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HEART RATE AND VELOCITY PROFILE OF BASKETBALL PLAYERS

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INTRODUCTION

With the development of the heart rate monitor, the heart rate (HR) monitoring has become a widely used method in collective sports, as basketball, providing information about the effort during games. The HR may be used to establish the intensity of the exercise [1]. Other variable that is being related to the intensity of the efforts made by players is the velocity (v). It can be obtained from kinematic analysis system and has been used in different modalities. This paper aims to describe and analyze both heart rate and velocity of male basketball players during a game (T), discriminating the Live Ball (LB) and Dead Ball (DB) verifying differences among forwards, guards and centers and the possible correlation between HR and v.

METHODS

The sample consisted of nine players (3 guards, 3 forwards, 3 centers) from a professional male basketball team that played of a game in the 2011/2012 season of the “New Basket Brazil” (NBB) the main national championship. The study was authorized by the Research Ethics Committee of UNICAMP (CEP n° 1008/2010) as well as approval for video acquisition, obtained from National League of Basketball (LNB), and the players have signed a term of free and informed consent. For the HR data collection, were used a Polar heart rate monitor, model Team System, with sampling frequency of 0.2 Hz, starting in the warm up and finishing in the end of the match. The same game was filmed by four digital cameras (JVC, model GZHD10), placed in fixed positions at the gymnasium corners, at the

highest possible point from the ground. The images sequences were analyzed at 7.5 Hz using the DVideo System were manual processes of the screen coordinates were done, as the calibration, time synchronization and reconstruction of two dimensional coordinates of the players in the court. The periods separation in LB and DB periods was done automatically from a footage of the scoreboard [2]. A chronometer was used to determine the beginning of the HR sample collection of each player and the beginning of the game, that was used as a parameter for the synchronization of the HR and v signals. The HR and v data were smoothed by a digital filter model Butterworth low pass, of 4th order, with a cutoff frequency of 0.2 Hz and 0.45 Hz, respectively, and subsequently interpolated to the frequency of 7.5 Hz.

The 2D coordinates of position versus time, used in the calculation of the velocities, were obtained by finite difference. Then, was calculated the mean and standard deviations of the percentage of HR_{max} and v for the whole game and for periods of LB and DB, for each one of the players analyzed, considering only the time spent on the court, and separately for each quarter. In each quarter, it was verified the normality using a Shapiro-Wilk Test (p < 0.05), the Spearman correlation test (p < 0.05), to verify possible relationships between means and periods of DB, LB and T, and among the guards, forwards and centers.

RESULTS AND DISCUSSION

Table 1 shows the variables of the HR_{max} percentage of each player in each quarter of game.

Table 1: Average of HR_{max} percentage of basketball players by playing position, in the Live Ball (LB), Dead Ball (DB) and Total Time (T) periods.

	1th Quarter			2th Quarter			3th Quarter			4th Quarter			
	DB	LB	Total	DB	LB	Total	DB	LB	Total	DB	LB	Total	
Guard 1	87.36 ± 8.89	95.67 ± 4.59	91.38 ± 8.21	88.82 ± 5.71	93.31 ± 6.75	91.81 ± 6.53	Guard 1	85.86 ± 6.46	88.74 ± 5.66	87.12 ± 6.23	79.83 ± 8.97	91.6 ± 5.36	84.98 ± 9.50
Guard 2	96.94 ± 1.45	98.00 ± 3.65	97.56 ± 1.65	86.24 ± 10.33	93.56 ± 6.01	90.28 ± 8.94	Guard 2	95.26 ± 3.06	95.24 ± 4.62	95.30 ± 3.21	82.21 ± 11.26	91.46 ± 5.76	86.37 ± 10.25
Guard 3	-	-	-	81.79 ± 12.22	93.03 ± 6.26	87.62 ± 11.07	Guard 3	81.87 ± 10.17	92.71 ± 6.86	86.27 ± 10.38	-	-	-
Forward 1	-	-	-	81.16 ± 11.38	91.90 ± 5.82	86.48 ± 10.48	Forward 1	88.41 ± 5.03	94.55 ± 6.17	91.44 ± 6.07	81.91 ± 13.76	93.13 ± 6.30	86.95 ± 12.32
Forward 2	85.40 ± 8.50	95.05 ± 4.89	89.97 ± 8.46	-	-	-	Forward 2	85.66 ± 5.51	92.12 ± 5.86	88.19 ± 6.35	-	-	-
Forward 3	85.69 ± 8.58	94.68 ± 5.08	90.18 ± 8.28	87.16 ± 8.77	93.48 ± 5.71	90.67 ± 7.66	Forward 3	89.67 ± 5.30	92.86 ± 5.65	90.91 ± 5.55	89.11 ± 11.51	92.83 ± 6.74	91.01 ± 9.44
Center 1	95.01 ± 5.14	97.87 ± 3.50	96.55 ± 4.10	88.20 ± 9.15	91.67 ± 5.82	90.11 ± 7.63	Center 1	85.56 ± 9.55	88.87 ± 8.16	87.11 ± 9.02	-	-	-
Center 2	85.17 ± 8.52	94.85 ± 4.97	89.73 ± 8.50	-	-	-	Center 2	89.33 ± 4.77	92.58 ± 6.02	90.55 ± 5.25	80.04 ± 6.77	93.64 ± 5.52	85.86 ± 9.13
Center 3	90.12 ± 8.71	97.58 ± 3.51	93.54 ± 7.62	82.72 ± 12.1	93.78 ± 6.27	88.78 ± 10.80	Center 3	88.26 ± 7.14	94.85 ± 5.80	91.98 ± 7.00	74.90 ± 11.25	91.89 ± 6.65	82.24 ± 12.69

Table 2: Velocity average of basketball players by player position, in the Live Ball (LB), Dead Ball (DB) and Total Time (T) periods.

	1th Quarter			2th Quarter			3th Quarter			4th Quarter			
	DB	LB	Total	DB	LB	Total	DB	LB	Total	DB	LB	Total	
Guard 1	0.59 ± 0.72	2.09 ± 1.31	1.31 ± 1.29	0.69 ± 0.55	2.18 ± 1.47	1.67 ± 1.42	Guard 1	0.89 ± 0.76	2.04 ± 1.34	1.39 ± 1.19	0.56 ± 0.68	1.81 ± 1.20	1.14 ± 1.14
Guard 2	1.01 ± 0.69	2.15 ± 1.42	1.61 ± 1.27	0.71 ± 0.75	2.15 ± 1.58	1.51 ± 1.46	Guard 2	0.72 ± 0.71	2.39 ± 1.52	1.50 ± 1.42	0.66 ± 0.72	1.97 ± 1.40	1.25 ± 1.29
Guard 3	-	-	-	0.66 ± 0.65	2.23 ± 1.40	1.47 ± 1.35	Guard 3	0.71 ± 0.75	2.19 ± 1.50	1.31 ± 1.33	-	-	-
Forward 1	-	-	-	0.77 ± 0.75	2.19 ± 1.40	1.47 ± 1.32	Forward 1	0.74 ± 0.75	2.01 ± 1.30	1.36 ± 1.25	0.74 ± 0.84	2.12 ± 1.39	1.36 ± 1.31
Forward 2	0.59 ± 0.63	1.99 ± 1.30	1.25 ± 1.25	-	-	-	Forward 2	0.86 ± 0.78	2.02 ± 1.43	1.31 ± 1.22	-	-	-
Forward 3	0.66 ± 0.78	1.98 ± 1.30	1.32 ± 1.29	0.74 ± 0.73	1.96 ± 1.44	1.41 ± 1.32	Forward 3	0.73 ± 0.79	1.99 ± 1.47	1.31 ± 1.26	0.83 ± 0.95	1.82 ± 1.49	1.32 ± 1.34
Center 1	1.01 ± 1.00	1.87 ± 1.45	1.46 ± 1.33	0.54 ± 0.63	1.87 ± 1.37	1.27 ± 1.28	Center 1	0.74 ± 0.89	2.02 ± 1.58	1.34 ± 1.41	-	-	-
Center 2	0.48 ± 0.70	1.81 ± 1.39	1.10 ± 1.27	-	-	-	Center 2	0.96 ± 1.05	1.62 ± 1.43	1.20 ± 1.24	0.59 ± 0.83	1.76 ± 1.36	1.09 ± 1.23
Center 3	0.75 ± 0.91	1.92 ± 1.35	1.28 ± 1.28	0.61 ± 0.73	1.84 ± 1.24	1.28 ± 1.20	Center 3	0.87 ± 0.92	1.83 ± 1.28	1.42 ± 1.22	0.55 ± 0.69	1.77 ± 1.30	1.07 ± 1.28

The averages of %HR_{max} and v obtained in the periods of LB were significantly higher than in DB and T periods, indicating that efforts of high intensity are in this period; that the DB periods correspond to active resting and must contribute to the recovering process of players, and it's necessary to separate the DB from T periods for the analysis of %HR_{max} and v. Some studies that have investigated the heart rate in basketball, separating the LB and T periods, found values of 92.5 ± 3.3 % and 89.1 ± 3.9 % [3], respectively. In another study with Australian players, values above 85 % were prevalent in 65 % of the total time with an average of 87 ± 2 % of HR_{max}, while the average in LB periods was above 85 % during 75 % of the time, with an average of 89 ± 2 % of maximum heart rate [4]. The averages of %HR_{max} of guards showed no significant differences in relation to centers or forwards. Unlike our finds, a study conducted with young Spanish players [5] found differences in %HR_{max} between forwards and guards (p < 0.05) and between guards and centers (p < 0.0001). Another study done with Tunisian under-19 players [6] verified higher averages in the guards in relation to the centers in the first three quarters. These differences may be related to the characteristics of each team and the physical conditions of each player, in addition to different functions performed.

The average velocity of the guards was higher than that of the centers, while centers had higher averages if compared to forwards. To explain these differences it is necessary to consider separately the defense and attack situations and that during the game the positions can change the characteristics, as these velocities may depend on the scoreboard situation or on the tactics of the team. Studies [4,6] indicate that the high intensity running, or high-speed running happens every 21 seconds of the LB and 39 seconds between the high intensity actions.

By comparing the variables of %HR_{max} and v, it was verified a correlation in the first and last quarters, during the DB period (coefficients values of 0.92 and 0.94, respectively) and during T (coefficients values of 0.85 and 0.88, respectively). In the DB periods low correlations with coefficients of 0.32 were found (1th Quarter) and negative correlations with coefficients of -0.39 (2th Quarter), -0.05 (3th Quarter) and -0.25 (4th Quarter). The periods of DB correspond to low intensity actions and recovering of physical condition, thus, there is a decrease of HR and low velocities, justifying the correlations found. The actions of high intensity occur in the LB periods and few time per game [7], causing a correlation between %HR_{max} and v in T. The correlations between %HR_{max} and v in the periods of DB are high due to the predominance of low or zero velocities, characterized by a period of rest, where HR will

decrease. In LB periods actions of high and medium intensity are made intermittently, with a set of v corresponding to a HR increase, however without correlation between the averages. Knowing that in a basketball game, it's possible to have actions where effort demands take different forms and intensities, comparing the %HR_{max} to v data, it's not possible to establish a linear relationship between them, although both represent an increase of intensity and effort, unlikely a street running for instance, where there is a continuous effort pattern, beyond the activities of upper limbs, which also changes the effort intensity.

CONCLUSIONS

This study presented the profile of HR in terms of % and HR_{max}, and velocities of Brazilian elite basketball players, providing important information for the players physical preparation. It also shows the importance of analyzing HR and v, discriminating periods of DB and LB, the differences found for the roles in team and in some periods of the game. Despite it's being widely used to determine the intensity of different efforts, mainly continuous, the HR can be influenced by psychological aspects, common during the games, suggesting that velocity can describe with better accuracy the efforts realized.

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