DISTANCE COVERED IN DIFFERENT GAME SITUATIONS BY HIGH-LEVEL BASKETBALL PLAYERS FROM BRAZIL

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The aim of this study was to propose a way to classify four different game situations in a basketball game and quantify the covered distances by player positions in each category, using a video-based system. One game of the season 2011/2012 New Basketball Brazil was analyzed. The data on distance covered by the players on both teams was obtained with a video-based manual tracking method (Dvideo System). The game situations were classified as: attack, defense, transition to attack or transition to defense. The distances covered are shown by each player's position. Significant differences were observed between attack and defense vs. transition to attack and transition to defense, and also for transition to attack vs. transition to defense.

KEYWORDS: kinematics, sports, biomechanics, tracking.

INTRODUCTION: In recent years, different studies have been developed to provide data for game, performance, or notational analysis in different sports. Aided by video and other measurement methods, such studies are now feasible to be performed during competitions, without interfering within the players performance. The covered distance , for example, is a variable related to the player performance in collective sports that can be used to plan their training season (Scanlan et al., 2011; Ben Abdelkrim et al., 2010). The dynamics of the Basketball has an intermittent pattern of athlete movement. After excluding the periods which the game clock is stopped, the different game situations can be classified in four categories of tactical situations: defense, attack, transition to defense and transition to attack. The aim of this study was to propose a way to classify these game situations and quantify the covered distances in each game situation, using a video-based method in an official Basketball match.

METHODS: One game of the New Basketball Brazil (NBB), season 2011/2012, the principal male adult national championship, organized by the National Basketball League (NBB), was recorded by four digital video cameras (JVC, GZHD10). Following synchronization the image sequences were down sampled and analyzed at 7.5 Hz (Misuta et al., 2005, Barros et al., 2007; Sarro et al., 2010). Approval for video acquisition was obtained from the organizing committee LNB (Brazilian National Basketball League). This research was approved by the Research Ethics Committee of the School of Medical Sciences, State University of Campinas, Brazil. For the calibration of the cameras, 16 reference points were created on the basketball court line intersections, and its coordinates were measured by a laser measuring tool (Leica DISTO D5). The temporal synchronization was performed using the numbers transition in the shot clock, which was registered by all cameras. The 2D reconstruction of players' position on the basketball court was based on the Direct Linear Transformation method (DLT).
The *Dvideo* system was used to measure the players' position on the court, which were manually tracked using the body mass center estimated projection in the court (Monezi et al., 2013). The 2D data were smoothed with Butterworth digital filter (0.45 Hz cut-off frequency). The distance covered on the plane of the court was calculated as the cumulative sum of player displacement between two successive frames.

The distance covered during times which the game clock was stopped were not considered for this analysis. The classification of the different game situations (attack, defense, transition to attack and transition to defense) were qualitatively identified (based on de Rose Junior (2006). The attack (which corresponds as the defense situation of the opposite team) occurs after all players cross the court central line and after having 1-to-1-marking or zone-marking; The transition to attack (which corresponds to a transition to defense of the opposite team) starts with a change in ball possession, in defense zone, and finishes with the attack formation or loss of ball possession.
The covered distances are shown divided for each position in the team, which are: Point Guard (PG), Shooting Guard (SG), Small Forward (SF), Power Forward (PF), and Center (C). The positions were determined in the beginning of each quarter and it is kept, if there is any substitution, by the player who goes to the game. The Lilliefors test was applied to test for normality, followed by One-way ANOVA, for differences of game situation. Statistical significance was adopted at $p<0.05$, using Tukey post-hoc test.

RESULTS AND DISCUSSION: The distance covered by each position, in each situation, for both teams, is presented in Table 1.

Table 1
Distance Covered (m) by Each Position in Each Situation

Team	Position	A	D	TA	TD
	PG	1053.2	608.9	1612.7	1438.4
	SG	869.0	551.4	1558.4	1475.8
A	SF	757.5	498.9	1317.1	1345.5
	PF	788.7	508.9	1489.9	1387.4
	C	761.6	533.5	1476.6	1342.5
	PG	723.6	690.2	1784.6	1429.4
	SG	660.0	825.4	1686.5	1483.9
B	SF	633.1	742.9	1648.4	1468.4
	PF	548.7	724.9	1610.3	1335.7
	C	651.3	597.6	1550.1	1326.6
	%	17.1	14.4	36.2	32.3

The figure 1 illustrates the distance data for the different game situations. Post hoc tests showed difference in distance covered between attack and defense vs. transition to attack and transition to defense; and also for transition to attack vs. transition to defense. There was no significant difference between distance covered in attack and defense situations.

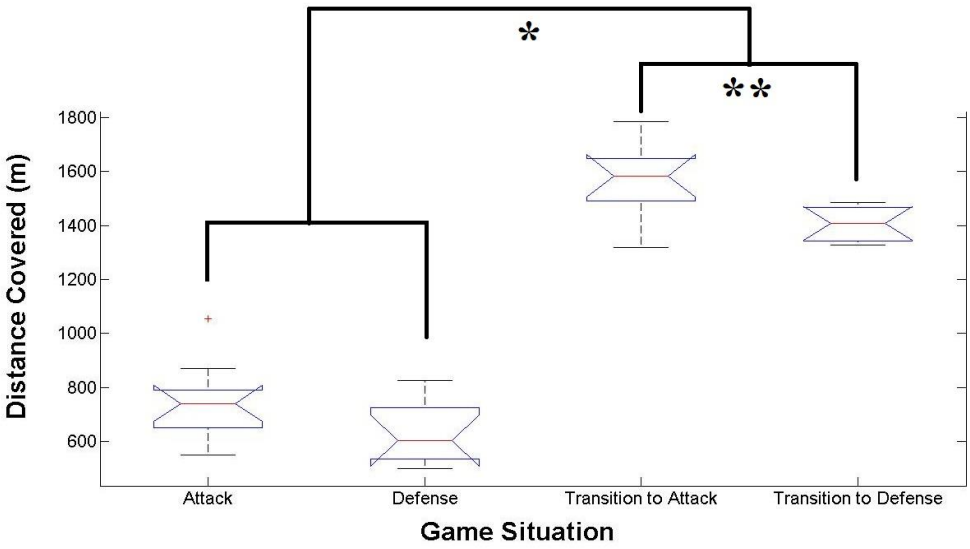

Figure 1: Distance Covered in each situation: attack, defense, transition to attack and transition to defense; * p<0.05 for attack and defense vs. transition to attack and transition to defense; ** p<0.05 for transition to attack vs. transition to defense.

The lack of significant difference between distances covered in attack and defense situations might be due to a preference of the teams to use a man-to-man defense. The difference found between distances covered in transition to attack and transition to defense might be due to the attackers relative position (closer to the opposite target) and their need to get off their markers, as to have a better condition to receive the ball.

CONCLUSION: This study showed the distance covered by elite Brazilian basketball players and classified them in four tactical game situations (during working game clock). It showed that it is possible to use a video-based tracking system in basketball matches, even though it used a manual measurement step. The data presented supports training prescription as it gives information about the physical demands during game, adding specific details for the coaches. Further studies are underway to add more games to perform these comparisons and look for a better understanding of basketball.

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