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The Intensity of Load Experienced by Female Basketball Players during Competitive Games

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***Abstract*—**This study compares the intensity of game load among player positions and between the 1st and the 2nd half of the games. Two guards, three forwards, and three centers (female basketball players) participated in this study. The heart rate (HR) and its development were monitored during two competitive games. Statistically insignificant differences in the intensity of game load were recorded between guards, forwards, and centers below and above 85% of the maximal heart rate (HR_{max}) and in the mean HR as % of HR_{max} (87.81±3.79%, 87.02±4.37%, and 88.76±3.54%, respectively). Moreover, when the 1st and the 2nd half of the games were compared in the mean HR (87.89±4.18% vs. 88.14±3.63% of HR_{max}), no statistical significance was recorded. This information can be useful for coaching staff, to manage and to precisely plan the training process.

***Keywords*—**Game load, heart rate, player positions, the 1st and the 2nd half of the games.

I. Introduction

BASKETBALL, with its dynamic development of the game, is one of the world's most popular sports. Basketball is characteristic for its simultaneous existence of the cooperation and opposition relationship in either offensive or defensive phase of the game [1]. From a conditioning point of view basketball is a sport with intermittent physical load [2]-[4]. The game includes time-phases in which the players manage distances in movements of various intensities of physical load with irregularly changing intervals of rest. General demands of a basketball game, therefore, require the physiological spread of the physical activity from both aerobic and anaerobic energy systems [5]-[7].

The concept of the whole training process should be based on real game conditions. Ultimately, it is one of the main aspects leading to success. From this point of view, it is necessary to have knowledge of physical and physiological demands of competitive games [8]. Hence, the analysis of internal and external indicators of the physical load emerges as an important prerequisite to increase the efficiency of the training process. The internal indicators of the physical load are most frequently expressed by the heart rate (HR) and the blood lactate concentration. We understand the external load as the distance and speed characteristics (time-motion analysis) of the physical activity. The HR is a noninvasive and the most accessible indicator for evaluation of the physical load of the cardiovascular system, it reacts very sensitively to the increase of the intensity of load, moreover, HR may be monitored repeatedly, without any great financial expenses [9]-[11].

The effectivity of training process, along the progress of players, is related to the specificity of the training stimulus. It means that differences among player positions occur and not only in anthropometric, fitness, physiological, and technical characteristics [12]-[15], but also in physical and physiological demands of competitive games [16]. Therefore, to advance players' performance an individualized training process according to player positions is necessary. On the other hand, also a systematic stimulus of all determinants of players' performance is needed. Based on the monitoring of HR under game conditions, some studies present differences in the intensity of load between the individual player positions [5], [17]. Reference [5] shows statistically significant differences in the mean HR an in the blood lactate concentration between the guards and centers in male U19 category, where the guards reached in both indicators higher values. The mean HR of all basketball players, regardless the player positions, was 91±2% of the maximal heart rate (HR_{max}) of the total time. When the external physical load was compared, significant differences were monitored between the guards and the centers, and between the guards and the forwards. Similar findings are introduced in [17] – the difference in % of HR_{max} between the guards and forwards, and between the guards and centers, in male category. The physical demands of competitive games may also depend on the level of competition. Differences in all movements between elite and sub-elite backcourt and elite and sub-elite frontcourt male basketball players during the game are documented in [18]. The elite backcourt players show significantly higher range of all movements than sub-elite backcourt players (2733±142 vs. 1911±283). As well as the elite backcourt players, the frontcourt players performed significantly more movements than sub-elite frontcourt players (2749±137 vs. 2014±131).

The aim of this study is to compare the intensity of load between the individual player positions in female basketball and between the 1st and the 2nd half of the competitive games.

II. Methodology

A. Subjects' Characteristics

Female basketball players (n=8) of senior category, of the 2nd national division, are the subject of this research. The average age of these basketball players was 20±2.6, the average body height was 179.9±4.5 cm, and the average body weight was 66.8±5.3 kg. Two guards, three forwards, and three centers participated in the monitoring of the HR under

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the game conditions. The players weekly (7 days) completed, on average, 4 training sessions and every other weekend 2 competitive games in their category.

B. Procedure

For the interpretation of the monitored HR values we built on the recommendations of [19], therefore our results relate to the % of HR_{max} – they are expressed in relative values. The HR_{max} of each player was determined by the 20 m shuttle run test [20]. To monitor the HR during the 2 competitive games was used the telemetric system Suunto Team (Suunto Oy, Vantaa, Finland), which consists of the HR recorder with internal memory (Suunto Memory Belts), transmitting antenna for online transmission of data (Suunto Team Pod), and of software programs for interpretation of the data (Suunto Monitor and Suunto Training Manager). System Suunto Team was also used in similar basketball studies [21], [22]. The HR was monitored in 2-second intervals and the belts were in time synchronization with the start of the game. The video camera Canon HG10 (Canon Inc., Tokyo, Japan) was used to record both games. The games were played under the rules of FIBA (2 referees, court dimensions: 28x15 m, 4 quarters: each 10 min, 2 min. break between the quarters, 15 min half-time break). The HR was assessed from the total time [19]. The total time did not include the time spent on the bench and breaks between the quarters, however, time-outs and free-throw shooting was accounted for [23]. Based on the % of HR_{max} was the HR during the games evaluated below the level of 85% of HR_{max} (<85% of HR_{max}) and above and inclusive 85% of HR_{max} (≥85% of HR_{max}) [2], [3].

C. Statistical Analysis

The results are here stated as mean ± standard deviation (SD). The normality distribution of data was verified by Shapiro-Wilk test and the homogeneity of data by Levene's test. After the verification of the normality and homogeneity of data we chose the nonparametric tests of significance to compare the values below and above 85% of HR_{max}. To compare the mean HR as the % of HR_{max} were employed the parametric tests of significance. The differences between the player positions below and above 85% of HR_{max} were compared with the use of nonparametric Kruskal-Wallis test. One-way ANOVA was employed to compare the mean HR as the % of HR_{max}. The differences between the 1st and the 2nd half below and above 85% of HR_{max} were compared by the nonparametric Mann-Whitney U-test. The parametric t-test was used for comparison of the mean HR as the % of HR_{max} values [24]. All tests of the statistical significance were performed in the Statistica 12 program (StatSoft, Inc., Tulsa, USA) on the level of statistical significance α=0.05.

III. Results and Discussion

The monitored female basketball players were active below 85% of HR_{max} as follows: guards 26.96±21.17%, forwards 27.26±15.86%, and centers 20.48±13.68% of total time. Above 85% of HR_{max} were guards active 73.04±21.17%, forwards 72.74±15.86%, and centers 79.56±13.68% of total time (Fig. 1). Kruskal-Wallis test did not prove any statistically significant differences ($p>0.05$), in % of the total time, when the player positions below and above 85% of HR_{max} were compared. The mean HR reached levels: guards 87.81±3.79% of HR_{max}, forwards 87.02±4.37% of HR_{max}, and centers 88.76±3.54% of HR_{max} (Fig. 1). ANOVA did not detect any statistically significant differences ($p>0.05$) of the mean HR (as % of HR_{max}) between the individual player positions. Based on the results it is possible to state that between the player positions, of this age category and of equal level of performance, the differences, from the intensity of load's point of view, are insignificant.

The differences between the player positions in male and also female categories are documented in several studies. Reference [5] determined difference in the mean HR between the guards and the centers and between the guards and the forwards in the male U19 category. Reference [17] also states a difference in % of HR_{max} between the guards and centers and between the guards and forwards in the senior male category. Reference [25] noted the difference in the mean HR between the guards and forwards, the forwards and centers, and the guards and centers in the senior female category. The difference in % of HR_{max} between the guards (frontcourt) and forwards plus centers (backcourt) is presented in [4].

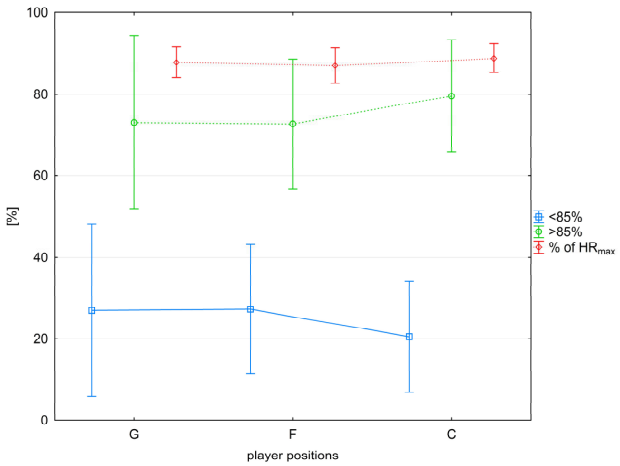

Fig. 1 Mean total time ± SD played below and above 85% of HR_{max} and mean HR (as % of HR_{max}) of guards (G), forwards (F) and centers (C)

In the 1st half of both games the female basketball players were active below 85% of HR_{max} 25.87±17.86% and above 85% of HR_{max} 74.13±17.86% of the total time and in the 2nd half of both games, below: 22.09±14.52%, above: 77.91±14.52%. The value of the mean HR was at level 87.89±4.18% of HR_{max} (1st half) vs. 88.14±3.63% of HR_{max} (2nd half) (Fig. 2). Mann-Whitney U-test did not demonstrate and statistically significant differences ($p>0.05$) between the 1st and the 2nd half in the total time below and above 85% of HR_{max}. When the mean HR (as % of HR_{max}) of both halves was compared, no statistically significant differences ($p>0.05$) were recorded.

The results are similar to the [2] and [23]; however, these studies demonstrate significant differences between the 1st and the 2nd half. Higher level of mean HR (as % of HR_{max}) was reached by the players in the 1st half [14]. The U19 male players were more active above 85% of HR_{max} in the 1st half when compared to the 2nd half [2]. The difference between halves could have been caused by many factors: e.g. the tactics, the 2nd half of dramatic games is interrupted more frequently than the 1st half (free-throw shooting, time-outs).

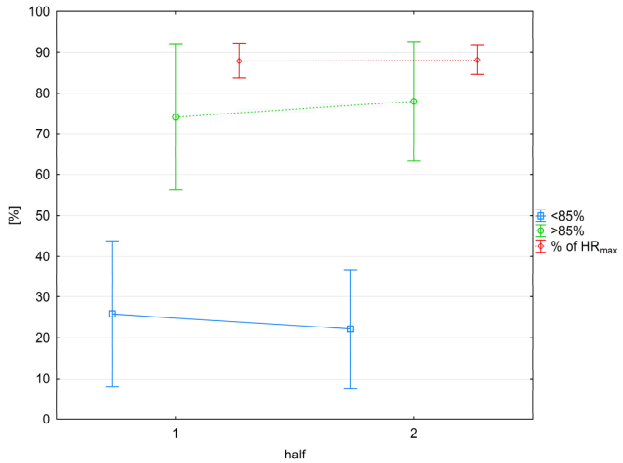

Fig. 2 Mean total time ± SD played below and above 85% of HR_{max} and mean HR (as % of HR_{max}) of the 1st and the 2nd half

The female basketball players were active below 85% of HR_{max} 23.96±16.24% and above 85% of HR_{max} 76.05±16.24% of the total time (Fig. 3). The ratio of the total time below and above 85% of HR_{max} is approximately 1:3.2. The mean HR reached 88.02±3.88% of HR_{max}. Similar values are presented in [25] (90.8% and 94.6% of HR_{max} in national and international women's competition) and [23] (the mean HR 89.1% of HR_{max}; 80.4% of the total time above 85% of HR_{max} – university female Premier league). Slightly lower values were presented in [4] (68.6% of HR_{max} in the regional women's competition). In [26] the players were active above 85% of HR_{max} 63.11 % of total time (U18 senior male category).

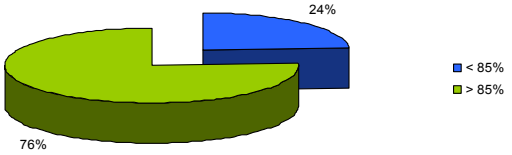

Fig. 3 The total time played below and above 85% of HR_{max}

All these results point to the fact that the physiological demands of the basketball game may depend on the age, category, on the level of performance, sex, and probably also the tactics and the conditioning level of the player. The comparison of HR values with other studies is presented in Table I. An example of forward's HR response during one whole game is illustrated in Fig. 4.

TABLE I
COMPARISON OF HEART RATE VALUES MEASURED DURING THE GAMES WITH OTHER STUDIES

Sex	Study	Level of competition	≥85% of HR_{max}	% of HR_{max}
Female	Present study	2nd national division	76.05±16.24	88.02±3.88
	[4]	State-level	-	68.6±3.1
	[23]	University premier league	-	89.1±3.9
	[25]	National	-	90.8
		International	-	94.6
Male	[2]	National U19	75.3±4.9	-
	[3]	National	66.4±7.2	86.8±2.3
	[5]	National U19	-	91±2
	[26]	Warm-up matches U18	63.11±16.39	85.06±6.4

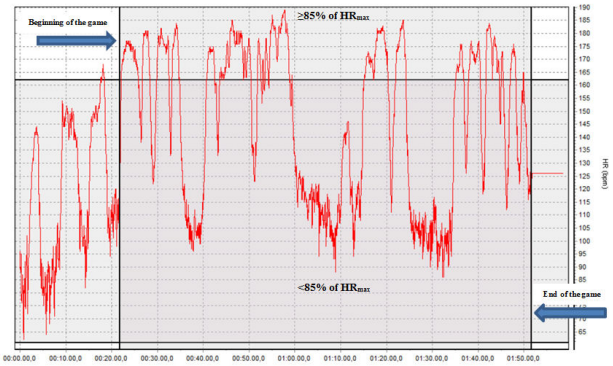

Fig. 4 Heart rate response of forward during one game

IV. CONCLUSION

This study points out to the high physiological demands of the individual player positions and both halves of a competitive basketball game. These findings may be used in training (the intensity of load below and above 85% of HR_{max} is in the ratio approx. 1:3.2) where the intensity of load should have intermittent character. The proposed data may be compared with the intensity of load in the training process and thus it should lead to its optimization. For research of similar character we suggest to add the analysis of the distance and speed characteristics (time-motion analysis) and measurement of the blood lactate, and also increase the number of monitored subjects and number of basketball games.

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