1995; Scanlan, Dascombe, & Reaburn, 2011), there are intervals within the game where the players

perform at submaximal and maximal intensity and intervals, where the performance is at a moderate or low intensity. Ben Abdelkrim et al. (2007) and Matthew & Delextrat (2009) state that changes in physical activity during a basketball match occurred every 2-3 seconds. The intensity and character of the physical load during a match may, therefore, depend on the frequency of interruptions during the game such as substitutions, free throw shooting, transition phases and other factors. Therefore, the intensity of load is related to the level of effort and to the functional demands of physical activity. As an objective indicator of load intensity seems to be the heart rate (HR) (Achten & Jeukendrup, 2003; Benson & Connolly, 2011).

Analysis of the load intensity in basketball, based on HR monitoring, has been implemented in several studies (Ben Abdelkrim et al., 2007; Hůlka, Cuberek, & Bělka, 2013; Klusemann, Pyne, Hopkins, & Drinkwater, 2013; Matthew & Delextrat, 2009; Rodríguez-Alonso, Fernández-García, Pérez-Landaluce, & Terrados, 2003; Scanlan, Dascombe, Reaburn, & Dalbo, 2012; Vaquera et al., 2008) Ben Abdelkrim et al. (2007) report that the mean HR during a match in the men's U19 category was 91% of HR_{max} and also found significant differences in mean HR between the guards and centers. Scanlan et al. (2012) discovered a slightly lower value of a mean HR 82.4 % of HR_{max} for basketball players at the national level. Similar results are also presented by Vaquera et al. (2008), where a statistically significant difference in % of HR_{max} was found between the guards and forwards and also between guards and centers. Matthew & Delextrat (2009) and Ben Abdelkrim et al. (2010) reported that during a match, players of the female senior category and U19 men's category had a HR above 85% of HR_{max} during 80.4% and 75.3% of their total playing time, respectively.

The aim of this research was to identify the differences in the intensity of the load related to a player's position and halves in the female senior category.

METHODS

Participants: The participants of this research were 10 female basketball players from the 2nd division of the senior female category. Game positions: 3 guards, 4 forwards, 4 centers. The average age was 20.4 ± 2.8 years, the average height 178.5 ± 5.2 cm and the average weight 65.4 ± 5.7 kg. The players have been acquainted with the objective of the study and they have signed the informed consent. **Procedure:** Basketball players were subjected to a beep test (Léger, Mercier, Gadoury, & Lambert, 1988). The heart rate has been monitored with a commercially available telemetric system Suunto Team (Suunto Oy, Vantaa, Finland) during all three matches. The HR scan has been carried out in 2-second intervals. The HR records have been further analyzed by the Suunto Training Manager software. The competitive matches were played according to the FIBA rules for the year 2012/2013 and were captured by a digital camera Canon HG10 (Canon Inc., Tokyo, Japan). The software Dartfish TeamPro 6.0 (Dartfish, Fribourg, Switzerland) (O'Donoghue & Holmes, 2015) has been then used for the digital analysis of the records. The HR values from the total playing time have been used in the result evaluation (Ziv & Lidor, 2009). The total playing time constitutes of the period during which the basketball players were on the field, including the short interruptions of the match, shooting free throws and the time-outs. Substitutions of the players and breaks between the quarters have not been included in the total playing time. The HR has been evaluated in three zones of load intensity according to Ben Abdelkrim et al. (2010): < 85 % of HR_{max}, 85-95 % of HR_{max}, > 95 % of HR_{max}.

Statistical analysis

Differences between the individual player positions were compared in each zone of the intensity of load. In the same manner were compared both halves of the game, not considering the player positions. Results are introduced as mean ± standard of deviation. Data normality was verifies by Shapiro-Wilk's test and the homogeneity of variance by Levene's test. Differences between player positions in 1st, 2nd and 3rd zone were compared by non-parametric test (player positions – Kruskal-Wallis test) and differences between halves were tested by Mann-Whitney U-test. Differences between player

positions in mean HR (% of HR_{max}) were determined by one-way ANOVA and differences between halves by t-test. The results were supplemented by effect size—in Kruskal-Wallis η^2, in ANOVA ω^2 and to compare the halves Cohen's *d* coefficient (Ellis, 2010; Thomas, Nelson, & Silverman, 2011). Level of statistical significance was set to α=0.05 and all tests were calculated in Statistica 12 software (StatSoft, Inc., Tulsa, USA).

RESULTS AND DISCUSSION

Basketball players were active, in average: (a) guards in 1st, 2nd and 3rd zone of the total time 24 ± 19.4 %, 63.7 ± 17.6% and 12.3 ± 13.9 %, respectively and mean HR was 88.2 ± 3.5% of HR_{max}; (b) forwards in 1st, 2nd and 3rd zone of the total time 24.3 ± 12.5 %, 67.9 ± 10.7% and 7.9 ± 10.8 %, respectively and mean HR was 87.8 ± 3.1% of HR_{max}; (c) centers in 1st, 2nd and 3rd zone of the total time 19.8 ± 13 %, 65.9 ± 15.8% a 14.2 ± 16.2 %, respectively and mean HR was 88.9 ± 3.4% of HR_{max} (see Fig. 1).

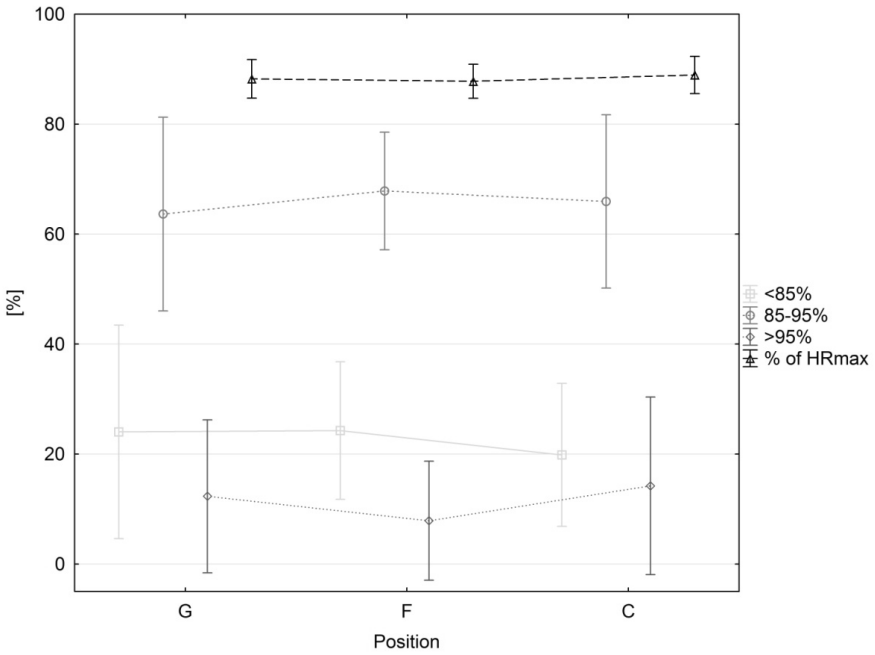

Fig. 1 Mean total time ± SD played in individual zones and mean HR (as % of HR_{max}) of guards (G), forwards (F) and centers (C)

No statistically significant differences between player positions were detected when data from all three zones were compared (in 1st <85% of HR_{max}, in 2nd 85-95% of HR_{max}, and in 3rd >95% of HR_{max}). Effect size had small effect. ANOVA also did not demonstrate any statistically significant differences between player positions in mean HR expressed as % of HR_{max}. The size of effect size had small effect (see Tab. 1). Ben Abdelkrim et al. (2007) state inequality between HR of guards and centers in male U19 category. Significant differences were detected between all player positions in male category by Vaquera et al. (2009). Rodríguez-Alonso et al. (2003) note difference in mean HR between all player positions in female category. Scanlan et al. (2012) present difference in % of HR_{max} between guards (frontcourt players) and forwards along with centers (backcourt players). Some studies, however, introduced comparisons of mean HR in absolute values (beats per minute). Therefore, authors could have reached distorted results since these values do not respect the individuality of each player.

Tab. 1 Comparison of the individual zones and values of % of HR_{max} between the player positions

Zone	Players positions			Statistical significance	Effect size
	guards	forwards	centers		
< 85%	24 ± 19.4	24.3 ± 12.5	19.8 ± 13	$p = 0.268$	$\eta^2 = 0.029$
85 – 95%	63.7 ± 17.6	67.9 ± 10.7	65.9 ± 15.8	$p = 0.774$	$\eta^2 = 0.006$
> 95%	12.3 ± 13.9	7.9 ± 10.8	14.2 ± 16.2	$p = 0.163$	$\eta^2 = 0.041$
% of HR_{max}	88.2 ± 3.5	87.8 ± 3.1	88.9 ± 3.4	$p = 0.349$	$\omega^2 = 0.001$

Time played in the individual zones in both halves is presented in Tab. 2. The results show that the intensity of load in both halves are similar, no statistical or practical significance. Similar values are presented by Rodriguez-Alonso et al. (2003), who note this fact–no difference between halves in mean HR in % of HR_{max}. However, Matthew & Delextrat (2009) state difference between the halves, higher HR was detected in the 1st half. Difference could have been caused by frequent interruptions in the last quarter (time-outs, free throws shooting) in, predominantly, dramatic games.

Tab. 2 Comparison of the individual zones and values of % of HR_{max} in both halves

Zone	1st half	2nd half	Statistical significance	Effect size
< 85%	22.6 ± 15.1	21.7 ± 13.6	$p = 0.866$	$d = 0.063$
85–95%	64.5 ± 16	67.9 ± 12.9	$p = 0.506$	$d = -0.234$
> 95%	12.9 ± 16	10.4 ± 12.2	$p = 0.574$	$d = 0.176$
% of HR_{max}	88.6 ± 3.4	88.3 ± 3.3	$p = 0.649$	$d = 0.089$

Female players were active in 1st, 2nd and 3rd zone in average 22.2 ± 14.4, 66.1 ± 14.6 and 11.7 ± 14.2 % of total time, respectively (see Fig. 2). Mean HR reached 88.4 ± 3.3 % of HR_{max}. Matthew & Delextrat (2009) note similar 80% share of the total time over 85% of HR max in female category. Ben Abdelkrim et al. (2010) present, however, lower share – 75.3% of total time over 85% of HR_{max} in male U19 category. Similar values of mean HR (as % of HR_{max}) state Rodríguez-Alonso et al. (2003) (90.8 % and 94.6 % of HR_{max} in national and international female category) and Matthew & Delextrat (2009) (89.1% of HR_{max} in 1st division national female category). Lower values of mean HR are presented by Scanlan et al. (2012) (71.8% of HR_{max} in regional female category). The given data shows that the physiological demands of a basketball game may depend on age category, level of performance, sex and, probably, on chosen tactics and conditioning performance of players.

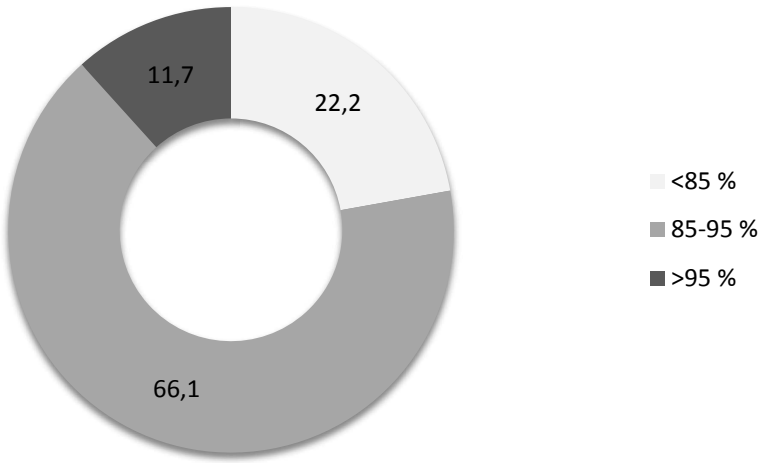

Fig. 2 Total time played in individual zones

CONCLUSION

This study compares different physiological demands of the individual player positions and both halves of the game. Results did not confirm statistically or practically significant differences neither between the player positions nor between the 1st and the 2nd half of the game. This indicates that the physiological demands of competitive games are high regardless the player positions. What should be authoritative for the training process is that the female basketball players were active under 85 % of HR_{max} 22.2 % and over 85 % of HR_{max} 77.8 % of the total time. Physical activity of low and moderate intensity (< 85 % of HR_{max}) is in the ratio to physical activity of submaximal and maximal intensity (>85 % of HR_{max}) approximately 1 : 3.5. The obtained data can be useful when compared to the training process data to optimize the player's performance. Since the load in basketball has an intermittent nature a time-motion analysis should be added to these results (Hůlka et al., 2013; Klusemann et al., 2013).These results can create a solid base for conditioning and also game-based training programs. A higher number of measurements and participants could lead to a more generalized results.

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