EFFECTS OF GAME LOCATION, TEAM QUALITY AND FINAL OUTCOME ON GAME-RELATED STATISTICS IN PROFESSIONAL HANDBALL CLOSE GAMES

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Abstract:

The aim of this study was to identify the effects of team quality, game location and final outcome on handball performance indicators during close games. The sample consisted of 126 close games (goal differences of 1.98±1.37) from the Spanish Professional Men's Handball League (2012/13). Factor analysis identified six factors: Factor 1 – successful 6m and 7m shots and unsuccessful 6m, 7m and 9m shots; Factor 2 – successful 6m and 9m shots and unsuccessful saves from 9m shots; Factor 3 – successful and unsuccessful counter-attack shots, assists, blocks and recovered balls; Factor 4 – successful and unsuccessful saves from 7m shots; Factor 5 – successful and unsuccessful saves from counter-attack shots; Factor 6 – yellow cards and successful saves from 6m shots. A mixed linear model identified the effects of *team quality*, *game location* and *game outcome* on the previously identified factors. *Game location* effects were significant for Factor 3, with higher values for home teams. *Game outcome* main effects were identified for Factors 3, 5 and 6, with teams having higher values when winning. The *team quality* was significant for Factor 3, with higher values for superior teams. The *team quality* x *game outcome* and *team quality* x *game location* interactions were significant for Factor 3. The *game location* x *game outcome* interaction was significant for Factors 2 and 3. These findings can contribute to a better understanding of the situational variables' determinants of elite handball performances, helping the coaches to prepare the players accordingly.

Key words: *performance analysis, situational variables, performance indicators*

Introduction

Nowadays, the effect of situational variables has become a topic of great interest in performance analysis in team sports (Gómez, Lago, & Pollard, 2013; Gómez, Lorenzo, Ibáñez, & Sampaio, 2013; Lago, 2009; Lago & Martín, 2007; Moreno, Gómez, Lago, & Sampaio, 2013; Rogulj, Srhoj, & Srhoj, 2004; Taylor, Mellalieu, James, & Shearer, 2008; Tucker, Mellalieu, James, & Taylor, 2005). Handball matches are a result of interactive activity of two confronting teams and external influences of the environment that may affect the game outcome (Srhoj, Rogulj, Padovan, & Katić, 2001). In particular, specific game constraints account for several differences when game location, team quality, or game type was studied. Home advantage effect in handball was described as relevant in final outcome with values ranging from 61% to 66% in European leagues (Pollard & Gómez, 2012). Also, the importance of game type was argued by Meletakos and Bayios (2010). The authors stated that close games (i.e. those defined as games where both teams have the same chance to win with goal difference of two or less goals) defined the competitiveness of a league. Besides, the importance of game type and team quality increases the importance of interactive effects of situational variables. For example, there are more different game constraints during a close game played by high-quality (strong) teams, where the game pace may reduce the number of ball possessions, for example, than there are during an unbalanced game played by low-level (weak) teams, where the game pace is high and the number of ball possessions can be large (see Gómez, Lorenzo, Barakat, Ortega, & Palao, 2008; Sampaio & Janeira, 2003). The research focused on close games in team sports such as basketball, volleyball, water polo or football (Castellano, Casamichana, & Lago, 2012; Gómez, et al., 2008; Gómez, Lorenzo, et al., 2013; Lupo, Condello, & Tessitore, 2012; Lupo, Condello, Capranica, & Tessitore, 2014; Marcelino, Sampaio, & Mesquita, 2011) has reflected the importance of this game outcome type and specifically the determination of particular situations in the game and consequently the performance indicators related to each situation-related condition. Within this

research framework, the study of situational variables in handball is very scarce; from a dynamic perspective the only available study was developed by Oliveira, Gómez, and Sampaio (2012). The authors studied the attack performance indicators according to game period, team quality and game location. Their results showed that shooting efficiency was higher for home teams from the court zones closer to the goal (i.e. close-range shots or 6m shots). Also, both teams (home and away) scored more goals during the last five minutes of both halves of handball matches. However, interest in identifying and describing the importance of performance indicators in both phases, that is, in attack and defense, according to game location, game outcome and team quality during handball close games does exist. Therefore, the aim of the present study was to identify the importance of performance indicators according to situational variables (game location and team quality) and game outcome (win, draw, defeat) in Spanish handball close games.

Methods

Sample and variables

Data was collected from the open-access official website of the Spanish Professional Men's Handball League (ASOBAL) during the season 2012/13. The sample was comprised of 240 games. In order to control for the highest game competitiveness, the sample was pooled into different game types according to goal difference, then three types of games were obtained (using *k*-means cluster analysis): close games (goal difference of 1.98±1.37; n=126), balanced games (goal difference of 6.66±1.52; n=87), and unbalanced games (goal difference of 14.96±2.79; n=27). As was stated by Meletakos and Bayios (2010), close games represent the highest level of performance between confronting teams in an open outcome affected by environment and contextual factors. Therefore, the present study used the sample of the close games described (n=126). Ethics approval was obtained from the Faculty of Physical Activity and Sport Sciences from the Polytechnic University of Madrid, Spain.

Data was collected by professional technicians of the league. To assess data reliability four games were randomly selected and two different observations were done to assess inter-rater reliability. As for the game-related statistics, the obtained Cohen's Kappa was high (above .96). The following performance indicators were gathered: successful and unsuccessful 6m, 7m, 9m and counter-attack shots (*successful* was defined when the player scored a goal, and *unsuccessful* when the player missed the shot), yellow cards, exclusions, assists, blocked shots, recovered balls, turnovers, successful and unsuccessful (goalkeepers') saves from 6m, 7m, 9m throws, and counter-attack shots (*successful* was defined when the goalkeeper saved the shot, and *unsuccessful* when the goalkeeper conceded a goal).

Dependent variables

Factor analysis using principal components and varimax rotation was done on performance indicators to reduce the dimensions of the analysis. Kaiser-Meyer-Olkin measure of sampling adequacy was high (.67) and the anti-image correlation matrix revealed that all variables were above the acceptable level of .5. Analysis of the communalities did not reveal the values below the acceptable level of .5. If the communality for a variable was less than 50%, the factor solution contained less than a half of the variance in the original variable, and thus the explanatory power of that variable might be better represented by the individual variable. The obtained principal components model accounted for 71.6% of the total variance. Six factors were extracted with eigenvalues above 1, and the criterion of |.60| for identifying substantial loadings on factors was used: Factor 1 (successful 6m and 7m shots, and unsuccessful 6m, 7m and 9m shots); Factor 2 (successful 6m and 9m shots and unsuccessful saves from 9m shots); Factor 3 (successful and unsuccessful counter-attack shots, assists, blocks and recovered balls); Factor 4 (successful and unsuccessful saves from 7m shots); Factor 5 (successful and unsuccessful saves from counter-attack shots); Factor 6 (yellow cards and successful saves from 6m shots). The extracted factor scores were saved as variables to be used in further data analysis (Table 1).

Independent variables

The variables *team quality*, *game location* (playing at home or away) and *game outcome* (win, draw, defeat) were used as independent variables comparing the six factors described previously. *K*-means cluster analyses were used to classify teams according to team quality. This variable was derived from the final ranking in the competition. From this analysis, three groups of teams were obtained: superior teams (finally ranked in the national league from 1st to 6th place), intermediate teams (ranked from 7th to 11th place), and inferior teams (ranked from 12th to 16th place).

Data analysis

A mixed linear model was applied to identify the main effects and interactions of team quality, game location and game outcome on the previously identified factors as already done by Sampaio, Drinkwater, and Leite (2010) and Gómez, Gómez, Lago, and Sampaio (2012). The Scheffé and Bonferroni *post-hoc* tests were carried out to establish comparisons between the groups. Similarly, the sizes of the impact were calculated using the partial eta squared (η_p^2). Effect sizes (ES) were calculated

Table 1. Factor loadings, eigenvalues, and variance explained using factor analysis

Performance indicators	Factors					
	1	2	3	4	5	6
Successful 6m shots	-.03	**-.79**	-.01	-.02	-.08	-.18
Successful 7m shots	**.98**	-.02	-.05	.01	-.03	-.01
Successful 9m shots	**.65**	**.64**	-.05	-.04	-.02	-.05
Successful counter-attack shots	-.01	.02	**.69**	.02	-.21	-.05
Unsuccessful 6m shots	**.98**	-.11	-.05	-.04	-.00	-.01
Unsuccessful 7m shots	**.99**	-.02	-.03	-.02	-.01	-.01
Unsuccessful 9m shots	**.99**	-.00	-.03	-.02	-.01	-.01
Unsuccessful counter-attack shots	-.05	-.07	**.63**	-.06	.38	.01
Successful saves from 6m shots	-.01	-.22	-.25	-.21	.02	**.68**
Successful saves from 7m shots	-.01	-.15	-.11	**.83**	.15	-.07
Successful saves from 9m shots	-.11	**.60**	-.20	-.34	.08	-.20
Successful saves from counter-attack shots	-.03	.03	.12	-.05	**.93**	.05
Unsuccessful saves from 6m shots	.05	-.81	-.25	-.14	.08	.31
Unsuccessful saves from 7m shots	-.01	-.08	-.15	**.91**	-.02	-.03
Unsuccessful saves from 9m shots	-.09	**.88**	-.02	-.14	-.08	-.17
Unsuccessful saves from counter-attack shots	-.03	.00	.11	.06	**.91**	.07
Yellow cards	-.03	.45	.06	.27	.01	**.61**
Exclusions	-.13	.24	-.18	.52	-.32	.01
Assists	-.03	.10	**.71**	-.07	.20	.04
Turnovers	-.04	-.17	.11	-.02	.08	.35
Blocks	-.06	-.01	**.61**	-.13	.14	-.23
Recovered balls	-.04	-.04	**.70**	-.15	.02	.21
Eigenvalue	4.48	3.34	3.10	1.97	1.70	1.17
Variance	20.39	15.22	13.95	8.95	7.73	5.33

to show the magnitude of the effects, and their interpretation was based on the following criteria: 0.01 ≤ small effect, 0.06 ≤ medium effect, 0.14 ≤ large effect (Cohen, 1988). The statistical analyses were performed using IBM SPSS statistics for Windows, version 20.0 (SPSS Inc., Chicago IL), and statistical significance was set at $p<.05$.

Results

Table 2 presents the descriptive results for all performance indicators in each game context.

Table 3 presents the results of the mixed linear model for Spanish handball men teams. The *team quality* main effect was identified for Factor 3. The superior teams obtained better values, followed by the intermediate and then inferior teams. The *game location* main effect was identified for Factor 3. Home teams performed better than away teams. The *game outcome* effect was significant for Factor 2, Factor 5 and Factor 6. The teams obtained higher values when winning than when drawing or losing a game.

The interaction between *team quality* and *game location* (Figure 1), as well as the interaction between *team quality* and *game outcome* was statistically significant for Factor 3 (Figure 2).

The interaction between *game location* and *game outcome* was statistically significant for Factor 2 and Factor 3.

Discussion and conclusions

This study provides new information about the effects of *team quality*, *game location* and final *game outcome* on the game-related statistics of close games in elite handball. In general, the data processed allowed us to identify those critical game-related indicators that were affected by playing either at home or away, as well as which of these variables were related to *game outcomes* and *team quality*. Despite the importance of close games in elite handball (Meletakos & Bayios, 2010), the research focusing on these games type is limited (Oliveira, et al., 2012) and the findings are still inconclusive. On the other hand, principal components analysis allowed us to reduce previously available game-related statistics to six main factors, although the uncorrelated nature of the original variables and difficulties in creating the factors with a sub-

Table 2. Descriptive results (means and standard deviations) in handball close games for each game statistic according to situational variables and all games

Game statistics	Team Quality						Game Outcome						Game Location				All games	
	Superior		Intermediate		Inferior		Win		Draw		Defeat		Home		Away			
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Successful 6m shots	15.3	5.6	14.8	4.8	14.5	6.1	15.5	5.1	15.3	6.8	14.0	5.1	14.8	5.3	14.7	5.6	14.8	5.4
Successful 7m shots	2.4	1.5	2.7	1.4	3.8	11.4	2.7	1.5	2.4	1.1	3.6	10.2	2.7	1.5	3.4	9.8	3.1	7.1
Successful 9m shots	6.8	5.0	6.2	4.3	7.0	6.8	6.5	4.6	6.0	4.6	6.9	6.3	6.6	4.7	6.5	6.1	6.6	5.5
Successful CA shots	2.9	2.2	2.4	2.1	2.4	1.7	2.8	2.2	2.1	1.8	2.4	1.8	2.5	1.9	2.5	2.0	2.5	2.0
Unsuccessful 6m shots	9.3	4.5	10.1	4.9	13.6	11.5	9.1	4.6	9.0	4.2	13.7	36.8	9.2	4.7	13.1	35.3	11.2	25.4
Unsuccessful 7m shots	1.1	0.9	0.7	0.8	19.4	15.7	0.9	0.9	0.9	1.1	15.7	13.9	1.1	1.0	14.2	13.2	7.8	15.3
Unsuccessful 9m shots	7.2	3.7	6.3	3.7	37.2	24.0	6.6	4.1	7.3	5.1	31.1	22.0	7.1	4.5	29.3	21.8	18.0	15.8
Unsuccessful CA shots	0.8	1.1	0.8	1.3	0.5	0.7	0.7	0.8	0.3	0.5	0.7	1.3	0.8	1.3	0.6	0.8	0.7	1.1
Successful saves from 6m	18.8	7.1	24.0	16.5	25.4	17.7	16.1	15.4	21.1	11.7	27.2	14.8	17.7	16.2	25.4	14.6	23.5	15.4
Successful saves from 7m	5.1	7.0	8.2	8.1	7.9	7.6	8.0	8.3	7.3	11.4	7.4	6.5	6.9	6.7	8.2	8.6	7.6	7.8
Successful saves from 9m	18.5	24.3	12.6	18.6	15.9	22.3	13.5	22.1	10.6	13.1	17.8	22.6	14.6	19.9	15.4	22.6	15.0	21.3
Successful saves from CA	4.8	8.7	13.1	12.7	7.2	11.5	6.3	13.4	8.5	13.4	12.5	9.4	10.6	12.3	9.0	8.5	9.8	8.1
Unsuccessful saves from 6m	14.8	5.6	15.4	5.0	14.2	5.9	14.1	5.3	15.2	6.7	15.4	5.1	14.2	5.6	15.5	5.3	14.9	5.5
Unsuccessful saves from 7m	2.4	1.4	2.7	1.6	3.5	9.4	3.3	9.3	2.2	1.3	2.8	1.5	3.1	8.1	2.7	1.6	2.9	5.8
Unsuccessful saves from 9m	7.7	4.8	5.6	4.1	6.6	6.3	6.6	5.9	6.1	4.6	6.2	4.7	6.9	5.8	5.8	4.4	6.3	5.2
Unsuccessful saves from CA	2.2	1.9	3.0	2.4	2.8	1.9	2.5	1.9	2.3	1.8	3.2	2.3	2.8	2.3	2.8	2.0	2.8	2.1
Yellow cards	3.2	0.6	3.1	0.6	3.2	0.8	3.1	0.6	3.1	0.9	3.3	0.5	3.2	0.7	3.2	0.6	3.2	0.7
Exclusions	3.8	1.5	4.4	1.7	4.2	1.8	4.3	1.8	4.5	1.9	4.1	1.6	4.2	1.7	4.3	1.8	4.2	1.7
Assists	3.5	41	1.8	2.3	0.6	1.5	1.8	3.2	1.5	2.6	1.5	2.2	1.9	3.2	1.4	2.1	1.6	2.7
Blocks	1.2	1,.3	1.3	1.5	0.5	0.8	1.2	1.4	1.2	1.8	0.8	0.9	1.1	1.5	0.9	1.1	1.0	1.3
Recovered balls	2.7	28	1.9	2.4	1.2	1.8	2.6	3.0	1.2	2.1	1.3	1.6	2.5	2.9	1.1	1.4	1.8	2.3
Turnovers	5.7	4.0	8.0	4.6	5.7	5.5	7.2	5.3	5.4	4.6	6.7	4.8	7.2	5.2	6.2	4.7	6.7	5.0

Legend: CA = counter-attack; M = mean; SD = standard deviation

Table 3. Results of the effect of team quality (superior, medium and inferior teams), game location (playing at home and away), and game outcome (win, draw, defeat) and their interactions on the previously identified factors (Principal Component Analysis, PCA)

Variable	Effect	F	P	Effect size	
First PCA Factor	Team quality	0.39	.673	---	
	Game location	0.00	.995	---	
	Game outcome	0.59	.554	---	
	Team quality x Game location	1.00	.368	---	
	Team quality x Game outcome	0.72	.540	---	
	Game location x Game outcome	0.75	.470	---	
Second PCA Factor	Team quality	0.19	.823	---	
	Game location	0.62	.430	---	
	Game outcome	1.42	.242	---	
	Team quality x Game location	0.33	.714	---	
	Team quality x Game outcome	1.51	.211	---	
	Game location x Game outcome	5.48	.005	.041	
Third PCA Factor	Team quality	18.54	.001	.127	SW; SI; IW
	Game location	7.07	.008	.027	
	Game outcome	3.77	.024	.029	WL
	Team quality x Game location	24.99	.001	.163	
	Team quality x Game outcome	18.81	.001	.181	
	Game location x Game outcome	5.47	.005	.041	
Fourth PCA Factor	Team quality	0.88	.414	---	
	Game location	0.41	.519	---	
	Game outcome	0.49	.611	---	
	Team quality x Game location	1.80	.167	---	
	Team quality x Game outcome	0.45	.715	---	
	Game location x Game outcome	0.32	.720	---	
Fifth PCA Factor	Team quality	2.77	.064	---	
	Game location	0.48	.489	---	
	Game outcome	20.03	.001	.135	WL
	Team quality x Game location	2.20	.113	---	
	Team quality x Game outcome	1.45	.229	---	
	Game location x Game outcome	0.30	.736	---	
Sixth PCA Factor	Team quality	0.48	.616	---	
	Game location	1.49	.223	---	
	Game outcome	4.60	.011	.035	WL
	Team quality x Game location	0.87	.419	---	
	Team quality x Game outcome	1.98	.116	---	
	Game location x Game outcome	0.45	.636	---	

Note: SI = statistically significant differences between the superior and intermediate teams p<.05; SW= statistically significant differences between the superior and inferior teams p<.05; IW = statistically significant differences between the intermediate and inferior teams p<.05; WL = statistical significant differences between the games won and lost (p<.05).

stantial amount of explained variance was evident (range 5.33% to 20.39%). It is likely that this is a reflection of the nature of handball, as can be seen from quite a number of possible interactions between all variables (McGarry & Franks, 2003; Reed & O'Donoghue, 2005).

The results obtained through mixed linear modelling allowed the identification of several important trends regarding game location, team quality and final outcome effects and their interactions. Previous research argued that game location and type of competition would configure different game tactics and strategies, and this would be reflected in different discriminant game-related indicators (Glamser, 1990; Schwartz & Barsky, 1977). One of the interesting results of our research is the importance of *game location* variable, in particular, the home teams showed higher values than away teams on

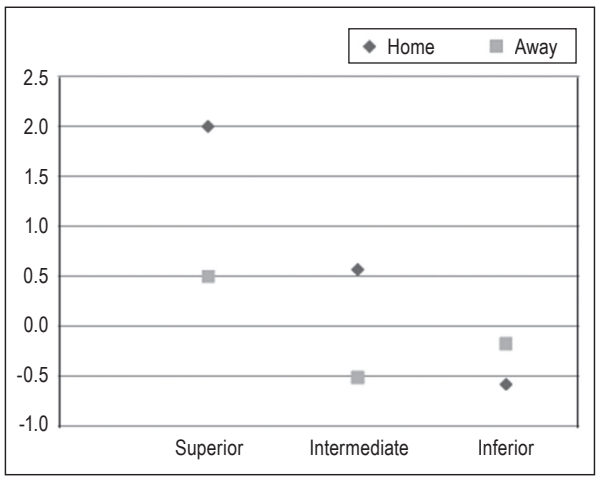

Figure 1. Variation of the principal components analysis factors (PCA Factor 3) in home and away games according to team quality (only the statistically significant results are presented).

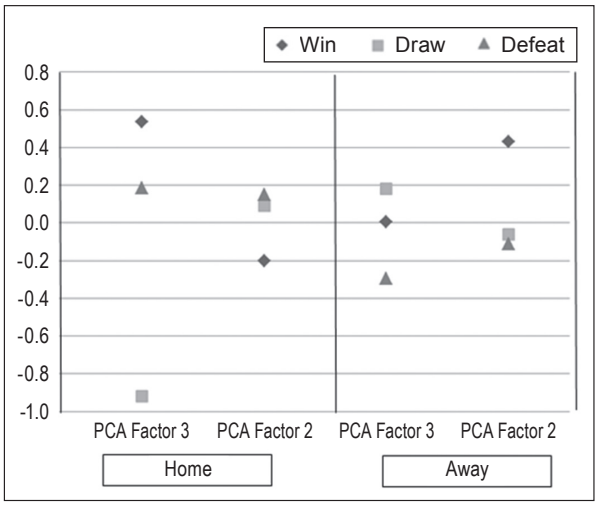

Figure 2. Variation of the Principal Components Analysis Factors 2 and 3 according to game location and game outcome (only the statistically significantly results are presented).

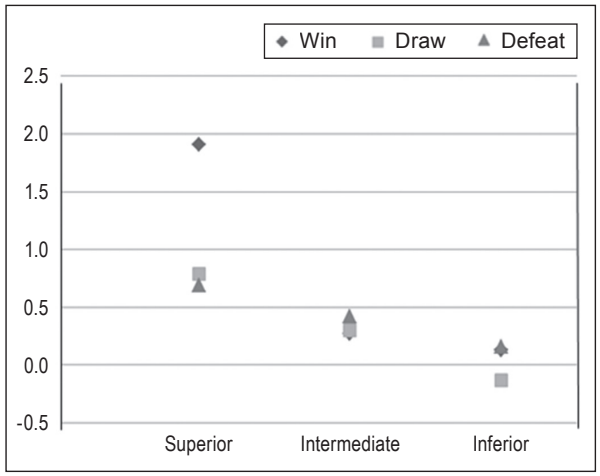

Figure 3. Variation of the Principal Components Analysis Factor 3according to team quality and game outcome (only the statistically significant results are presented).

Factor 3. Accordingly with the approach developed by Varca (1980), the present results showed that home teams outperformed their opponents in terms of instrumentality aggressive behaviour (i.e. behaviour aggressive enough to facilitate obtaining a victory), such as shots blocked, successful defensive actions and anticipations that may generate turnovers from the away teams showing dysfunctional aggressive behaviours. Given that team handball is marked by a large number of powerful physical contacts as far as their application is permitted by the rules of the game, the attacking and defensive actions are of paramount importance to seizing the best shooting position, the concept of territorial protection might be more important in handball than in other sports like basketball or soccer. With regard to attack statistics, our results have shown that assists, successful and unsuccessful counter-attack shots were more frequent for home teams. These results are partially similar to those provided by Oliveira et al. (2012), who found that shooting efficiency from the close range zones was higher for home teams. The results may be explained by a more assertive attitude of home teams (Sampaio, Ibáñez, Gómez, Lorenzo, & Ortega, 2008; Varca, 1980) suggested by an effect of match constraints, that is, home teams have increased their knowledge regarding the environment (e.g. crowd, court area, floodlights) and may decide to play with a higher defensive risk, the consequence being the increase in frequencies of counter-attack actions.

However, when interacting with *team quality* (see Figure 1), the results reflected different game trends. The superior teams performed better than the inferior and intermediate teams in Factor 3, when playing both at home and away. Conversely, the inferior teams performed better in Factor 3 during away games, and intermediate teams scored better on Factor 3 during home games. These results reinforce the importance of scoring effectiveness for superior teams in team handball. Ohnjec, Vuleta, Milanović, and Gruić (2008) found out that top-quality teams were more efficient in all the variables related to goal shooting (i.e. Factor 3: recovered balls, blocks, assists and both successful and unsuccessful counter-attack shots). Also, as was stated in the available literature, superior teams showed higher scoring effectiveness from different positions on the court (Rogulj, et al., 2004; Ohnjec, et al., 2008; Oliveira, et al., 2012). Conversely, the inferior teams may show the permeability of defenses when playing away and also, the non-defined situational efficiency of back court attackers. These behaviours may be caused by a poor quality of ball circulation (precision, speed and timing) in different contexts (i.e. playing at home or away) as was reflected by Factor 3 (assists, recovered balls

and blocked shots) (Gruić, Vuleta, & Milanović, 2006). The intermediate teams showed an increased feeling of territoriality when playing at home with higher values in defensive actions such as blocked shots, assists and successful counter-attack shots reflecting higher intensities during home games as opposed to away games.

The obtained results also showed an intriguing interaction of *final outcome* and *game location* on Factor 3 (recovered balls, blocks, assists and both successful and unsuccessful counter-attack shots): the home teams presented higher values when winning, and the away teams when drawing (Figure 2).

The available research into home advantage effect stated that referee bias may affect the *game outcome*. In fact, the referees' decisions may favour home teams in disciplinary decisions, as was found by Meletakos and Bayios (2010). Besides, one characteristic of away teams is the poorer defensive actions due to a dysfunctional aggression, meaning the defensive players have no success when preventing the attackers with allowed contacts, and then away players are forced to make fouls or violations sanctioned by 7m throws or free-throws (Shroj, et al., 2001). These results are more evident during winning games by home teams. However, in our research the away teams obtained higher results on Factor 3 during draw games. This fact may reflect that during a close game the pressure affects home teams and, consequently, the shooting effectiveness from 7m decreased. Also, home teams performed better on Factor 2 (successful 6m and 9m shots, and unsuccessful saves from 6m and 9m shots) when losing or drawing, while in away games when winning (Figure 2). These results reinforce the idea of better defensive actions and higher attack efficiency when playing at home than in away games (Sampaio, et al., 2008; Varca, 1980).

The results of the final outcome effects emphasize the impact both of the goalkeepers' saves efficiency and field shots efficiency in elite handball, as suggested in previous research (Gruić, et al., 2006; Rogulj, et al., 2004; Ohnjec, et al., 2008). Great influence of the goalkeeper's effectiveness on the game outcome in handball has been highlighted in several studies (Fuertes, Lago, & Casáis, 2010; Pori, Mohorič, Tomazini, & Šibila, 2009; Volossovitch & Gonçalves, 2003). Concerning the second group of variables, Vuleta, Milanović, and Sertić (2003) determined that the winning teams of the 2000 Men's European Handball Championship were significantly more efficient than the defeated teams in practically all types of shots: back-court shots, 6m shots and 7m throws. In fact, several studies have tried to provide a 'formula' of winning by reporting statistics of successful teams on the assumption that mimicking these figures would create a 'winning formula'. For example, by using a binomial logistic regression Volossovitch and Gonçalves (2003) proposed three variables that had a significant effect on the game outcome: goalkeeper's efficiency, field shot efficiency and counter-attack efficiency. Accordingly, our results showed (Figure 3) that Factor 3 (recovered balls, blocks, assists and both successful and unsuccessful counter-attack shots) was statistically significant when interacting with *team quality* x *game outcome*. In fact, the superior teams managed to win through success in recovered balls, assists and successful counter-attacks. Conversely, the intermediate and inferior teams obtained higher values when the result was a draw or defeat, reflecting that defensive pressure and counter-attack opportunities are match status-dependent, so the intermediate and inferior teams take risks in attack and defensive actions when drawing or losing. These results are in accordance with Gruić et al. (2006). These authors found that the top-level teams (best half teams of the league) are characterized by better counter-attack scoring efficiency due to an adequate defensive system applied (i.e. recovered balls), quick reactions to the opponents' unsuccessful shots (i.e. blocked shots), fast running and good selection of passing and shooting techniques (i.e. assists and successful counter-attack shots).

The existing notational analysis has provided preliminary information on the effects of situational variables on sporting performance at a behavioural level (for a review, see Gómez, et al., 2013). Nonetheless, most of the previous research has examined situational variables independently, not accounting for the possibility of higher-order interactions (e.g. playing at home, or losing). The results from interactive effects of game location, game outcome and team quality suggest how critical game statistic indicators might be affected by a particular context of the game. The present results contribute to a better understanding of the determinants of situational variables of elite handball performances, thus helping coaches to prepare their players accordingly. For example, if a notational analyst or coach has identified that some aspects of performance are adversely influenced by specific situational variables, possible causes can be examined, so that consequently the players' preparation for the match can be focused on reducing such effects.

Although this study has considered the impact of situational variables and game outcome in close games at a behavioural level in greater depth than any previous investigation, there are several limitations that should be addressed in future research. First, from a methodological perspective, the findings are limited to a certain extent by the sample size in that due to logistical and resource constraints, the matches were sampled only from one national championship (league) season. Future investigations should therefore attempt to maintain the current level of detailed analyses present in our study, but should apply it across different seasons

and/or national championships. In addition, the defensive and attack formations were not taken into account in the current study. Future studies should verify the impact of these variables. Finally, we suggest that tactical variables such as the duration of attacks, the number of attacking players involved, or the time segment of a game should also be considered.

In summary, the processed data allowed us to identify those critical game-related statistics that are affected during close games with a particular context of the game (playing at home or away and team quality) and the game outcome. The importance of these factors is reflected in changes in the teams' and players' activities as a response to match situations. Coaches should take into account these findings in order to improve the quality of technical, tactical and physical training.

References

Castellano, J., Casamichana, D., & Lago, C. (2012). The use of match statistics that discriminate between successful and unsuccessful soccer teams. *Journal of Human Kinetics*, *31*, 139-147.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). New York: Academic Press.

Fuertes, X., Lago, C., & Casáis, L. (2010). La influencia de la eficacia del portero en el rendimiento de los equipos de balonmano. [The influence of goalkeeper's effectiveness in handball team's performance. In Spanish.] *Apunts, Educación Física y Deportes, 99*, 72-81.

Glamser, F. (1990). Contest location, player misconduct, and race: A case from English soccer. *Journal of Sport Behavior, 13*(1), 41-49.

Gómez, M.A., Lago, C., & Pollard, R. (2013). Situational variables. In T. McGarry, P. O'Donoghue & J. Sampaio (Eds.), *Routledge handbook of sports performance analysis* (pp. 259-269). Oxon: Routledge.

Gómez, M.A., Gómez-López, M., Lago, C., & Sampaio, J. (2012). Effects of game location and final outcome on game-related statistics in each zone of the pitch in professional football. *European Journal of Sport Science, 12*(5), 393-398.

Gómez, M.A., Lorenzo, A., Barakat, R., Ortega, E., & 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., & 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, 14*, 1578-1587.

Gruić, I., Vuleta, D., & Milanović, D. (2006). Performance indicators of teams at the 2003 Men's World Handball Championship in Portugal. *Kinesiology, 38*(2), 164-173.

Lago, C. (2009). The influence of match location, quality of opposition, and match status on possession strategies in professional Association football. *Journal of Sports Sciences, 27*(13), 1463-1469.

Lago, C., & Martín, R. (2007). Determinants of possession of the ball in soccer. *Journal of Sports Sciences, 25*(9), 969-974.

Lupo, C., Condello, G., & Tessitore, A. (2012). Notational analysis of elite men's water polo related to specific margins of victory. *Journal of Sports Science and Medicine, 11*, 516-525.

Lupo, C., Condello, G., Capranica, L., & Tessitore, A. (2014). Women's water polo World Championships: Technical and tactical aspects of winning and losing teams in close and unbalanced games. *Journal of Strength and Conditioning Research, 28*(1), 210-222.

Marcelino, R., Sampaio, J., & Mesquita, I. (2011). Investigação centrada na análise do jogo: Da modelação estática à modelação dinámica. [Research on the game analysis: From static to dynamic modeling. In Portuguese.] *Revista Portuguesa de Ciências do Desporto, 11*(1), 481-499.

McGarry, T., & Franks, I. (2003). The science of match analysis. In T. Reilly & A.M. Williams (Eds.), *Science and soccer* (pp. 265-275). London: Routledge.

Meletakos, P., & Bayios, I. (2010). General trends in European Men's Handball: A longitudinal study. *International Journal of Performance Analysis in Sport, 10*(3), 221-228.

Moreno, E., Gómez, M.A., Lago, C., & 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.

Ohnjec, K., Vuleta, D., Milanović, D., & Gruić, I. (2008). Performance indicators of teams at the 2003 World Handball Championship for women in Croatia. *Kinesiology, 40*(1), 69-79.

Oliveira, T., Gómez, M., & Sampaio, J. (2012). Effects of game location, period and quality of opposition in elite handball performances. *Perceptual and Motor Skills, 114*(3), 783-794.

Pollard, R., & Gómez, M.A. (2012). Reassessment of home advantage in Spanish handball: Comment on Gutiérrez et al. (2012). *Perceptual and Motor Skills*, *115*, 1-7.

Pori, P., Mohorič, U., Tomazini, D., & Šibila, M. (2009). Differences in goalkeepers´ performance indicators at three consecutive Men's European Championships held in 2002, 2004 and 2006. In A. Hökelmann, K. Witte & P. O´Donoghue (Eds.), *Current Trends in Performance Analysis: World Congress of Performance Analysis of Sport VIII* (pp. 56-9). Aachen: Shaker Verlag.

Reed, D., & O'Donoghue, P. (2005). Development and application of computer-based prediction methods. *International Journal of Performance Analysis in Sport, 5*(3), 12-28.

Rogulj, N., Srhoj, V., & Srhoj, L. (2004). The contribution of collective attack tactics in differentiating handball score efficiency. *Collegium Antropologicum, 28*(2), 739-746.

Sampaio, J., Drinkwater, E.J., & Leite, N.M. (2010). Effects of season period, team quality, and playing time on basketball players' game-related statistics. *European Journal of Sport Science, 10*(2), 141-149.

Sampaio, J., Ibáñez, S.J., Gómez, M.A., Lorenzo, A., & Ortega, E. (2008). Game location influences basketball players' performance across playing positions. *International Journal of Sport Psychology, 39*(3), 205-216.

Sampaio, J., & Janeira, M. (2003). Statistical analysis of basketball team performance: Understanding teams' wins and losses according to a different index of ball possessions. *International Journal of Performance Analysis in Sport, 3*, 40-49.

Schwartz, B., & Barsky, S. (1977). The home advantage. *Social Forces, 55*(3), 641-661.

Srhoj, V., Rogulj, N., Padovan, M., & Katić, R. (2001). Influence of the attack end conduction on match result in handball. *Collegium Antropologicum, 25*(2), 611-617.

Taylor, J.B., Mellalieu, S.D., James, N., & Shearer, D.A. (2008). The influence of match location, quality of opposition and match status on technical performance in professional Sssociation football. *Journal of Sports Sciences, 26*(9), 885-895.

Tucker, W., Mellalieu, S.D., James, N., & Taylor, J.B. (2005). Game location effects in professional soccer. A case study. *International Journal of Performance Analysis in Sport, 5*, 23-35.

Varca, P. (1980). An analysis of home and away game performance of male college basketball teams. *Journal of Sport Psychology, 2*, 245-257.

Volossovitch, A., & Gonçalves, I. (2003). The significance of game indicators for winning and losing team in handball. E. Müller, H. Schwameder, G. Zallinger & V. Fastenbauer (Eds.), *Proceedings of the 8th Annual Congress of European College of Sport Science* (pp. 335). Salzburg: ECSS.

Vuleta, D., Milanović, D., & Sertić, H. (2003). Relations among variables of shooting for a goal and outcomes of the 2000 Men's European Handball Championship matches. *Kinesiology, 35*(2), 168-183.

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