

Performance analysis of game dynamics during the 4th game quarter of NBA close games

Miguel Angel Gomez¹, Lorenzo Gasperi² and Corrado Lupo³

¹Faculty of Physical Activity and Sport Sciences, Polytechnic University of Madrid, Spain.

²SUISM Centro Servizi, University of Torino, Turin, Italy.

³Motor Science Research Center, SUIISM Centro Servizi, Department of Medical Sciences, University of Torino, Turin, Italy.

Abstract

The purpose of the present study was to identify which situational variables and technical-tactical variables allow to discriminate home and away teams during the fourth quarters of close NBA basketball games according to the scoring trends. The sample comprised 48 men's NBA close games (below 10 points of difference) during the 2013-14 regular season. The situational variables (starting quarter score, game location, and quality of opposition) and technical-tactical variables (game situation, defense type, outcome, shot type, technical execution, defense on the shooter, play events and mean played clock-time) were studied. The main results showed that the variables that best differentiated home and away teams were: i) starting quarter score, free-throws scored, 3-point field-goals from central positions, and defensive fouls during balanced scoring trends between teams; ii) game location, quality of opposition, ball possession success, 2-point field-goals inside and outside the central positions, 3-point field-goals from central and right court positions, and defensive rebounds during home teams' positive scoring trends; and iii) starting quarter score, game location, quality of opposition, ball possession success, alley-hop, the stop-shot, the 1 defense on the shooter, the 2 or >2 defense on the shooter and block 1 in defense during away teams' positive scoring trends. The identified trends allow improving the game understanding during last stages of close games and help the coaches to plan practice sessions and deciding better in competition.

Key Words: elite basketball, situational variables, performance analysis.

1. Introduction

In the last decade, the game-related statistics and the notational analysis method have been highly considered to define the profile of several team sports and their consequent practical applications (Lupo et al., 2012; Gomez et al., 2006; Vaz et al., 2010; Marcelino et al. 2011; Oliveira et al., 2012; Duarte et al., 2013). In line to this scientific approach, several studies (Sampaio et al., 2010) have been focused on the technical and

tactical aspects of elite basketball teams. Nevertheless, only few studies (Jones, 2008; Sampaio et al., 2006, 2015) reported technical and tactical data on the National Basketball Association (NBA), the most popular and important basketball league in the world. Particularly, the available research has showed the importance of successful 2- and 3-point field-goals (Janeira and Sampaio, 1997; Satter, 2003; Onwuegbuzie, 2000), defensive and offensive rebounds (Janeira and Sampaio, 1997; Krause, 1999) and assists (Melnick, 2001) discriminating winning and losing teams in the NBA league. However, this research is limited to general information and lacks of results related to specific situational conditions. In particular, the quality of opposition, game location or starting quarter score have been demonstrated to be crucially influent on the final outcomes of basketball games (Gomez et al., 2013; Moreno et al., 2013).

On the one hand, Jones (2008), analysed the games played during the 2002-2003 to 2003-2004 NBA seasons. The author compared the home and away teams' scoring performance along the game (i.e., quarter by quarter as a game long-process). In particular, the home teams obtained better results than away teams, especially during the first quarters, which mainly determined the most part of the final advantage (two thirds of the home advantage) with slight increments during the second, third and fourth game-quarters. In addition, the authors stated the influence of quarter by quarter score-line that determines the tendencies of home advantage along the game. On the other hand, de Saá et al. (2013) studied the teams' scoring performances during 6,150 games from the NBA 2005-2006 to 2009-2010 seasons. Their results showed that the basketball scoring trends do not follow a uniform behaviour along the game. The non-linear scoring performances were critical during the third and fourth game quarters when the game becomes unpredictable due to close score differences. In line to this experimental approach, also the margin of victory represents a relevant lack in the technical and tactical analyses of the NBA games. In fact, the authors found that a 65% of the regular season games were played below 10 points of difference showing a high competitive context between confronting teams. These scenarios may generate that the teams drop into a critical state at the end of the games where unpredictable episodes (i.e., fastbreak after a turnover, defensive pressure, etc.) may modify the score-line and then the final outcome during the last game actions.

Although, it seems reasonable to expect that the game dynamics are influenced by the game location, quality of opposition and the score-line, at present, the NBA competition has not been investigated according to this rationale, even considering a specific part of the performance (i.e., the last quarter of a game). Thus, similarly to previous studies on elite basketball (Sampaio et al., 2010), the linear regression models and discriminant analyses have been applied to predict the effects on the observed situational variables and technical and tactical indicators discriminating home and away teams. Therefore, for all these reasons, a notational analysis focused on the technical and tactical aspects occurring during the 4th quarter of NBA closed games should be provided in relation to the following three scoring categories: A) maintaining the same scoring trend between home and away teams; B) home team positive trends during the first three quarters; and C) away team positive trends during the first three quarters. Thus, the aim of the present study was to quantify the effects of situational variables for the three NBA game conditions (i.e., A, B, C), which reported a close margin of victory at the end of the third quarter, also showing eventual effects related to technical and tactical parameters.

In consideration of the fact that two thirds of the home advantage which NBA teams obtained when playing at home is accumulated in the first quarter, and only additional smaller increments were made in the second, third, and fourth quarters (Jones, 2007), it could be hypothesised heterogeneous game dynamics during the 4th quarter for the games which reported a close game condition at the end of the 3rd quarter (i.e., technical and tactical aspects which are related to the maintaining, increasing, or decreasing of small score advantage/ disadvantage).

2. Method

2.1. Participants

A notational analysis was performed on 48 men's NBA close games (below 10 points of difference, de Saá et al., 2013) played by 27 teams during the 2013-14 regular seasons of NBA. The sample was based on a randomly selection of 48 close games from the close games played in the NBA league during the season. This approach represents our best opportunity to collect data according the criterion of inclusion (i.e, close games of the same season) as the highest level of performance between confronting teams described by de Saá et al. (2013) during the NBA close games. According to the game discrimination considered for the present study, the games have been classified into A (n=29, 60%, same scoring trend between teams: even outcome at the end of the 3rd and 4th quarter), B (n=10, 21%, home team positive trend: home team winning by less than 10 points or even outcome at the end of the 3rd quarter and winning at the end of the 4th quarter), and C (n=9, 19%, away team positive trend: away team winning by less than 10 points or even outcome at the end of the 3rd quarter and winning at the end of the 4th quarter) categories, respectively.

2.2. Procedures

The videos of the 4th quarter of all NBA games were downloaded from a website (www.basket.canalblog.com). The notational analysis was developed by two experienced observers (Graduated in Sports Sciences and certified as basketball coaches with a minimum of ten years of experience) that were trained for this task for a duration of three months. Ten game quarters were randomly observed in order to assess inter- and intra-observer reliability (weighted *Kappa* correlation coefficients) after a 4-week period (O'Donoghue and Holmes, 2015). The intra-observer reliability results were very good (values greater than .86), and the inter-observer reliability results were very good (values greater than .81) (Altman, 1991). Then, each playing action has been successfully played by means of a computer to perform a notational analysis according to the technical and tactical indicators reported in the table 1.

Finally, for the indicator "mean played clock-time", the average of clock-time of each possession (according to that electronically registered by referees) has been calculated. In order to control the effects of situational variables, Game Location, Quality of Opposition, and the Starting Quarter Score from the third quarter were analyzed. The quality of opposition was measured according to Gómez, Lago, and Pollard (2013) as the difference in the winning percentage between teams (differences between winning% team A – winning% team B).

Table 1. List of technical and tactical indicators considered to perform the notational analysis of the 4th quarter NBA close games.

Indicator	Meaning
Ball possession	Playing offensive phase recognizable from the moment that a player gained possession of the ball until possession was lost to the opposing team or re-obtained after shot, or other play event coincident with the resetting of the 24-s action-time.
Offensive possessions	
Even	Possession referring to a number of offensive players relative to the ball position never larger than that of the defence during the final offensive team arrangement.
Primary counterattack	Possession characterized by 1, 2, or 3 offensive players and a corresponding lower number of defensive ones relatively to the ball position, determining a real numerical advantage for the offensive players at the moment of the end of the action.
Fast break	Even possession performed within 10 s from the resetting of the 24-s action-time.
Secondary counterattack	Possessions characterized by 4 or 5 offensive players and a corresponding lower number of defensive ones relatively to the ball position, determining a real numerical advantage for the offensive players at the moment of the end of the action.
Defensive arrangements	
Pressing	Defensive arrangement recognizable by each defensive player individually positioned in front of an opponent, and between the latter and own basket.
Zone	Defensive arrangement where at list 4 defensive players are clustered to the center area under own basket.
Outcome	
Success	Possession ending with the scoring of at list 1 point.
Failed	Possession ending with no scored point.
Shot type/origin	
2pt out central	2 points scored by means of a shoot originated centrally, outside the "3s area", inside the 2 points area.
2pt out right	2 points scored by means of a shoot originated on the right area with respect to the "3s area" and the "2pt out central", inside the 2 points area.
2pt out left	2 points scored by means of a shoot originated on the left area with respect to the "3s area" and the "2pt out central", inside the 2 points area.
3pt central	3 points scored by means of a shoot originated centrally with respect to the main lines of the "3s area", outside the 2 points area.
3pt right	3 points scored by means of a shoot originated on the right area with respect to the "3pt central" area.
3pt left	3 points scored by means of a shoot originated on the left area with respect to the "3pt central" area.
Technical Execution	
Stop-jump-shot	Shot performed following up a jump without running start.
Tap-in	Shot performed by tapping a rebounding ball back into the basket.
Penetration	Shot after a running start among opponent players.
Alley-hop	Shot where the ball is grabbed in mid-air and then dunked.
Shoulders	Shot performed with a beginning back body position with respect to opponent basket.
Stop-shot	Shot performed after have faked one or more shots.
On the Shooter	
1 defensive player	Shot performed against the pressure of one defensive player.
≥2 defensive players	Shot performed against the pressure of two or more defensive players.
Play Events	
Defensive rebound	Changing of the ball possession, and consequent resetting of the 24s period, after a shot performed by the opponents during their offensive possession.
Offensive Rebound	Maintaining of the ball possession, and consequent resetting of the 24s period, after a shot performed by the own team during their offensive possession.
Assists	Passing to a teammate that determines the scoring of a field goal.
Offensive foul	A violation resulting from illegal contact with a defensive player during own offensive ball possession.
Defensive foul	A violation resulting from illegal contact with an offensive player during the opponent offensive ball possession.
Stopped	Stopping of an opponent's shot or pass.
Block 1	The first stopping of the opponent's moving during a single offensive possession.
Block 2	The second stopping of the opponent's moving during a single offensive possession.
Turnover	A losing of the ball to an opponent player without shooting.
Pick and Roll 1	The first offensive play in which a player sets a screen, the pick, for a teammate handling the ball and then slips behind the defender, the roll, to accept a pass, in a single possession.
Pick and Roll 2	The second offensive play in which a player sets a screen, the pick, for a teammate handling the ball and then slips behind the defender, the roll, to accept a pass, in a single possession.
Steal	Turnover determinate by a defensive player's legal action.

2.3. Statistical Analyses

Stage 1: Effects of quality of opposition and performance factors on final point differential.

The linear regression model was used to explore the effect of independent variables on final point differential (game outcome). When estimating the models, no heteroscedasticity in residuals or multicollinearity among regressors was observed. When interpreting the statistical results, positive or negative coefficients indicate a greater or lower propensity to increase/decrease game final outcome, respectively. Three independent variables were included: Starting Quarter Score, Game Location and Quality of Opposition. The model is as follows:

$$\text{Final Points Differential} = \beta_0 + \beta_1 * \text{Starting Quarter Score} + \beta_2 * \text{Game Location} + \beta_3 * \text{Quality of Opposition} + \epsilon_i$$

β_0 is the intercept; β_1 , β_2 and β_3 are the impacts of each predictor variable of the independent variables; and ϵ_i is the disturbance term.

Stage 2: Game-related statistics that discriminate between home and away teams according to game type

The discriminant analysis was used to identify the performance indicators that best differentiate winning and losing teams in close NBA games. The structural coefficients (SC) above $|0.30|$ were used when identifying the variables that best contribute to differentiate both groups (winners and losers). Validation of discriminant models was conducted using leave-one-out classification (Tabachnick and Fidell, 2007).

All statistical analyses were performed using PASW statistics 20 (SPSS Inc., Chicago, IL, USA). Statistical significance was set at $p < 0.05$.

3. Results

Stage 1: Effects of quality of opposition and performance factors on final point differential.

The effects of the three independent variables on final point differential are presented in Table 2. The final point differential was explained by Starting Quarter Score ($p=0.001$) and Quality of Opposition ($p=0.009$) in all games. Additionally, in games type A, only the Starting Quarter Score ($p=0.001$) explained the final point differential. Also, in games type B the variables Game Location ($p=0.007$) and Quality of Opposition ($p=0.003$) explained the final point differential. Finally, the Starting Quarter Score ($p=0.032$), Game Location ($p=0.001$) and Quality of Opposition ($p=0.042$) were important predictor in games type C.

Table 2. The influence of Starting Quarter Score, Game Location and Quality of Opposition on final point differential for all games and in each game type (results from the four regression models with standard error in parentheses)

Situational Variables	All games	Type A games	Type B games	Type C games
Starting Quarter Score	0.56 (0.14)**	1.15 (0.14)**	0.22 (0.38)	0.92 (0.39)*
Game Location	-0.59 (1.29)	1.30 (1.40)	-8.81 (2.89)**	13.92 (3.23)**
Quality of opposition	0.10 (0.04) **	0.02 (0.04)	0.18 (0.05)**	0.16 (0.07)*
Intercept	2.30 (0.90)*	-3.65 (0.94)*	4.40 (1.56)*	-6.96 (1.98)**
Number of observations	96	54	22	20
R^2	0.29	0.67	0.68	0.69

* $p < .05$; ** $p < .01$

Stage 2: Game-related statistics that discriminate between home and away teams according to game type

Means and standard deviations for the game-related statistics for home and away teams in all games are presented in Table 3. The univariate analysis showed significant differences between home and away teams in 2 point field-goals inside, 3-point field-goals from central positions, stop-jump-shot executions, and defensive fouls. The home teams performed better in 2 point field-goals inside and defensive fouls, and conversely the away teams performed better in 3-point field-goals from central positions and stop-jump-shot executions.

For games type A, B and C, means and standard deviations were presented in table 4, in type A games, there were significant differences between home and away teams in free-throws scored, 3-point field-goals from central positions and defensive fouls. During type B games, the home teams obtained better values in ball possession success, 2 point field-goals inside and out central, conversely the away teams obtained higher values in 3-point field-goals from central positions and right court, and defensive rebounds. Finally, during type C games, the home teams obtained better values in ball possession success, penetrations and 2 or >2 on the shooter, and the away teams obtained higher values in missed free-throws.

Table 3. Mean standard deviations, game related statistics and univariate differences for home and away teams in all games.

	Home		Away		<i>p</i>
	M	SD	M	SD	
Ball possessions	25.87	2.45	26.21	2.94	.544
Game Situation					
Even	20.57	2.36	20.83	2.67	.624
Primary counterattack	0.91	0.35	0.94	0.25	.735
Fast break	3.96	2.10	4.06	1.95	.799
Secondary counterattack	0.43	0.85	0.38	0.61	.782
Defense					
Pressing	23.77	2.77	24.09	3.34	.615
Zone	2.11	1.67	2.13	2.14	.957
Outcome					
Succes	11.79	2.43	11.45	2.25	.483
Failed	14.09	2.69	14.77	2.80	.233
Shot type/origin					
Free-throws scored	5.74	3.35	4.64	3.07	.098
Free-throws missed	1.57	1.47	1.38	1.48	.531
2pt inside	6.00	3.10	4.40	3.69	.025*
2pt out central	3.02	1.97	2.89	1.89	.749
2pt out right	2.23	1.70	2.09	1.49	.652
2pt out left	2.13	1.60	2.00	1.32	.674
3pt central	2.43	3.07	4.30	3.51	.007**
3pt right	2.26	1.24	2.70	1.43	.109
3pt left	2.66	1.29	3.06	1.67	.193
Technical Execution					
Stop-jump-shot	10.21	3.25	11.64	3.59	.046*
Tap-in	0.45	0.69	0.40	0.58	.745
Penetration	7.19	2.33	6.53	2.40	.180
Alley-hop	0.26	0.57	0.30	0.55	.713
Shoulders	1.23	1.15	1.23	1.20	.098
Stop-shot	1.32	2.11	1.30	1.99	.960
On the Shooter					
1 defensive player	17.26	3.04	18.04	2.98	.208
2 or >2 defensive players	3.38	2.14	3.26	2.25	.779
Play Events					
Defensive rebound	7.57	2.26	7.57	1.93	.950
Offensive Rebound	1.81	1.23	2.15	1.63	.255
Assists	3.74	2.98	4.45	2.77	.240
Offensive foul	1.13	1.24	1.55	1.54	.145
Defensive foul	5.74	2.35	4.38	2.08	.004**
Stopped	2.40	2.57	2.89	2.50	.352
Block 1	12.40	2.80	11.60	2.61	.151
Block 2	1.96	1.37	1.62	1.45	.245
Turnover	1.38	1.03	1.57	1.41	.455
Pick and Roll 1	3.96	2.75	4.62	2.38	.217
Pick and Roll 2	0.21	0.46	0.15	0.36	.458
Steal	0.89	0.89	1.06	1.11	.415
Mean Played Clock-time	12.39	1.60	12.69	1.55	.354

Table 4. Mean standard deviations, game related statistics and univariate differences for home and away teams in games type A, B and C.

	GAME TYPE A				GAME TYPE B				GAME TYPE C			
	Home		Away		Home		Away		Home		Away	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Ball possessions	26.23	1.77	26.81	2.91	25.92	3.50	24.82	3.25	24.63	2.26	26.11	2.26
Game Situation												
Even	20.27	1.76	21.44	2.69	21.31	3.15	20.09	2.81	20.38	2.67	19.89	2.15
Primary counterattack	1.00	0.28	0.93	0.27	0.77	0.44	0.91	0.30	0.88	0.35	1.00	0.00
Fast break	4.35	2.12	4.15	1.94	3.69	1.89	3.18	1.94	3.13	2.30	4.89	1.76
Secondary counterattack	0.62	1.02	0.30	0.47	0.15	0.55	0.64	0.81	0.25	0.46	0.33	0.71
Defense												
Pressing	23.96	2.47	24.70	3.56	24.15	3.51	22.91	3.30	22.50	2.27	23.67	2.40
Zone	2.27	1.73	2.11	2.26	1.77	1.36	1.91	1.51	2.13	2.03	2.44	2.60
Outcome												
Success ^{b,c}	11.81	2.15	11.67	2.04	13.00	1.73	9.91	2.21	9.75	3.11	12.67	2.12
Failed	14.42	2.21	15.15	2.81	12.92	3.35	14.91	2.55	14.88	2.70	13.44	2.96
Shot type/origin												
Free-throws scored ^a	6.23	3.43	4.26	2.78	5.31	2.90	4.73	3.13	4.88	3.91	5.67	3.87
Free-throws missed ^c	1.77	1.45	1.19	1.69	1.69	1.75	1.45	1.21	0.75	0.71	1.89	1.05
2pt inside ^b	6.42	2.45	6.48	3.50	8.15	1.52	1.36	1.43	1.13	1.13	1.89	1.17
2pt out central ^b	3.23	1.99	3.19	1.98	8.15	1.52	1.36	1.43	1.13	1.13	1.89	1.17
2pt out right	1.77	1.73	2.11	1.60	3.15	2.08	1.91	1.14	2.13	1.73	3.22	2.11
2pt out left	2.35	1.41	2.52	1.37	2.77	1.79	2.27	1.35	2.88	0.99	1.78	1.39
3pt central ^{a,b}	1.00	0.85	2.00	2.00	1.62	1.33	8.09	2.81	8.38	2.67	6.56	2.19
3pt right ^b	2.81	1.20	2.63	1.15	1.31	0.85	3.09	2.02	2.00	0.93	2.44	1.42
3pt left	3.04	1.34	2.85	1.35	2.00	1.00	2.82	2.09	2.50	1.20	4.00	1.87
Technical Execution												
Stop-jump-shot	10.54	3.75	12.33	3.42	10.31	2.36	9.82	2.96	9.00	2.73	11.78	4.35
Tap-in	0.42	0.70	0.44	0.58	0.62	0.77	0.45	0.69	0.25	0.46	0.22	0.44
Penetration ^c	6.50	2.12	6.33	2.42	7.23	2.05	7.64	2.62	9.38	2.26	5.78	1.79
Alley-hop	0.38	0.70	0.26	0.45	0.15	0.38	0.18	0.40	0.00	0.00	0.56	0.88
Shoulders	1.27	0.92	1.41	1.34	1.00	1.15	1.00	1.00	1.50	1.77	1.00	1.00
Stop-shot	1.50	2.50	0.93	1.33	1.38	1.76	1.82	2.52	0.63	0.92	1.78	2.82
On the Shooter												
1 defensive player	17.54	3.11	17.74	3.12	17.38	2.40	18.00	3.07	16.13	3.80	19.00	2.50
2 or >2 defensive players ^c	3.04	1.84	3.78	2.19	3.31	2.21	2.91	2.43	4.63	2.72	2.11	1.90
Play Events												
Defensive rebound ^b	7.92	2.35	7.19	1.69	6.62	1.94	8.91	1.45	8.00	2.27	7.11	2.52
Offensive Rebound	1.81	1.06	2.37	1.71	1.69	1.44	1.55	1.13	2.00	1.51	2.22	1.86
Assists	3.77	2.53	5.11	2.95	4.00	4.26	2.73	2.24	3.25	1.98	4.56	2.01
Offensive foul	1.08	1.23	1.89	1.72	1.38	1.39	1.36	1.36	0.88	1.13	0.78	0.83
Defensive foul	6.42	2.04	4.52	1.89	5.46	2.33	3.82	2.36	4.00	2.62	4.67	2.40
Stopped	2.50	1.98	3.44	2.59	2.46	3.76	2.36	2.46	2.00	2.20	1.89	2.03
Block 1	12.15	3.09	11.44	2.71	12.77	2.55	11.45	3.21	12.63	2.39	12.22	1.39
Block 2	1.92	1.20	1.70	1.17	1.85	1.72	0.91	1.58	2.25	1.39	2.22	1.86
Turnover	1.15	1.05	1.70	1.51	1.77	1.09	1.91	1.22	1.50	0.76	0.78	1.09
Pick and Roll 1	4.35	2.31	4.78	2.52	3.08	3.43	4.45	2.07	4.13	2.90	4.33	2.55
Pick and Roll 2	0.19	0.40	0.15	0.36	0.23	0.60	0.18	0.40	0.25	0.46	0.11	0.33
Steal	1.04	1.00	1.00	1.11	0.69	0.75	1.00	1.00	0.75	0.71	1.33	1.32
Mean Played Clock-time	12.03	1.56	12.61	1.46	12.61	1.67	13.03	1.86	13.18	1.43	12.50	1.54

a Univariate statistically significant differences between home and away teams in type A games ($p < 0.05$).

b Univariate statistically significant differences between home and away teams in type B games ($p < 0.05$).

c Univariate statistically significant differences between home and away teams in type C games ($p < 0.05$).

Table 5. Discriminant analysis structure coefficients for game-related statistics of home and away teams in games type A and C (only significant discriminant functions were presented).

	Variables	GAMES A	GAMES C
Game Situation	Mean Played Clock-time	.145	-.029
	Even	.195	-.013
	Primary counterattack	-.102	.033
	Fast break	-.037	.055
	Secondary counterattack	-.153	.009
Defense	Pressing	.091	.032
	Zone	-.030	.009
Outcome	Succes	-.025	.070
	Failed	.108	-.032
Shot type/origin	Free-throws scored	-.240	.013
	Free-throws missed	-.140	.079
	2pt inside	.007	.042
	2pt out central	-.009	.036
	2pt out right	.078	-.057
	2pt out left	.047	-.138
	3pt central	.245	-.047
	3pt right	-.057	.023
Technical Execution	3pt letf	-.053	.060
	Stop-jump-shot	.190	-.195
	Tap-in	.013	.288
	Penetration	-.028	-.015
	Alley-hop	-.081	-.308*
	Shoulders	.045	-.155
On the Shooter	Stop-shot	-.109	.401*
	1 defensive player	.025	.329*
	2 or >2 defensive players	.138	-.524*
Play Events	Defensive rebound	-.137	.007
	Offensive Rebound	.149	.021
	Assists	.185	.228
	Offensive foul	.205	-.251
	Defensive foul	-.367*	.171
	Stopped	.155	.236
	Block 1	.058	.320*
	Block 2	-.070	-.271
	Turnover	.160	-.216
	Pick and Roll 1	.068	.216
	Pick and Roll 2	.040	.136
	Steal	-.008	-.006
	Ball possessions	.091	.041
	Eigenvalue	82.52	70.78
	Wilks Lambda	0.007	0,014
	Canonical correlation	0.80	0.90
	χ^2	35.63	32.35
	<i>P</i>	0.04	0.01
	Reclassification %	88.7	94.4

* Structure coefficients discriminant value $\geq |0.30|$

The discriminant analyses differentiated home and away teams were significant only for type A and C games (see Table 5), when analyzing all games and type B games the discriminant functions were non-significant ($p=0.336$ and $p=0.109$, respectively). The cross-validation percentages obtained for significant analyses were 88.7% for type A

games and 94.4% for type C games. The most powerful discriminators between home and away teams in type A games were the defensive fouls (SC=-0.37). For type C games, the performance indicators that best differentiated both groups were the alley-hop (SC=-0.31), the stop-shot (SC=0.40), the 1 defense on the shooter (SC=0.33), the 2 or >2 defense on the shooter (SC=-0.52), and block 1 (SC=0.32).

4. Discussion

The aim of the present study was to identify the technical and tactical aspects and situational variables that affect the NBA teams' performance during the last game quarter of close games. The main results showed different trends according to the game conditions (i.e., home scoring positive trend, away scoring positive trend, or balance scoring trend). As was argued the game location is a key factor in elite basketball (Pollard and Gómez, 2013), but particularly it is quite evident in the NBA league (Jones, 2008). This situational variable showed that during the fourth quarter of games with close margins of victory the home advantage effect is scoring, time, and opponent dependent (Moreno et al., 2012). According to de Saá et al. (2013) the last phases of NBA close games are not uniform showing a non-linear scoring trend. Under these critical and unpredictable contexts the teams are in a non-equilibrium state where each technical and tactical behavior may alter the game state and then the differences in the score. These authors found the importance of each ball possession (i.e., longer ball possessions) and each point scored (i.e., the importance of field-goal selection and free-throws) under this pressure situations that may affect the final outcome. Thus, the results of the present study highlight the importance of direct practical applications when designing the training tasks that simulate these critical scenarios.

Firstly, the importance of Starting Quarter Score during games with balanced scoring trends (see Figure 1) reinforce the idea of unpredictability (de Saá et al., 2013). In fact, the results showed the importance of defensive fouls, free-throws scored, and 3-point field-goals from central positions. On the one hand, the defensive fouls and free-throws reflected the importance of drawing fouls and to stop the opponents when the score is balanced. Specifically, during the last stages of basketball games the fouls are a resource used by the teams to reduce the game pace and comeback the score differences (Bar-Eli and Tractinsky, 2000; Kozar et al., 1994). In addition, Malarranha et al. (2013) identified that the free-throws are important during the last five minutes of a close game for a positive game outcome (i.e., winning). Along these lines, the defensive fouling strategy during the last minutes tries to stop the game and reduces the points scored per possession by the fouling team via free-throws (e.g., fouling limits the chances of scoring 2- and 3-points field-goals in one possession) (Kenter, 2015). On the other hand, the importance of 3-point field-goals from central positions reflects the game-play based on inside-outside passes that generate open spaces for shooting and 1 on 1 situations (Mavridis et al., 2013). Additionally, de Saá et al. (2013) identified that ball possessions during close NBA games spend around 20 seconds for shooting during successful ball possessions. In fact, in the NBA league the point guard is the central role for ball distribution on shooting specialists that reduce the offensive predictability (Fewell et al., 2012). Thus, under this specific scenario the teams try to solve with better shot selection the ball possessions.

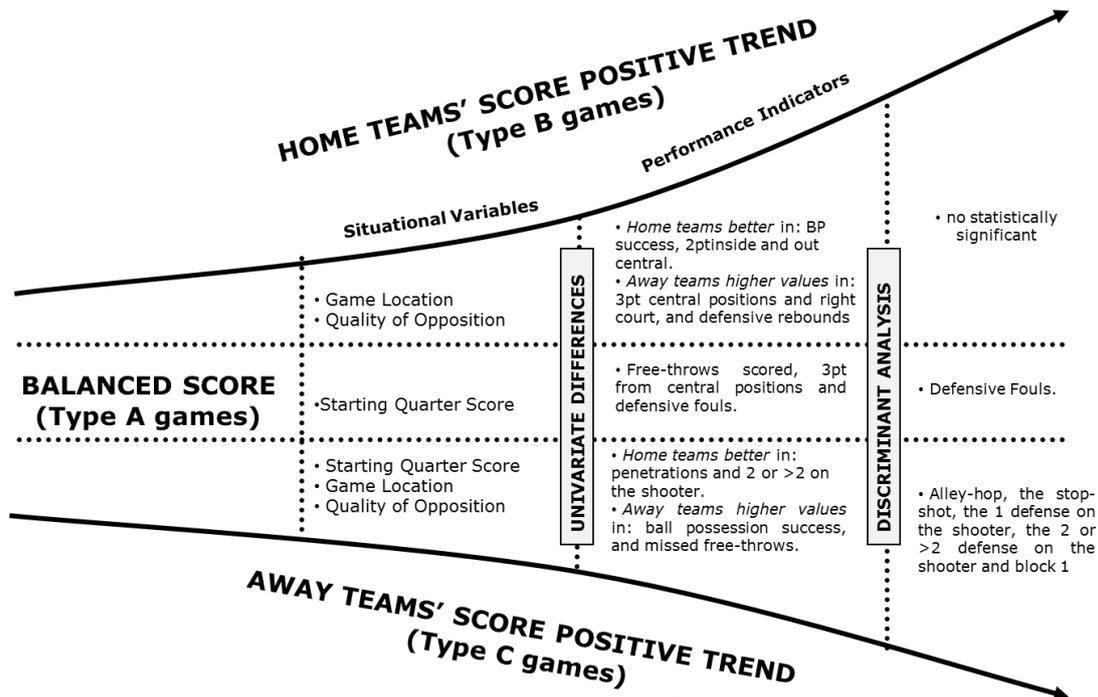


Figure 1. Significant situational variables and performances indicators according to game type and statistical analyses.

Secondly, the results of the home teams' positive trends (see Figure 1) showed the importance of quality of opposition (as better the home team as better their performance) and technical and tactical variables differentiating home and away teams. The home teams showed better performances in ball possession success, and 2-point field-goals inside and out from central positions. One of the main characteristics of the NBA league is the use of 1 on 1 situations to solve the possessions with the center players close to the basket (Fotinakis et al., 2002). This is a specific characteristic of the athleticism of the NBA players that allow them to shot near the basket and make dunks with a higher rate of effectiveness (Erculj and Strumbelj, 2015). On the other hand, the away teams were more focused on defensive rebounds and 3-point field-goals from central and right zones. According to Gómez et al. (2008) the away teams try to adapt their playing tactics to the home assertive actions such as rebounds or defensive pressure. Then, these teams may be forced to secure the defensive rebounds in an attempt to obtain each opponent's mistake (i.e., comeback the score). Also, the 3-point field-goals selection reflect that home teams defend more with man to man defenses that increase the pressure on the offensive players forcing the opponent to shot far from the basket (Gómez et al., 2010).

Thirdly, the results of games with away positive score trends (see Figure 1) reflected the importance of starting quarter score and quality of opposition (the best teams are less affected by the game location). These results reinforce the idea that game location and quality of opposition are time-dependent variables in basketball (Jones, 2008; Moreno et al., 2012). In fact, slight changes in the score (away teams' positive starting quarter scores) affect away teams' performance during the last stages of close games (de Saá et

al., 2013). On the one hand, the results showed that home teams obtained higher values in block 1, penetration, and 2 or >2 defensive players. These results can show that home teams try to stop the positive trends from away teams with defensive pressure on the shooter in order to steal the ball or to force bad shots from the offensive player (Gómez et al., 2010). In addition, the use of penetrations is a resource to obtain quick and effective ball possessions in an attempt to reduce the differences in the score. Then, the home teams can use man to man defenses pressing hard the opponents and shortening the ball possession durations with penetrations for coming back the score. On the other hand, the away teams obtained better values than the home teams in 1 defensive player, stop-shot, alley-hop and ball possession success. These results enhance the importance of physical fitness of NBA players to stop the opponents with intense activity in defense (i.e., man to man defense) and dunks in attack after alley-hops (Erculj and Strumbelj, 2015). The ball possession success reinforce the idea that away teams that are ahead in the score used longer possession durations that generate better field-goal selection and assists when the home teams increase the defensive pressure (Gómez et al., 2008, 2010).

The present study has some limitations that have to be addressed in future studies. Further research should control for the impact of physical and technical-tactical demands along the game during close NBA games in different contexts (e.g., regular season or playoffs). In addition, the players' and teams' performance variability, the players' rotation, the starting five or the fouling problems during critical phases of close games are key factors and variables for future studies. From a methodological approach, future studies should increase the sample including at least one close game played at home and away for each franchise of the NBA League.

Lastly, the identified trends have specific practical implications during these game contexts (home and away teams' performances during fourth quarters in close games). The technical and tactical factors found as significant can be used when improving the ball possession effectiveness. Also, the information can be used by coaches during competition management in order to take advantage over the opponent. Although the stress and pressure of a close game can difficulty be simulated during a training session, NBA coaches should highlight the presence of exercises related to the technical and tactical parameters that emerged as relevant in this study. This approach would allow to improve the quality of their teams in those skills which were fundamental in the final phases of a NBA close games. In fact, in this type of games, even the scoring of just one more point (due to a scored free shot, for example) could determine the successful of an entire game.

5. References

- Altman, D. G. (1991). Some common problems in medical research. In Altman, D.G. (Ed.), **Practical statistics for medical research**, pp. 403-409. London: Chapman and Hall.
- Bar-Eli, M., and Tractinsky, N. (2000). Criticality of game situations and decision making in basketball: an application of performance crisis perspective. **Psychology of Sport and Exercise**, 1, 27-39.

- De Saá, Y., Martín, J. M., Sarmiento, S., Rodriguez, D., Aguilar-López, N., and García-Manso, J. M. (2013). Basketball scoring in NBA games: an example of complexity. **Journal of Systems Science and Complexity**, 26(1), 94-103.
- Duarte, R, Araújo, D, Folgado, H, Esteves, P, Marques, P, and Davids, K. Capturing complex, non-linear team behaviours during competitive football performance. **Journal of Systems Science and Complexity**, 26, 62-72
- Erčulj, F., and Štrumbelj, E. (2015). Basketball Shot Types and Shot Success in Different Levels of Competitive Basketball. **PloS one**, 10(6), e0128885.
- Fewell, J. H., Armbruster, D., Ingraham, J., Petersen, A., and Waters, J. S. (2012). Basketball teams as strategic networks. **PloS one**, 7(11), e47445.
- Fotinakis, P., Laparidis, C., Karipidis, A., and Taxildaris, K. (2002). Due pallacanestro a confronto. **Science Dello Sport**, 21(55), 52-56.
- Gómez, M.A., Lago, C., and Pollard, R. (2013). Situational variables. In T. McGarry, P. O'Donoghue and J. Sampaio (Eds.), **Routledge handbook of sports performance analysis**. Oxon: Routledge, 259-269.
- Gómez, M. A., Lorenzo, A., Barakat, R., Ortega, E., and Palao, J. M. (2008). Differences in game-related statistics of basketball performance by game location for men's winning and losing teams. **Perceptual and Motor Skills**, 106(1), 43-50.
- Gómez, M. A., Lorenzo, A., Ibáñez, S. J., Ortega, E., Leite, N., and Sampaio, J. (2010). An analysis of defensive strategies used by home and away basketball teams. **Perceptual and Motor Skills**, 110, 159-166.
- Gómez, M. A., Lorenzo, A., Ibáñez, S. J., and Sampaio, J. (2013). Ball possession effectiveness in men's and women's elite basketball according to situational variables in different game periods. **Journal of Sports Sciences**, 31(14), 1578-1587.
- Gómez M.A, Tsamourtzis, E., and Lorenzo, A. (2006). Defensive systems in basketball ball possessions. **International Journal of Performance Analysis in Sport**, 6, 98-107.
- Janeira, M. and Sampaio, J. (1997). Those different Leagues. *Journal of basketball studies*. Retrieved from: <http://www.tsoft.com/~deano>.
- Jones, M. B. (2007). Home advantage in the NBA as a game-long process. **Journal of Quantitative Analysis in Sports**, 3(4).
- Jones, M. B. (2008). A note on team-specific home advantage in the NBA. **Journal of Quantitative Analysis in Sports**, 4(3).
- Kenter, F. H. J. (2015). An Analysis of the Basketball Endgame: When to Foul When Trailing and Leading. In 9th MIT Sloan Sports Analytics Conference. Retrieved from <http://www.sloansportsconference.com/wp-content/uploads/2015/02/SSAC15-RP-Poster-Paper-An-Analysis-of-the-Basketball-Endgame.pdf>
- Kozar, B., Vaughn, R. E., Whitfield, K. E., Lord, R. H., and Dye, B. (1994). Importance of free-throws at various stages of basketball games. **Perceptual and Motor Skills**, 78, 243-248.
- Krause, J. (1999). **Basketball skills and drills**. Champaign: Human Kinetics.
- Lupo C, Minganti C, Cortis C, Perroni F, Capranica L, and Tessitore A (2012). Effects of competition level on the centre forward role of men's water polo. **Journal of Sports Sciences**, 30, 889-897.

- Malarranha, J., Figueira, B., Leite, N., and Sampaio, J. (2013). Dynamic modelling of performance in basketball. **International Journal of Performance Analysis in Sport**, 13, 377-387.
- Marcelino, R, Mesquita, I, and Sampaio, J (2011). Effects of quality of opposition and match status on technical and tactical performances in elite volleyball. **Journal of Sports Sciences**, 29, 733-741.
- Mavridis, G., Laios, A., Taxildaris, K., and Tsiskaris, G. (2003). Developing offense in basketball after a return pass outside as crucial factor of winning. **Inquiries in Sport and Physical Education**, 2, 81-86.
- Melnick, M. J. (2001). Relationship Between Team Assists and Win-Loss Record in the National Basketball Association. **Perceptual and Motor Skills**, 92(2), 595-602.
- Moreno, E., Gómez, M. A., Lago, C., and Sampaio, J. (2013). Effects of starting quarter score, game location, and quality of opposition in quarter score in elite women's basketball. **Kinesiology**, 45, 48-54.
- O'Donoghue, P., and Holmes, L. (2015). **Data analysis in sport**. London and New York: Routledge Taylor and Francis Group.
- Oliveira, T., Gómez, M.A., and Sampaio, J. (2012). Effects of game location, period, and quality of opposition in elite handball performances. **Perceptual and Motor Skills**, 114, 783-794.
- Onwuegbuzie, A. J. (2000). Factors Associated with Success Among NBA Teams. **The Sport Journal**, 3(2), Retrieved from: <http://www.thesportjournal.org/2000Journal/Vol3-No2/Onwue.asp>.
- Pollard, R., and Gomez, M. A. (2013). Variations in home advantage in the national basketball leagues of Europe. **Revista de Psicología del Deporte**, 22(1), 263-266.
- Sampaio, J., Janeira, M., Ibanez, S., and Lorenzo, A. (2006). Discriminant analysis of game-related statistics between basketball guards, forwards and centres in three professional leagues. **European Journal of Sport Science**, 6, 173-178.
- Sampaio, J, Lago, C, and Drinkwater, EJ (2010). Explanations for the United States of America's dominance in basketball at the Beijing Olympic Games 2008. **Journal of Sports Sciences**, 28, 147-152.
- Sampaio, J., McGarry, T., Calleja-González, J., Jiménez Sáiz, S., Schelling, X., and Balciunas, M. (2015). Exploring game performance in the national basketball association using player tracking data. 2015, **Plos One**, Epub ahead of print, 10,7: e0132894.
- Satter, D. J. (2003). An empirical analysis of the final four participants in the NCAA Division I men's basketball tournament, 1987-2003., University of North Carolina., Chapel Hill.
- Tabachnick, BG, and Fidell, LS (2007). **Using Multivariate Statistics**. Boston: Allyn and Bacon.
- Vaz, L, Van Rooyen, M, and Sampaio, J (2010). Rugby game-related statistics that discriminate between winning and losing teams in IRB and Super twelve close games. **Journal of Sports Science and Medicine**, 9, 51-55.

Address correspondence:

Miguel Ángel Gómez Ruano
Faculty of Physical Activity and Sport Sciences
Polytechnic University of Madrid,
C/ Martín Fierro s/n; 28040,
Madrid, Spain.
E-mail (magor_2@yahoo.es).