Physical Activity Demands in Elite Basketball Games

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We describe a new classification of the physical demands of basketball by comparing different positions and functions of players on the team. We classified movements into three categories: horizontal displacements (divided into six subcategories), vertical displacements (divided into six subcategories), and contact forces (divided into two subcategories). The increased number of contact forces recorded in a basketball game reveals the importance of including this category in the analysis. This work reveals the importance of considering physical activities in different ways using more detailed categories.

KEY WORDS: playing position, training, activity profile.

INTRODUCTION: In competitive games such as basketball, it is important to determine and control variables that determine both internal and external loads. A study has been conducted based on time-motion analysis about the quantification of the external loads consisting of a method in which movements performed on the court are classified into several pre-determined categories (McInnes, Carlson, Jones, & McKenna, 1995). Next, the frequency of the movements is quantified, as well as the time spent in each movement performed during the game. The first study that applied this method proposed eight categories for the classification of movement, including displacements of varying intensities, displacements in defensive stance, and jumps. Ben Abdelkrim, El Fazaa, and El Ati (2007) adapted the categories from the work of McInnes et al. and proposed a new category that includes the displacements in defense positions and other types of movements that differ from running and walking categories. Scanlan, Dascombe, Reaburn, and Dalbo (2012) also proposed an additional classification system based on categories presented by McInnes et al. (1995), but based on values of the velocities of futsal players (Barbero Alvarez, Soto, Barbero Alvarez, & Granda Vera, 2008) in order to determine movements such as standing or walking, jogging, running, and sprinting more objectively. It is clear that limitations arise when it is necessary to reliably quantify the physical efforts of a game. Despite the fact that the time-motion analysis performed by Scanlan et al. (2012) considered upper limb movements, which increases physiological responses during a game, these authors did not consider contact forces such as screens or other types of displacements such as running backwards and sideways, which affects physiological demands (Ben Abdelkrim et al., 2007). This same issue arises when jumps are quantified, since this seemingly simple activity involves many complex factors, such as jump skills, layups or shooting, rebounds, dunks, blocks, and jump-passing. Furthermore, it is known that classifications created by Scanlan et al. (2012) based on futsal velocities do not match the velocities sustained by basketball players due the dimensions of the playing court. Here, the aim of this study is to propose new classification system for the physical demands in basketball, based on the frequencies of occurrence in each class. We also aim finding differences of categories proposed between positions/functions of the players on a team.

METHODS: Twelve elite players from a basketball team belonging to the first division of the Brazilian National Basketball League were selected for analysis. Approval for video data collection was obtained from the League; this research was also approved by the local Research Ethics Committee. Four cameras (JVC® GZ-HD620, fullHD, 30 Hz) were used to acquire the image data. The cameras were statically positioned to frame the basketball court

from different viewpoints. The registration of physical activity was performed using a Dvideo System with a sampling frequency of 7.5 Hz (Barros et al., 2007). We classified the physical activity performed in the basketball game into three categories: horizontal displacements (hd), divided into six subcategories; vertical displacements (vd), also divided into six subcategories, and contact forces (cf), divided in two subcategories, defined as follows: (a) Horizontal displacements: Forward, Backward, Side, Dribble, Defense Stance, and Stand, (b) Vertical displacements (Jumps): rebound (jr), layup (jl), jump shot (js), block (jb), dunk (jd) and jump pass (js), and (c) Contact Forces: Screen and Fault, or Box Out and 1vs1. The frequencies and spent time in the each subcategory are shown for each position, which are: Point Guard (PG), Shooting Guard (SG), Small Forward (SF), Power Forward (PF), and Center (C). The positions were determined at the beginning of each quarter and were maintained by the person who originally started in that position. We performed two different statistical analyses to evaluate different sets of player positions for each subcategory. The first set was based on Scanlan et al. (2012), who grouped players as backcourt (PG and SG) and frontcourt (SF, PF, and C). In the second analysis, SF players were excluded from the frontcourt group and included in the backcourt group. To check the normality of the data, we performed the Lilliefors test. For normal variables, we applied the two-sample *t*-test was applied. For all other cases, we used the Wilcoxon rank-sum test. We adopted a significance level of $p < 0.05$.

RESULTS & DISCUSSION: The absolute frequencies of the physical activity are presented in Table 1. In Table 2, we present the statistical analysis with two player positions. A total of 3873 actions were registered, which is greater than the 1750 ± 186 actions reported for female Australian basketball players (Scanlan et al., 2012) and the 997 ± 183 actions reported for male Australian basketball players (McInnes et al., 1995). Our proposed categorization includes a larger number of actions than either of these two previous studies.

Table 1
Results of Analyses of Five Player Positions

	Guard	Point Guard	Small Forward	Power Forward	Center	Total
Horizontal Displacements (HD)						
Forward	339	310	221	298	285	1453
Backward	162	147	99	181	124	713
Side	66	61	30	33	45	235
Dribble	54	38	24	21	9	146
Defense Stance	16	14	15	6	16	146
Stand	199	163	119	152	168	801
Total HD	836	733	508	691	647	3494
Vertical Displacements (Jumps)						
Rebound	3	1	13	7	13	37
Layup	9	2	4	1	4	20
Jump Shot	8	12	7	4	9	40
Block	5	6	8	2	19	40
Dunk	0	0	0	3	0	3
Jump Pass	4	5	7	2	0	18
Total Jumps	29	26	39	19	45	158
Contact Force (CF)						
Screen or Fault	4	7	7	28	49	95
Box Out or 1vs1	25	32	34	42	72	205
Total CF	29	39	41	70	121	300
Total	894	798	588	780	813	3873

* Frequencies over the course of the entire game.

High frequencies were recorded for horizontal displacements, particularly in forward (1453) and backward (713) displacements. The number of vertical displacements recorded (158) was fewer than found in other studies (Ben Abdelkrim et al., 2007; McInnes et al., 1995; Scanlan et al., 2012). A more detailed analysis can be performed when the different jumps are considered, resulting in a larger contribution of rebounds, blocks, and jump shots. This fact suggests that the jumps arise from several technical actions. A relevant quantification of contact force was developed, which included 300 actions dominated by SF, PF, and C. Others papers have not evaluated contact forces (Ben Abdelkrim et al., 2007; McInnes et al., 1995; Scanlan et al., 2012).

Table 2
Comparison of Two Different Player Positions Sets

	backcourt	frontcourt	PG SG SF	PF C
Horizontal Displacements (HD)				
Forward	81.0 ± 12.6	72.0 ± 14.9	77.7 ± 11.4	72.5 ± 18.4
Backward	38.9 ± 7.6	36.2 ± 13.5	36.2 ± 8.7	38.9 ± 15.0
Side	13.8 ± 7.0	8.6 ± 4.7	12.3 ± 7.2	8.3 ± 3.1
Dribble	11.5 ± 2.9	4.8 ± 3.6*	10.0 ± 3.9	3.8 ± 3.0*
Defense Stance	3.8 ± 1.5	2.5 ± 1.8	3.8 ± 1.5	1.9 ± 1.6 *
Stand	45.3 ± 10.6	39.5 ± 8.2	43.0 ± 9.9	40.0 ± 8.9
Total HD	190.4 ± 27.1	161.1 ± 32.9	179.1 ± 27.9	163.4 ± 40.4
Vertical Displacements (Jumps)				
Rebound	0.5 ± 0.5	2.3 ± 1.9*	0.8 ± 0.7	2.8 ± 2.3*
Layup	1.4 ± 1.2	0.8 ± 0.7	1.3 ± 1.0	0.6 ± 0.7
Jump Shot	2.6 ± 1.8	2.1 ± 1.1	2.7 ± 1.6	1.8 ± 1.0
Block	1.1 ± 1.4	2.4 ± 2.5	0.3 ± 0.6	0.6 ± 1.1
Dunk	0.3 ± 0.7	0.5 ± 0.9	1.5 ± 1.9	2.5 ± 2.6
Jump Pass	1.1 ± 1.1	1.1 ± 1.6	1.5 ± 1.6	0.5 ± 0.8
Total Jumps	7.0 ± 2.1	9.3 ± 4.0	8.1 ± 2.8	8.8 ± 4.5
Contact Force (CF)				
Screen or Fault	7.4 ± 3.9	12.2 ± 6.0	7.9 ± 3.8	13.8 ± 6.4*
Box Out or 1vs1	0.9 ± 1.1	7.8 ± 5.0*	1.4 ± 1.4	10.5 ± 3.7*
Total CF	8.3 ± 3.9	20.0 ± 9.9*	9.3 ± 4.3	24.3 ± 9.1*

*Significant Difference between means ± standard deviation by quarter.

Based on the player position classification of Scanlan *et al.* (2012), significant differences were found in dribble displacements, rebounds, and box out/1vs1. On the other hand, for backcourt with SF included, significant difference were found in dribble displacements, defense stance displacements, rebounds, screen/fault, and box out/1vs1. Indeed, the two different groupings yielded different results, showing that the specificity of each position must be considered since even two or more players in the same position may perform different functions on the court. For the first analysis, the dribble displacement was greater in the backcourt than in the frontcourt. However, the rebound and box out/1vs1 was greater in the frontcourt. In the second analysis, the same results were largely found, but with two differences: the defense stance displacement activity was greater for the group with PG, SG, and SF, and the screen/fault activity was greater for the group with PF and C.
The increased number of contact forces that we noted between positions in both position sets, motivates a discussion about the importance of different resistance training routines for conditioning for different positions, including isometric force. Only the total number of contact forces was significantly different, meaning that if none of the detailed subcategorizations were considered, the player positions would tend to be equal for the general actions performed (displacements and jumps).

CONCLUSION: The classification proposed seems suitable to be apply in basketball games analysis, since the movements quantified are found during competition game. The inclusion of the several types of horizontal displacements, jumps and contact forces allows explore other ways for investigation concerning physical demands in basketball players. We have found difference of categorized physical demands between positions, but only some of them presented significant difference. It highlight the importance of considering the positions of players during prescriptions of physical conditioning and its application. As the present study is about a first propose of a new classification system, it certainly need to be more refined for a more accurate quantification of physical demands during basketball games.

REFERENCES:

Barbero Alvarez, J. C., Soto, V. M., Barbero Alvarez, V., & Granda Vera, J. (2008). Match analysis and heart rate of futsal players during competition. *Journal of Sports Sciences*, *26*(1), 63–73. doi:10.1080/02640410701287289

Barros, R. M. L., Misuta, M. S., Menezes, R. P., Figueroa, P. J., Moura, F. A., Cunha, S. A., … Leite, N. J. (2007). Analysis of the distances covered by first division Brazilian soccer players obtained with an automatic tracking method. *Journal of Sports Science and Medicine*, *6*(2), 233–242.

Ben Abdelkrim, N., El Fazaa, S., & El Ati, J. (2007). Time-motion analysis and physiological data of elite under-19-year-old basketball players during competition. *British Journal of Sports Medicine*, *41*(2), 69–75; discussion 75. doi:10.1136/bjsm.2006.032318

McInnes, S. E., Carlson, J. S., Jones, C. J., & McKenna, M. J. (1995). The physiological load imposed on basketball players during competition. *Journal of Sports Sciences*, *13*(5), 387–397. doi:10.1080/02640419508732254

Scanlan, A. T., Dascombe, B. J., Reaburn, P., & Dalbo, V. J. (2012). The physiological and activity demands experienced by Australian female basketball players during competition. *Journal of Science and Medicine in Sport / Sports Medicine Australia*, *15*(4), 341–347. doi:10.1016/j.jsams.2011.12.008

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