2018, *Retos, 33,* 228-232
 ISSN: Edición impresa: 1579-1726. Edición Web: 1988-2041 (www.retos.org)

Game-Related Statistics in the Spanish Water Polo League: Differences between Seasons

Estadísticas de partido en la Liga Española de Waterpolo: Diferencias entre temporadas

María del Carmen Iglesias Pérez, Enrique García Ordóñez, Carlos Touriño González
Universidad de Vigo (España)

Abstract: The aim of this study was to identify the differences between seasons in men´s water polo regular competition by analysing the changes of game-related statistics. The sample comprised 88 games from the Spanish Professional Water Polo League (2011-2014). The game-related statistics were clustered into five groups: attacks in relation to the different playing situations, shots in relation to the different playing situations, attacks outcome, origin of shots and technical execution of shots. Univariate (ANOVA, Kruskal-Wallis and Generalized Linear Model tests) and multivariate (Discriminant) analyses were used to compare seasons, and statistical significance and effect sizes of the differences between seasons were calculated for the game-related statistics. The data were compositional data, therefore the variables were modified with additive log-ratio transformation. During the 2011-2012 season, the teams had significantly higher averages in even attacks ($p<.01$) and shots from zone 3 ($p<.05$). In the 2013-2014 season, teams had significantly higher averages in counterattack ($p<.001$), counterattack shots ($p<.01$), shots from zone 6 ($p<.05$) and 4 ($p<.05$). The variables that best distinguished between seasons were counterattack shots, counterattack, shots from zone 6 and 3, and even attacks. The group that best discriminated among seasons was «Origin of shots» (46.5% original sample and 42.3% cross-validation). The increase in counterattacks and in zone 6 shots seems to indicate a trend towards faster games and greater relevance of the centre forward. These findings can contribute to a better understanding of the evolution of water polo performance indicators, helping the coaches to prepare the players accordingly.
Keywords*:* Performance indicators, performance profile, discriminant analysis, compositional data analysis.

Resumen: El objetivo de este estudio fue identificar las diferencias entre temporadas para las estadísticas de juego en waterpolo masculino. La muestra consistió en 88 partidos de la Liga Española de Waterpolo (2011-2014). Las estadísticas de juego fueron agrupadas en cinco grupos: ataques según las diferentes situaciones de juego, lanzamientos según las situaciones de juego, resultado del ataque, origen de lanzamiento y ejecución técnica de lanzamiento. Se aplicaron varios métodos estadísticos, univariantes (ANOVA, Kruskal-Wallis y Modelo Lineal Generalizado) y multivariantes (análisis discriminante) para comparar las estadísticas entre las diferentes temporadas, calculándose diferencias significativas y tamaños del efecto. Debido a la existencia de datos composicionales, las variables fueron transformadas utilizando la función log-cociente aditiva. Se observó que durante la temporada 2011-2012 los equipos realizaron más ataques en igualdad ($p<.01$) y lanzamientos desde zona 3 ($p<.05$). En la temporada 2013-2014, realizaron más contraataques ($p<.001$), lanzamientos en contraataque ($p<.01$) y lanzamientos desde zona 6 ($p<.05$) y 4 ($p<.05$). Las variables que mejor discriminaron entre temporadas fueron los contrataques, lanzamientos en contrataque, lanzamientos de zona 6 y 3, y ataques en igualdad. El grupo que mejor discriminó entre temporadas fue «Origen de lanzamiento» (46,5% muestra original y 42,3% validación cruzada). El aumento de contraataques y lanzamientos de zona 6 parecen indicar una tendencia hacia juegos más rápidos y mayor relevancia del boya. Estos hallazgos pueden contribuir a mejorar el conocimiento de la evolución de los indicadores de rendimiento en waterpolo, ayudando a los entrenadores para preparar a sus jugadores de acuerdo a estos cambios.
Palabras clave: Indicadores de rendimiento, perfil de rendimiento, análisis discriminante, análisis datos composicionales.

Introduction

Modern water polo has very little in common with the original game that originated from England. Almost every aspect of the game has been changed since its inception over a hundred years ago (Donev & Aleksandrovic, 2008). During the last few years, the rules of water polo have been changed on numerous occasions. The basic intention behind all the changes was to accelerate the pace of the game to make it more entertaining for spectators (Lozovina & Lozovina, 2009). The augmented speed and rapid fire play greatly enhances the spectacle of water polo and the changes in training arise from the evolution of expert and scientific cognitions in the field of kinesiology in sports (Lozovina & Lozovina, 2009). It seems reasonable to ask whether these changes have an influence on the performance of the teams. The main aim of the performance analysis is to identify the strengths and weaknesses of the teams to improve their performance (Carling, Williams & Reilly, 2005). A performance indicator is a selection, or combination, of game-related statistics that aims to define some or all the aspects of a performance. The values of the performance indicators are influenced for many factors which can change through the time. For example, in handball (a sport similar to water polo), Jiménez, Espina & Manchado (2017) indicated that the quality of the shots is influenced by psychological aspects (González & Valádez, 2016), training methods and technique improvement (Pascual, Alzamora, Martínez & Pérez, 2015), as well as the control of the training load and rest periods (Reynoso-Sánchez, Hernández-Cruz, López-Walle, Rangel-Colmenero, Quezada-Chacón & Jaenes-Sánchez, 2016; González-Fimbres, Griego, Cuevas-Castro & Hernández, 2016; Murillo, Álvarez & Manomelles, 2016). Some of these elements are trainable with specific programs based on the improvement of strength, specificity and speed (Van den Tillar, 2004) and can modify the performance.

Since the literature on performance analysis in water polo is recent, for now the available research has tried to identify the performance characteristics of the game for both men´s and women´s competitions (Escalante, Saavedra, Mansilla & Tella, 2011; Escalante, Saavedra, Tella, Mansilla, García & Domínguez, 2012; Escalante, Saavedra, Tella, Mansilla, García & Domínguez, 2013; Lupo, Condello & Tessitore, 2012a). García, Touriño & Iglesias (2015) identified the offensive performance indicators that discriminated between match score (favourable, balanced or unfavourable) in the regular seasons (2011-2014). They observed that favourable games had averages that were significantly higher for counterattack attacks and shots, goals, and shots from zone 5 and 6, whereas unfavourable games had significantly higher averages in even attacks and shots, no goal shots, and shots originated from zone 3 and 4. In the same way, they identified the offensive performance indicators that distinguished the top clubs from the others (Iglesias, García & Touriño, 2016), which were counterattacks, even attacks, penalties, goals, no goals shots and shots from zone 2, 3, 4, 5 and 6, drive shots and shots after 2 flakes. Moreover, these authors identified groups of offensive performance indicators in water polo which best distinguished between match score (García, Iglesias & Touriño, 2016), and they found that the group that most discriminated between match score was «Attacks Outcome», while the performance indicators that most discriminated were goals, counterattack attacks and counterattack shots. However, in water polo few studies have focused on analysing the change of game-related statistics between seasons, unlike what had happened in other sports (Meletakos, Vagenas & Bayios, 2011). Considering the need to observe and describe the behaviour of game-related statistics over different seasons, the aim of the current study was to identify differences of offensive performance indicators between seasons from 2011-2014 in the Spanish Water Polo League.

Fecha recepción: 10-03-17. Fecha de aceptación: 04-09-17
María del Carmen Iglesias Pérez
mcigles@uvigo.es

Material and Methods

Participants

The sample comprised 88 games from the first Spanish Water Polo League in the regular seasons 2011-2012, 2012-2013 and 2013-2014. Furthermore, 47 games were balanced and 41 unbalanced (difference of the final score higher than 3 points). This sample represents the 22.2% of all the matches played.

Teams were the same during the three seasons, and 10 teams were represented: Barceloneta (62.7 points), Sabadell (48 points), Terrassa (49.3 points), Canoe (38 points), Mataró (37.7 points), Mediterrani (34.7 points), Navarra (26 points), San Andreu (27.7 points), Barcelona (27.3 points) and Cataluña (24 points). Taking into account the mean of the points obtained during the three seasons (shown in parentheses), Barceloneta was always the highest level team, clearly outperforming the following classified ones. The last four teams showed a weak level.

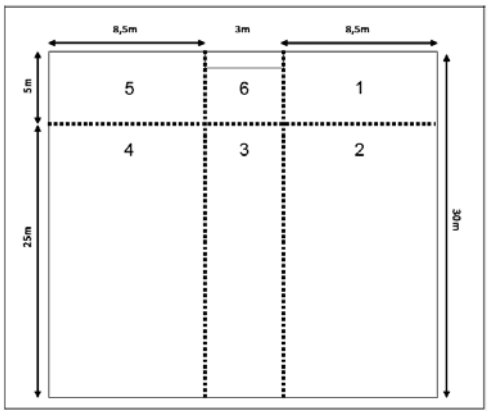

Figure 1.
Schema of the division of the court according to 6 zones (Lupo, et al., 2012a)

Measures

Independent variables

The study analysed 26 game-related statistics, which were selected in agreement with the study by García et al. (2015), and also used by different researchers (Hraste, Dizdar & Trninic, 2010; Escalante, et al., 2012; Lupo, et al., 2012a; Lupo, Condello & Tessitore, 2014). These game-related statistics (defined in Table 1) were clustered in five groups: «Attack Situation», «Shot Situation», «Outcome», «Zone» and «Flakes». Considering that the variables of each group (Table 1) had a constant sum which equals 100%, the data were compositional data. Based on Aitchison (1986) the variables of each composition were transformed with log-quotient transformation between the parts (specifically, additive log-ratio (alr) transformation) and applying a discriminant analysis with the transformed variables. For example, in the group «Attack Situation» the variables EA, PO, CO and PE were transformed in: log(PO/EA), log(CO/EA), and log(PE/EA). EA was chosen as denominator due to its higher variance and mean.

Dependent variable

The variable season was used to compare the 26 game-related statistics described previously. The seasons were 2011-2012, 2012-2013 and 2013-2014.

Procedures

The matches were recorded by a video camera positioned at a side of the pool, at the level of the midfield line. A match analysis system (LongoMatch, System version 0.20.8, Barcelona, Spain) was used for the notational analysis, which was carried out by the authors of this work.

To assess data reliability three games were randomly selected and two different observations were done to evaluate intra-observer reliability. As for the game-related statistics, the obtained Cohen´s Kappa was high (0.97).

Statistical analysis

The basic descriptive statistics (mean, standard deviation, median) were calculated separately for each season. Normal distribution was checked with the Kolgomorov–Smirnov and Shapiro-Wilk tests. To compare the distribution of the variables different tests were used: One-way ANOVA was used to compare means, Kruskal-Wallis test was used to compare medians and GLM with binomial response was used for the percentage variables. A significance level of 5% was considered. Moreover, Bonferroni post hoc pairwise comparisons were performed after ANOVA analyses with significant effects.

Subsequently, the results were subjected to a discriminant analysis to identify which game-related statistics best distinguished between the seasons; thus, two discriminant functions were obtained. Indicators with structure coefficients (SC1, SC2) values > 0.30 were considered relevant when their SC belonged to a significant discriminant function. The dependent variable was the season, and the independent variables were those giving p-value < 0.05 in the one dimensional tests. The eigenvalue, the canonical correlation index, Wilk´s lambda, and the percentage of right classification were used to measure the discriminant power. The homogeneity assumption was evaluated with the Box´s M test. To deal with the problem of essential zeros in the log-quotient transformation of the variable PE, two analyses have been made: for matches with penalties and for matches without penalties. For groups «Shot Situation» and «Outcome», we have used the same methods to transform the compositional data and to deal with the zeros. The groups «Zone» and «Flakes» presented only one analysis with all the matches due to the non-essential zeros. The log-transformation improved the normality of the variables allowing the use of models that assume normality, such as the discriminant analysis. All statistical analyses were performed using SPSS software release 18.0 (SPSS Inc., Chicago, IL, USA).

Table 1.
List of game-related statistics clustered in five groups.

Groups	Performance indicator	Definition
Attacks in relation to the different playing situations ("Attack Situation")	% Even attacks (EA)	Percentage of even attacks respect to total attacks
	% Power-play (PO)	Percentage of power-play attacks respect to total attacks
	% Counterattack (CO)	Percentage of counterattack respect to total attacks
	% Penalties (PE)	Percentage of penalties attacks respect to total attacks
Shots in relation to the different playing situations ("Shot Situation")	% Even shots (ES)	Percentage of even shots respect to total shots
	% Power-play shots (POS)	Percentage of power-play shots respect to total shots
	% Counterattack shots (COS)	Percentage of counterattack shots respect to total shots
	% Penalties shots (PES)	Percentage of penalties shots respect to total shots
Attacks outcome ("Outcome")	% Goals (G)	Percentage of goals respect to total attacks
	% No goal shots (NG)	Percentage of no goal shots respect to total attacks
	% Exclusions (EX)	Percentage of exclusions achieved respect to total attacks
	% Penalties achieved (PEAC)	Percentage of penalties achieved respect to total attacks
	% Offensive fouls (OF)	Percentage of offensive fouls respect to total attacks
	% Lost possessions (LP)	Percentage of lost possessions respect to total attacks
Origin of shots (see Figure 1) ("Zone")	% Shots zone 1 (S1)	Percentage of shots originated from zone 1 respect to total shots
	% Shots zone 2 (S2)	Percentage of shots originated from zone 2 respect to total shots
	% Shots zone 3 (S3)	Percentage of shots originated from zone 3 respect to total shots
	% Shots zone 4 (S4)	Percentage of shots originated from zone 4 respect to total shots
	% Shots zone 5 (S5)	Percentage of shots originated from zone 5 respect to total shots
	% Shots zone 6 (S6)	Percentage of shots originated from zone 6 respect to total shots
Technical execution of shots ("Flakes")	% Drive shots (DS)	Percentage of drive shots respect to total shots
	% Shots after 1 flakes (S1F)	Percentage shots after 1 flake respect to total shots
	% Shots after 2 flakes (S2F)	Percentage of shots after 2 flakes respect to total shots
	% Shots more than 2 flakes (SM2F)	Percentage of shots more than 2 flakes respect to total shots

Results

Table 2 presents basic descriptors of the game-related statistics per season (2011-2012, 2012-2013 and 2013-2014), together with the corresponding one dimensional tests results. There were six variables (statistics) that differed between seasons. The game-related statistics with statistically significant differences between seasons were CO (p<.001), EA (p<.01), COS (p<.01), S3 (p<.05), S4 (p<.05), S6 (p<.05). Looking at the post-hoc comparisons, the third season presented significant differences from the other two (in CO, EA and S3), from the first one (COS) and from the second season (S4). In addition, there was a significant difference in the means of S6 between the first and second seasons.

Table 2.
Basics statistics (mean ± standard deviation, median) for the percentage (count) variables, ANOVA test (A), Post-hoc differences, Kruskal-Wallis test (K), Generalized Linear Models test (GLM) and effect size (E^2) for the percentage variables between seasons

	2011-2012 (F) (N=61)		2012-2013 (S) (N=64)		2013-2014 (T) (N=51)		A		K	GLM	E^2
	M±SD	Med	M±SD	Med	M±SD	Med	F	Post-hoc	Chi	Chi	
% Even attacks (Count EA)	71.3±7.4(34.6±3.2)	71.0(34.0)	73.0±7.0(36.2±3.4)	72.7(36.5)	67.7±8.5(33.8±3.8)	67.9(34.0)	7.0**	FT, ST	12.2**	19.3***	.075
% Power-play (Count PO)	18.0±4.6(8.8±2.6)	16.7(8.0)	18.1±4.4(9.1±2.7)	19.2(9.0)	17.3±4.7(8.8±3.0)	17.0(9.0)					
% Counterattack (Count CO)	8.5±5.2(4.2±2.8)	8.3(4.0)	7.5±5.0(3.7±2.6)	6.0(3.0)	13.1±6.8(6.6±3.5)	12.2(6.0)	15.7***	FT, ST	27.8***	55.8***	.153
% Penalties (Count PE)	2.2±2.2(1.1±1.2)	2.1(1.0)	1.5±1.6(.7±.8)	1.8(1.0)	1.9±2.2(.9±1.1)	1.9(1.0)					
% Goals (Count G)	16.6±6.3(8.1±3,.2)	16.0(8.0)	18.0±5.6(9.0±2.8)	18.2(9.0)	17.7±7.2(8.9±3.8)	17.4(8.0)					
% No goal shots (Count NG)	38.1±7.6(18.5±3.6)	38.3(18.0)	36.9±7.1(18.4±4.0)	35.8(18.0)	37.5±8.8(18.8±4.5)	36.2(19.0)					
% Exclusions (Count EX)	17.3±4.1(8.4±2.3)	17.0(8.0)	17.0±3.8(8.5±2.3)	17.3(9.0)	16.3±4.6(8.3±2.8)	16.1(8.0)					
% Penalties achieved (Count PEAC)	2.2±2.2(1.1±1.2)	2.1(1.0)	1.4±1.6(7±.8)	1.8(1.0)	1.9±2.1(1.0±1.1)	2.0(1.0)					
% Offensive fouls (Count OF)	10.0±4.2(4.8±2.1)	9.4(5.0)	10.7±5.0(5.3±2.4)	10.8(5.0)	10.4±4.6(5.1±2.2)	10.0(5.0)					
% Lost possessions (Count LP)	16.0±5.0(7.8±2.5)	16.0(8.0)	16.1±6.0(7.9±2.8)	15.5(8.0)	16.1±6.4(8.0±3.0)	15.1(8.0)					
% Even shots (Count ES)	57.8±13.1(15.4±4,.1)	59.1(15.0)	57.9±11.6(15.8±3.5)	56.6(15.0)	55.7±11.7(15.3±3.8)	54.2(14.0)					
% Power-play shots (Count POS)	29.3±9.9(7.7±2.5)	27.6(7.0)	28.5±8.2(7.8±2.5)	28.8(8.0)	27.9±9.7(7.8±2.9)	26.7(8.0)					
% Counterattack shots (Count COS)	8.8±7.9(2.4±2.3)	7.4(2.0)	11.0±7.6(3.0±2.2)	9.7(3.0)	13.2±8.4(3.7±2.6)	12.5(3.0)	4.2*	FT	12.2**	14.9**	.047
% Penalties shots (PES)	4.2±4.3(1.1±1.2)	3.7(1.00)	2.6±2.8(.7±.8)	3.1(1.0)	3.5±4.1(.9±1.1)	3.4(1.0)					
% Shots zone 1 (Count S1)	8.6±5.8(2.3±1.6)	7.7(2.0)	7.1±5.3(1.9±1.4)	6.9(2.0)	8.0±4.9(2.2±1.4)	8.3(2.0)					
% Shots zone 2 (Count S2)	17.3±6.4(4.6±1.7)	16.1(5.0)	18.8±8.3(5.1±2.4)	19.2(5.0)	18.9±7.9(5.2±2.2)	17.9(5.0)					
% Shots zone 3 (Count S3)	30.9±9.6(8.2±2.8)	32.0(8.0)	30.8±9.1(8.4±2.7)	30.4(8.0)	26.9±7.6(7.3±1.9)	26.1(7.0)	3.5*	FT, ST	8.1*	8.9*	.039
% Shots zone 4 (Count S4)	17.1±7.9(4.5±2.1)	16.7(4.0)	14.4±7.4(4.0±2.1)	14.8(4.0)	18.0±8.3(5.0±2.4)	17.4(5.0)	3.4*	ST		8.2*	.038
% Shots zone 5 (Count S5)	10.5±5.8(2.8±1.6)	10.0(3.0)	9.6±6.4(2.6±1.8)	7.6(2.0)	9.6±4.8(2.7±1.4)	9.5(2.0)					
% Shots zone 6 (Count S6)	15.7±8.2(4.2±2.2)	15.4(4.0)	19.6±9.9(5.4±2.8)	19.7(5.0)	19.1±8.9(5.4±2.8)	17.9(5.0)	3.4*	FS	6.0*	11.1**	.037
% Drive shots (Count DS)	67.4±10.4(18.0±3.9)	68.0(17.0)	65.7±10.5(17.9±3.7)	65.3(17.0)	68.5±10.4(18.8±3.5)	68.2(19.0)					
% Shots after 1 flakes (Count S1F)	21.6±8.4(5.7±2.2)	20.0(5.0)	22.2±8.9(6.1±2.6)	22.0(6.0)	21.0±8.3(5.8±2.5)	20.7(6.0)					
% Shots after 2 flakes (Count S2F)	6.4±5.2(1.7±1.3)	5.0(1.0)	7.0±5.1(1.9±1.4)	6.7(2.0)	6.7±5.2(1.9±1.6)	6.9(2.0)					
% Shots more than 2 flakes (Count SM2F)	4.7±4.0(1.2±1.0)	3.8(1.0)	5.1±4.4(1.4±1.2)	3.8(1.0)	3.9±3.5(1.1±1.0)	3.6(1.0)					

Note: F=First Season; S=Second Season; T=Third Season
* p<.05, ** p<.01, ***p<.001

The results of the discriminant analysis (with the variables that have been significant in the univariate tests) are presented in Table 3. The discriminant functions classified correctly 61.4% (original sample) and 55.7% (cross-validation) of the season. In this discriminant analysis, the variables that had higher discriminatory power were COS (SC=.725), S6 (SC=.680), CO (SC=.636), S3 (SC=-.424) and EA (SC=-.384).

Table 3.
Results of a discriminant analysis between seasons with the variables that have been significant in the univariate tests

	SEASON	
	Structure coefficients	
	SC1	**SC2**
% Even attacks (EA)	**-.384**	
% Counterattack (CO)	**.544**	**.636**
% Counterattack shots (COS)		**.725**
% Shots zone 3 (S3)		**-.424**
% Shots zone 4 (S4)		
% Shots zone 6 (S6)		**.680**
Box´s M	74.318 (p-value=.004**)	
Eigenvalue	.505	.079
Canonical Correlation Index	.579	.270
Wilk´s Lambda	.616	.927
Sig	.000***	.024*
	% Correct Classification (Original sample)	**% Correct Classification (Cross-validation)**
% 2011-12 season	54.1	49.2
% 2012-12 season	71.9	65.6
% 2013-14 season	56.9	51.0
% classification	61.4	55.7

Only SC > 30 are displayed; *$p<.05$, **$p<.01$, ***$p<.001$

The results of the analysis (with alr transformed variables) are presented in Table 4, for each group (Table 1). Considering all measures of discriminant power (percentage of right classification is specifically showed), in matches with penalties, the group «Zone» provided the best qualifying (46.5% for the original sample, and 42.3% for cross-validation), followed by the group «Attack Situation» (43.4% for original sample, and 40.4% cross-validation), «Shot Situation» (43.6% for original sample, and 39.4% cross-validation), «Outcome» (43.4% for original sample, and 31.7% cross-validation) and «Flakes» (32.4% for original sample, and 27.8% cross-validation). In matches without penalties, the results were similar. Moreover, Table 4 shows that out of 11 variables corresponding to groups «Attack Situation», «Outcome» and «Shot Situation», only six of them had SC > .30 in matches with penalties, and out of eight variables corresponding to groups «Attack Situation», «Outcome» and «Shot Situation», only five variables showed SC >.30 in matches without penalties. The groups «Zone» and «Flakes» had five variables with relevant SC (> .30).

Table 4.
Discriminant analyses between the seasons for each group (see Table 1) with log-transformed variables for matches with penalty (P) and without penalty (S)

		Structure coefficients		Eigenvalue				Wilk´s Lambda				Box	% Original sample	% Cross-validation
		SC1	SC2	Eigenvalue		Can. Corr.		Lambda		Sig.		Sig.	TOTAL	TOTAL
Attack Situation	**log(PO/EA^P)**		**.612**	.184	.013	.384	.114	.834	.987	.008**	.539	.106	43.4	40.4
	log(CO/EA^P)	**.774**	**.593**											
	log(PE/EA^P)	**.489**	**-.615**											
	log(PO/EA^S)		**.990**	.253	.017	.449	.128	.785	.984	.003**	.293	.614	46.5	42.3
	log(CO/EA^S)	**.968**												
Outcome	**log(G/NG^P)**		**.638**	.109	.013	.314	.115	.890	.987	.339	.865	.078	43.6	31.7
	log(EX/NG^P)													
	log(PEAC/NG^P)	**.569**												
	log(OF/NG^P)		**-.398**											
	log(LP/NG^P)	**.505**	**.393**											
	log(G/NG^S)	**.610**	**-.388**	.072	.019	.259	.136	.915	.981	.632	.729	.434	45.9	37.8
	log(EX/NG^S)													
	log(OF/NG^S)	**.742**												
	log(LP/NG^S)	**.563**	**.644**											
Shot Situation	**log(POS/ES^P)**		**-.683**	.095	.054	.295	.226	.866	.949	.044*	.094	.038*	43.6	39.4
	log(COS/ES^P)	**.846**	**.360**											
	log(PES/ES^P)	**-.393**	**.424**											
	log(POS/ES^S)		**.988**	.084	.008	.278	.091	.915	.992	.220	.464	.649	39.7	39.7
	log(COS/ES^S)	**.902**	**.432**											
Zone	**log(S1/S6)**	**.387**		.076	.047	.266	.212	.888	.955	.090$^+$	.179	.591	46.5	42.3
	log(S2/S6)													
	log(S3/S6)	**.729**												
	log(S4/S6)	**.490**	**.415**											
	log(S5/S6)	**.598**												
Flakes	**log(S1F/DS)**			.015	.008	.120	.090	.978	.992	.884	.656	.708	32.4	27.8
	log(S2F/DS)	**.866**												
	log(SM2F/DS)		**.966**											

Only SC > 0.30 are displayed; * p<.05, ** p<.01, ***p<.001

Discussion

To the best of our knowledge, this is the first study to analyse differences of game-related statistics between seasons in a regular competition of water polo. The results of the initial univariate analysis identified the counterattack attacks and shots (increase), shots originated from zones 4 and 6 (increase), even attacks (decrease), and shots originated from zone 3 (decrease), as significant game-related statistics, while in the subsequent discriminant analysis the following variables were found to discriminate in relation to season: counterattack attacks and shots, shots from zone 6, shots from zone 3 and even attacks.

These results suggest that water polo is trending towards faster paced games due to increased counterattacks, and more relevance of the centre forward located in zone 6. In the same

way, Lozovina and Lozovina (2009) showed the basic intention behind all the changes was to accelerate the pace of the game and make it more entertaining for spectators. These developments lead us to believe that the teams who have adapted to these changes have achieved better results. In fact, García et al., (2015) found that the counterattack attacks and shots, shots originated from zone 6 were significantly higher for favourable games, supporting this idea. In the same line, Bilge (2012), in handball, found that the technical variables contributing to the superiority of European teams over other teams show that the fast break, pivot position and back court position efficiencies indicate that handball increasingly requires players to be quicker, more dynamic, versatile in both attack and defence, technically qualified, able to play at each position at least for a short time and to have excellent game perception.

Another line of sports-related research has focused on analysing changes, both physical as morphological (Pavicic, Lozovina & Lozovina, 2011; Lozovina, et al., 2012), aiming to identify a player profile. Although they are lines that handle different variables, an interest in observing the evolution of water polo is the link between both researches. The anthropometric characteristics of elite water polo players have changed over the past 28 years analysed, changes in body shape included augmented height, elongated limbs with thinner waist and broader shoulders, increased body mass, and muscle-to-fat mass ratio (Lozovina, et al., 2012). The observed changes are consequences of age-old population trends and sport related morphological adaptation. The results of our investigation about the game-related statistics between seasons reinforce this idea of water polo evolution towards something more physically demanding. Teams now perform with greater physical intensity. An increased number of counterattacks between the seasons that we analysed (2011-2014) gains greater significance when compared with previous studies (Lupo, Minganti, Cortis, Perroni, Capranica & Tessitore, 2012b), in which they observed during the 2005-2006 season in the Italian Serie A1 (similar to the Spanish League) an average of 2±1 counterattacks, accounting for about 4.1%, which is far from the average found in our study 6.6±3.5, equivalent to 13.1% of attacks. The increased of shots from zone 6 (usually the centre forward) indicates that this position is a conductive to offence and that players require more physical training, especially so far as strength is concerned.

As in other sports such as soccer or handball (Rampinini, Coutts, Castagna, Sassi & Impellizzeri, 2007; Bilge, 2012; Barreira, Garganta, Castellano, Prudente & Anguera, 2014; Barnes, Archer, Hogg, Bush & Bradley, 2014; Saavedra, Porgeirsson, Kristjansdottir, Chang & Halldorsson, 2017), water polo developments during this period of time, have led to a faster game with more relevance of the centre forward. The International Swimming Federation (FINA) has currently proposed a rule change, subtract one player from pool, and decrease the size of the ball and of the field dimensions to make the sport more visually appealing. It could be interesting to evaluate the impact of these rule changes in the frequency and success of game-related statistics and compare the future results with those obtained in this paper.

This study presents reference values of game-related statistics and shows those aspects of the game in which there are differences between seasons in water polo. These results contribute to a better understanding of the determinant game-related statistics of the elite water polo performances around different seasons, thus helping coaches to prepare their players accordingly. For example, if a notational analyst or coach has identified that some aspects of performance are changed between seasons, so that consequently the player´s preparation for the match can be focused on reducing such effects.

This study has some limitations. Firstly, although the sample is the largest one used in a water polo research that performs such a thorough analysis of the game-related statistics, the sample is not random because the difficulty in obtaining the videos. Also, only the ten teams that have remained in the top category during the three seasons have been considered, and it would have been convenient to include all available teams.

Secondly, in order to achieve a more complete analysis, the score of the match and the level of the teams should be taken into account.

Thirdly, we recognize that three seasons are insufficient to confirm a trend, however we believe the results found in this study are identifying the variables that will be relevant to confirm that future trend.

Conclusion

The aim of this study was to identify the differences between seasons in men´s water polo regular competition by analysing the changes of game-related statistics.

Firstly, the results seem to indicate that the water polo is heading for a faster paced game due to increased counterattacks, and towards more relevance of the centre forward, located in zone 6.

Secondly, the importance of these factors is related to changes in the teams´ and players´ activities as a response to trends of the water polo game-related statistics in the different seasons.

Thirdly, coaches should take into account these findings in order to improve the quality of technical, tactical and physical training.

References

Aitchison J. (1986). *The statistical analysis of compositional data*. Monographs on Statistics and Applied Probability. London: Chapman and Hall Ltd.

Barnes C., Archer D.T., Hogg B., Bush M., & Bradley P.S. (2014). The evolution of physical and technical performance parameters in the English Premier League. *International Journal of Sports Medicine, 35*(13), 1095-1100.

Barreira D., Garganta J., Castellano J., Prudente J., & Anguera M.T. (2014). Evolución del ataque en el fútbol de élite entre 1982-2010. *Revista de Psicología del Deporte, 23*(1), 139-146.

Bilge M. (2012). Game Analysis of Olympic, World and European Championships in Men´s Handball. *Journal of Human Kinetics, 35*, 109-118.

Carling, C., Williams, A. M., & Reilly, T. (2005). *Handbook of soccer match analysis: A systematic approach to improving performance*. New York Routledge, London.

Donev Y., & Aleksandrovic M. (2008). History of rules changes in water polo. *Sport Science 1*(2), 16-22.

Escalante Y., Saavedra J.M., Mansilla M., & Tella V. (2011). Discriminatory power of water polo game-related statistics at the 2008 Olympic Games. *Journal of Sports Sciences, 29*(3), 291-298.

Escalante Y., Saavedra J.M., Tella V., Mansilla M., García A., & Dominguez A.M. (2012). Water-Polo game-related statistics in Women´s International Championships: Differences and discriminatory power. *Journal of Sports Science and Medicine, 11*(3), 475-482.

Escalante Y., Saavedra J., Tella V., Mansilla M., García A., & Domínguez A.M. (2013). Differences and discriminatory power of Water-Polo game-related statistics in men in international championships and their relationship with the phase of the competition. *Journal of Strength & Conditioning Research, 27*(4), 893-899.

García E., Touriño C., & Iglesias M.C. (2015). Offensive performance indicators in a regular season of Water-Polo. *International Journal of Performance Analysis in Sport, 15*(3), 114-1123.

García E., Iglesias M.C., & Touriño C. (2016). Performance Assessment in Water Polo Using Compositional Data Analysis. *Journal of Human Kinetics, 54*(3), 143-151.

González Fimbres, R., Griego Amaya, H., Cuevas Castro, C., & Hernández Cruz, G. (2016). Influence of training load volume and intensity on heart rate recovery. *Retos. Nuevas Tendencias en Educación Física, Deporte y Recreación, 30*, 180-183.

Gonzalez Hernández, J., & Valadez Jimenez, A. (2016). Personality and psychological response in atheletes. Temporal and adaptive representation of the person-sport process. *Retos. Nuevas Tendencias en Educación Física, Deporte y Recreación, 30*, 211-215.

Hraste M., Dizdar D., & Trninic V. (2010). Empirical verification of the weighted system of criteria for the elite Water Polo player quality

evaluation. *Collegium Antropologicum, 34*(2), 473-479.
Iglesias M.C., García E., & Touriño C. (2016). Keys to Success in High Level Water Polo Teams. *International Journal of Performance Analysis in Sport, 16*(3), 995-1006.
Jiménez, J. M., Espina, J. J., & Manchado, C. (2017). Análisis histórico de la efectividad de los lanzamientos a portería de balonmano masculino. *Retos. Nuevas Tendencias en Educación Física, Deporte y Recreación, 32*, 228-232.
Lozovina M., & Lozovina V. (2009). Attractiveness lost in the water polo rules. *Sport Science, 2*, 85-89.
Lozovina M., Lozovina V., & Pavicic L. (2012). Morphological changes in elite male water polo players: survey in 1980 and 2008. *Acta Kinesiologica, 6*(2), 85-90.
Lupo C., Condello G., & Tessitore A. (2012a). Notational analysis of elite men´s Water Polo related to specific margins of victory**.** *Journal of Sports Science and Medicine, 11*(3), 516-525.
Lupo C., Condello G., & 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.
Lupo C., Minganti C., Cortis C., Perroni F., Capranica L., & Tessitore A. (2012b). Effects of competition level on the centre forward role of men´s Water-Polo. *Journal of Sports Sciences, 30*(9), 889-897.
Meletakos, P., Vagenas, G., & Bayios, I. (2011). A multivariate assessment of offensive performance indicators in Men´s Handball: Trends and differences in the World Championships. *International Journal of Performance Analysis in Sport, 11*, 285-295.
Murillo Lorente, V., Álvarez Medina, J., & Manomelles Marqueta, P. (2016). Control of training loads through perceived exertion. Prediction of heart rate. *Retos. Nuevas Tendencias en Educación Física, Deporte y Recreación, 30*, 82-86.
Pascual, N., Alzamora, E. N., Martínez Carbonell, J. A., & Pérez Turpin, J. A. (2015). Analysis of different teaching methods in Young soccer players. *Retos. Nuevas Tendencias en Educación Física, Deporte y Recreación, 28*, 94-97.
Pavicic L., Lozovina M., & Lozovina V. (2011). The differences in body physique between two generations of elite water polo players (1995-2008). *Sport Science, 4*(2), 48-54.
Rampinini E., Coutts A., Castagna C., Sassi R., & Impellizzeri F. (2007). Variation in Top Level Soccer Match Performance. *International Journal of Sports Medicine, 28*(12), 1018-1024.
Reynoso-Sánchez, L., Hernández-Cruz, G., López-Walle, J., Rangel-Colmenero, B., Quezada-Chacón, J., & Jaenes-Sánchez, J. (2016). Recovery-stress balance throughout a season in volleyball university players. *Retos. Nuevas Tendencias en Educación Física, Deporte y Recreación, 30*, 193-197.
Saavedra, J. M., Porgeirsson, S., Krisjansdottir, H., Chang, M., & Halldorsson, K. (2017). Handball game-related statistics in men at Olympic Games (2004-2016): Differences and discriminatory power. *Retos. Nuevas Tendencias en Educación Física, Deporte y Recreación, 32*, 260-263.
Van den Tillaar, R. (2004). Effect of Different Training Programs on the Velocity of Overarm Throwing: A brief review. *Journal of Strength and Conditioning Research, 18*(2), 388-396.