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Research article

Effects of consecutive basketball games on the game-related statistics that discriminate winner and losing teams

Sergio J. Ibáñez [1]✉, Javier García [1], Sebastian Feu [1], Alberto Lorenzo [2] and Jaime Sampaio [3]
[1] Faculty of Sports Sciences, University of Extremadura, Spain, [2] Faculty of Sports Sciences, Polytechnic University of Madrid, Spain, [3] Research Center for Sport Sciences, Health and Human Development, Portugal

Abstract
The aim of the present study was to identify the game-related statistics that discriminated basketball winning and losing teams in each of the three consecutive games played in a condensed tournament format. The data were obtained from the Spanish Basketball Federation and included game-related statistics from the Under-20 league (2005-2006 and 2006-2007 seasons). A total of 223 games were analyzed with the following game-related statistics: two and three-point field goal (made and missed), free-throws (made and missed), offensive and defensive rebounds, assists, steals, turnovers, blocks (made and received), fouls committed, ball possessions and offensive rating. Results showed that winning teams in this competition had better values in all game-related statistics, with the exception of three point field goals made, free-throws missed and turnovers ($p \geq 0.05$). The main effect of game number was only identified in turnovers, with a statistical significant decrease between the second and third game. No interaction was found in the analysed variables. A discriminant analysis allowed identifying the two-point field goals made, the defensive rebounds and the assists as discriminators between winning and losing teams in all three games. Additionally to these, only the three-point field goals made contributed to discriminate teams in game three, suggesting a moderate effect of fatigue. Coaches may benefit from being aware of this variation in game determinant related statistics and, also, from using offensive and defensive strategies in the third game, allowing to explore or hide the three point field-goals performance.

Key words: Fatigue, basketball, young players, game-related statistics.

Introduction

Performance analysis in ball team sports such as basketball is a fundamental tool for coaches, allowing them to have valid and reliable information concerning their team and opponents. Generally, coaches and researchers use this information to identify the most valuable players and the importance of certain specific roles (Sampaio et al., 2006a), to assess the impact of rule changes (Gómez et al., 2006), to investigate the home advantage (Carron et al., 2005; Pollard, 2008) or to evaluate the participation in the game by starting and reserve players, with the goal of determining how each player contributes to team performance (Sampaio et al., 2006b).

Available research has identified differences between winning and losing teams in two-point field goals and defensive rebounds (Gómez et al., 2008; Ibáñez et al, 2003; Ittenbach and Esters, 1995; Karipidis et al., 2001). However, it seems clear that the discriminant game-related statistics change according to the games specific context, i.e., a regular season game outcome depends upon the performance in different variables than a play-off game (Sampaio and Janeira, 2003). Therefore, other game-related statistics may emerge as discriminant in other specific contexts, such as free-throws (Christoforidis et al., 2000), three-point field goal attempts and assists (Gómez et al., 2006) in competitions such as the world championships. Research also attempted to relate the championships final classification with game ball possessions, offensive and defensive ratings. After analyzing five world championships (under-18, senior, men's, and women's), Ibáñez et al. (2003) concluded that the best ranked teams had higher offensive coefficients and fewer ball possessions.

The players and the teams' performances can decrease after several consecutive games. For example, Montgomery et al. (2008) identified decreases in several physical capacities (speed, agility, and jump power) during 3-day tournaments. This may be due to accumulated fatigue from successive games, which affects decision-making and skill execution (Gabbett, 2008; Lyons et al., 2006; Royal et al., 2006). This way, Balciunas et al. (2006) highlighted the importance of using adequate conditioning and recovery training programs. In fact, monitoring fatigue is important, particularly in younger players who always want to perform optimally in all the stages of the game, which may have the consequence of an excessive physical exertion after various consecutive games (Griffin and Unnithan, 1999).

Research has also analyzed the impact of high and moderate intensity total body fatigue in the precision of the pass, comparing expert and novice basketball players (Lyons et al., 2006). It was found that following high intensity fatigue the pass performance decreased in both groups. The results indicated that experts are better than novice when they are moderately or extremely fatigued. Furthermore, Royal et al. (2006) found that fatigue does not always affect athletes negatively because decision-making can improve when under high effort conditions.

Therefore, it seems very clear that these fatigue effects are present in basketball games, particularly in tournaments with consecutive games. Concerning the topic of match analysis, it seems plausible that the game-related statistics that determine winners and losers in the first game of these 3-day tournaments may be different from those of the last game. That is, fatigue may induce different consequences in teams' behaviour during basketball

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games. Thus, the aim of the present study was to identify the game-related statistics that better discriminated basketball winning and losing teams in each of the consecutive games played.

Methods

Sample

The data for this study were obtained from the Spanish Basketball Federation and include all played games during the 2005-2006 and 2006-2007 seasons in the Under-20 league. All data was gathered by the specialized trained technicians. From a sub-sample of 5 games, inter and intra-observer reliability scores were respectively above 0.95 and 0.97 for all game-related statistics. This national tournament is played in four periods each one consisting of a 3-consecutive day competition, i.e., each team plays one game per day. A total of 223 games were analyzed with the following variables, selected according to the FIBA (International Basketball Federation) normative for game analysis: two and three-point field goal (made and missed), free-throws (missed and made), offensive and defensive rebounds, assists, steals, turnovers, blocks (made and received), fouls committed, ball possessions and offensive rating. The ball possessions and the offensive rating were calculated as suggested by Oliver (2004) and Kubatko et al. (2007) by the following equations:

Ball Possessions = (field-goals attempted) - (offensive rebounds) + (turnovers) - 0.4 x (free-throws attempted)

Offensive Rating = (Points Scored / Ball Possessions) x 100

Data analysis

All the game-related statistics were normalized to 100 ball possessions in order to account for differences in game pace (Sampaio and Janeira, 2003). A 2 × 3 factorial Anova (game outcome: winners, losers; game number: first, second, third) was performed in order to identify univariate within main effects and interactions. Afterwards, a descriptive discriminant analysis was employed to identify a subset of game-related statistics that discriminated between winning and losing teams in each of the three consecutive games played in each 3-day competition. Also, this analysis allowed to identify the best mathematical equation so that the group means on the function were as different as possible and the accuracy of this equation (Klecka, 1990). In each of the three subsamples (consecutive games) one discriminant function was obtained and interpreted based on examination of the structure coefficients (SC) greater than |0.30| (Tabachnick and Fidell, 2007). Validation of discriminant models was conducted using leave-one-out classification (Norušis, 1993), i.e. each case is classified by applying the classification function computed from all the data except the case being classified (Lachenbruch, 1975). The statistical analysis was performed using SPSS software 15.0, and significance was set at $p \leq 0.05$.

Results

The descriptive results and univariate differences from both seasons of the under-20 league for each game played are presented in Table 1. Winning teams in this competition had better values in all game-related statistics, with

Table 1. Descriptive statistics and effects of game, game outcome and interaction of the game-related statistics in the under-20 league.

Game number	Game 1				Game 2				Game 3			
Outcome	Winners		Losers		Winners		Losers		Winners		Losers	
Variable	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
2-pt field goal made (GO)	37.48	7.80	29.69	7.71	37.38	8.63	29.99	6.40	38.74	7.50	30.56	7.36
2-pt field goals missed (GO)	36.51	10.73	40.24	10.83	36.46	10.76	41.22	9.95	37.88	9.53	41.20	10.18
3-pt field goal made (GO)	10.18	4.19	7.95	3.93	9.10	4.20	7.29	3.58	10.34	4.28	7.47	3.71
3-pt field goals missed	19.86	6.41	20.31	5.65	20.09	5.77	21.49	6.15	20.30	6.68	21.61	7.26
Free throw made (GO)	21.53	11.45	17.85	9.70	21.54	10.47	18.95	11.58	24.92	13.73	18.52	10.42
Free throws missed	13.06	8.17	12.34	7.47	11.82	8.45	13.19	9.77	13.13	7.90	11.16	6.00
Defensive rebounds (GO)	26.15	5.62	21.59	5.39	26.41	4.70	22.00	5.13	26.18	5.28	21.36	4.01
Offensive rebounds (GO)	19.79	7.71	17.24	7.87	18.97	7.07	18.55	6.39	20.28	8.13	17.35	8.32
Assists (GO)	18.95	8.50	13.04	6.15	19.05	7.16	13.33	6.46	19.95	7.26	14.07	6.96
Steals (GO)	19.48	7.17	15.94	6.00	18.60	7.45	15.80	4.88	18.46	9.44	14.89	6.14
Turnovers (GN, game 2 vs. 3)	30.04	7.27	31.13	7.64	29.36	8.96	31.52	8.75	28.33	8.19	28.35	7.71
Blocks made (GO)	5.84	4.79	4.82	3.38	5.43	3.62	4.48	3.26	6.40	4.02	4.25	3.45
Blocks received (GO)	4.67	3.30	5.60	4.63	4.42	3.56	5.48	3.70	4.62	4.39	6.12	4.06
Fouls committed (GO)	31.98	8.06	32.81	9.39	31.18	9.54	33.69	9.49	32.13	9.61	33.47	8.34
Fouls received (GO)	34.21	12.02	31.55	10.06	33.29	11.33	32.13	13.28	35.81	13.29	30.68	9.11
Offensive Rating (GO)	127.86	25.63	101.13	24.95	123.52	22.42	100.72	20.59	133.32	27.47	102.10	23.81
Defensive Rating (GO)	103.40	23.32	123.61	27.12	105.07	21.90	119.75	25.90	108.01	27.75	126.12	21.24

(GO) statistical significant effect of game outcome; (GN) statistical significant effect of game number, the numbers identify post-hoc pair differences between games 1, 2 or 3.

the exception of 3 point field goals and free throws missed and turnovers ($p \geq 0.05$). The main effect of game number was only identified in turnovers, with a statistical significant decrease between the second and third game. No interaction was found in the analysed variables (Table 1).

The results from the discriminant analysis are presented in Table 2. Overall function reclassifications were high for all three analyses (see Table 2). The structural coefficients allowed identifying the two-point field goals made, the defensive rebounds and the assists as common to the mean vectors that discriminate winning and losing teams in all three games. Additionally, only the three-point field goals made (SC = -0.34) has contributed to discriminate teams in game three.

Table 2. Discriminant variables between winning and losing teams in under-20 league during the 2005-2006 and 2006-2007 seasons. Results are the structure coefficients (SC) of the discriminant functions.

Game-related statistics	Game 1	Game 2	Game 3
2-pt field goal made	. 48 *	.46 *	.52 *
2-pt field goals missed	-.16	-.22	-.16
3-pt field goal made	. 26	.22	.34 *
3-pt field goals missed	-.03	-.11	-.08
Free throw made	. 16	.11	.25
Free throws missed	.04	-.07	.13
Defensive rebounds	. 40 *	.43 *	.49 *
Offensive rebounds	.15	.03	.17
Assists	. 38 *	.40 *	.39 *
Steals	-.25	.21	.21
Turnovers	-.07	-.11	-.00
Blocks made	.11	.13	.27
Blocks received	-.11	-.14	-.16
Fouls committed	-.04	-.12	-.07
Fouls received	.11	.04	.21
Eigenvalue	1.07	1.08	1.11
Wilk's Lambda	.48	.47	.47
Canonical Correlation	.72	.72	.72
Chi-squared	98.23	99.85	100.61
Significance	<.001	<.001	<.001
Reclassification	85.4%	88.3%	88.2%

* $SC \geq |.30|$.

Discussion

The aim of the present study was to identify variations in game-related statistics that discriminate basketball team's winning and losing performances when playing consecutive games. The only differences found by factorial ANOVA was a decrease in turnovers between the second and third game for both winners and losers, suggesting that team performances along the three consecutive games were very similar, thus, not confirming that accumulated fatigue may impair team performance. In fact, it might be suggested that this decrease in turnovers is due to players' extra precautions facing the importance of this last game towards the tournament final classification. Previous results from Drinkwater et al. (2005) have showed that fitness levels in high-performance basketball programs overall do not substantially change over the competitive season. Despite our results are concerning three consecutive games tournaments, it seems clear that unlimited player substitutions in basketball allow teams to maintain performance levels across games.

However, the link between fatigue and performance (Montgomery et al., 2008) can be better identified by the discriminatory power of the three-point field goal, appearing in the third game of the tournament. In fact, winning teams were able to shoot better from longer distances and this could be the result of exhibiting higher conditioning status and/or the losing teams' exhibiting low conditioning in defence. This last suggestion is also possible, because three-point field-goals defence demands for additional distance covered and most probably higher energy costs (Reilly, 1997). Research is scarce in these subjects, however in women's games Gómez et al. (2006) found that the game outcome was most discriminated by 3 point field-goals which may be supporting this argument. In fact, for players with less strength (younger players and women) this long-distance field-goal discriminates between skills and physical conditioning (strength and endurance). If there is less defensive opposition in the third consecutive game (probably by fatigue effects), players will shoot with less defensive pressure, and will probably increase shooting efficacy (Ibáñez et al., 2008). This supposed influence of fatigue in game performance should be specifically and directly addressed in future research.

The remaining results seem to confirm previous studies by identifying the same game-related statistics that discriminate winning and losing teams. The contribution of defensive rebounds to winning basketball games is already widely documented (Gomez et al., 2008; Ibáñez et al, 2008; Sampaio et al., 2006b). This statistic represents the "teams' ability to recover the ball after opponent's missed shots and a successful defensive rebounding team probably has more opportunities to shoot, score points and win the game" (Sampaio and Janeira, 2003). Indirectly, high level performances are associated with i) game rhythm, because more defensive rebounds implies more fast-break ball possessions; ii) players somatic characteristics, taller and stronger players secure more rebounds; iii) technical and tactical preparation, pivoting, blocking, anticipation, securing and pulling the ball away, and, iv) muscular fitness, particularly in stretch-shortening-cycle jumping performances.

These results also demonstrated the obvious importance of two-point field goals and assists to game outcome, which is also well documented in available research (Gomez et al., 2006; Ibáñez et al, 2003;Karipidis et al., 2001; Melnick, 2001). Expert performances in these game-related statistics dominate the skills and their teams generate advantageous offensive patterns situations, with low opposition. They require good decision-making, based on good game interpretation, anticipation, and coordination between players.

Conclusion

Overall team performances (as measured by game-related statistics) along the three consecutive games were very similar, thus, not confirming an accumulated fatigue effect. The identification of a decrease in turnovers between the second and third consecutive game strengthened the previous statement. However, the discriminatory power of

the three-point field goal in the third game suggested that winning teams were able to shoot better from longer distances and this could be the result of exhibiting higher conditioning status and/or the losing teams' exhibiting low conditioning in defense. Facing these results, basketball coaches (and players) may benefit from being aware of this small variation in game determinant related statistics. Also, they could benefit from using offensive and defensive strategies in the third game allowing for exploring or hide the tree point field-goals variable

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Key points

- Overall team performances along the three consecutive games were very similar, not confirming an accumulated fatigue effect.
- The results from the three-point field goals in the third game suggested that winning teams were able to shoot better from longer distances and this could be the result of exhibiting higher conditioning status and/or the losing teams' exhibiting low conditioning in defense.

AUTHORS BIOGRAPHY

Sergio-José IBÁÑEZ
Employment
Associate Professor. Faculty of Sport Science. University of Extremadura.
Degree
PhD
Research interests
Monitoring training and competition in team sports. Game Analysis in Team Sports
E-mail: sibanez@unex.es

Javier GARCÍA
Employment
PhD student in Faculty of Sport Science. University of Extremadura.
Degree
Bachelor
Research interests
Game analysis in team sports.
E-mail: chapilotto@hotmail.com

Sebastian FEU
Employment
Associate Professor. Faculty of Sport Science. University of Extremadura.
Degree
PhD
Research interests
Monitoring training and competition in team sports.
E-mail: sfeu@unex.es

Alberto LORENZO
Employment
Associate Professor. Faculty of Physical Activity and Sport Sciences. Technical University of Madrid.
Degree
PhD
Research interest
Notational Analysis in Team Sports, Expertise and development of Talent.
E-mail: alberto.lorenzo@upm.es

Jaime SAMPAIO
Employment
Full Professor, Research Center in Sport Sciences, Health and human Development (CIDESD), University of Trás-os-Montes e Alto Douro at Vila Real.
Degrees
MSc, PhD
Research interests
Performance in team sports.
E-mail: ajaime@utad.pt

✉ **Sergio J. Ibáñez**
Associate Professor, Faculty of Sports Sciences, University of Extremadura, Avd. de la Universidad s/n, 10071 Cáceres, Spain